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Final

AQUATIC BASELINE ECOLOGICAL RISK ASSESSMENT

Bonita Peak Mining District Superfund Site

San Juan County, COLORADO

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Attachments

Attachment 1 Upper Animas Baseline Ecological Risk Assessment

Attachment 2 Draft Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment Biological Technical Assistance Group Comments and Agency Reponses.

Attachment 3 Additional and Revised Upper Animas Baseline Ecological Risk Assessment (BERA) Analysis Tables to Support Assimilating Results with the Aquatic BERA Risk Characterization Summaries.

LIST OF ABBREVIATIONS AND ACRONYMS

ARSG	Animas River Stakeholders Group
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	area use factor
BERA	baseline ecological risk assessment
BMI	benthic macroinvertebrate
BPMD	Bonita Peak Mining District
BRK	brook trout
BTAG	biological technical assistance group
BW	body weight
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CETIS	Comprehensive Environmental Toxicity Information System
cm	centimeter
CMP	conceptual monitoring plan
CO	Colorado
COPEC	contaminant of potential ecological concern
CDPHE	Colorado Department of Public Health and the Environment
CPW	Colorado Parks and Wildlife
CSM	conceptual site model
CTE	central tendency exposure
CTT	cutthroat trout
DF	dietary fraction
DL	detection limit
DM	dissolved metals
DO	dissolved oxygen
DW	dry weight
EcoSSL	ecological soil screening level
EDD	estimated daily dose
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
EPT	combined Ephemeroptera, Plecoptera, and Tricoptera taxa
ESA	Endangered Species Act
ESAT	Environmental Services Assistance Team
ESV	ecological screening value
EU	exposure unit
FIR	food ingestion rate
GKM	Gold King Mine
H’	Shannon-Weaver Diversity Index
HBI	Hilsenhoff Biotic Index
HI	hazard index
HQ	hazard quotient
LANL	Los Alamos National Laboratory

LOAEL	lowest observable adverse effect level
LOC	brown trout (Colorado Parks and Wildlife species code)
m	meter
MDEQ	Michigan Department of Environmental Quality
MDL	maximum detection limit
mg/kg	milligrams per kilogram (parts per million)
mg/kg-d	milligrams per kilogram per day
mg/kg BW-d	milligrams per kilogram body weight per day
mg/L	milligrams per liter
mL	milliliter
MMI	multi-metric index
MSI	Mountain Studies Institute
NPL	National Priorities List
NOAEL	no observable adverse effect level
RBT	rainbow trout
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
SGC	Sunnyside Gold Corporation
SIR	sediment ingestion rate
SLERA	screening-level ecological risk assessment
STIC	stream temperature, intermittency, relative conductivity logger
T&E	threatened and endangered
TL	total length
TRM	total recoverable metals
TRV	toxicity reference value
TVS	table value standard
UAA	use attainability analysis
UCL	upper confidence limit
UF	uptake factor
µg/L	micrograms per liter
USFWS	United States Fish Wildlife Service
USGS	United States Geological Survey
WB	whole body
WHO	World Health Organization
WIR	water ingestion rate
WQC	water quality criteria
WQS	water quality standard
WW	wet weight
WWTP	waste water treatment plant

EXECUTIVE SUMMARY

ES.1 Introduction

The United States Environmental Protection Agency (EPA) is conducting an aquatic baseline ecological risk assessment (Aquatic BERA) to characterize exposure and risks in aquatic-dependent ecological receptors associated with potential natural and anthropogenic contamination sources originating from the Bonita Peak Mining District (BPMD) located in unincorporated San Juan County, Colorado (CO). The BPMD is an approximate 150 square mile mining district located in and just outside of the extensively mineralized Silverton Caldera basin near the town of Silverton, CO. The basin was subject to both large and small mining operations in boom and bust fashion from 1871 to 1991. Years of mining and mine waste disposal practices as well as naturally mineralized areas contaminated aquatic habitats in and around the BPMD. In April 2016, EPA added 48 BPMD mine features to the National Priorities List (NPL). This addition formally initiated the remedial investigation/feasibility study (RI/FS) process which includes conducting risk assessments.

EPA uses information obtained from human health and ecological risk assessments to help guide risk management decisions in selecting and implementing cleanup actions as part of the RI/FS process. Decisions are, in part made after considering risk characterization information and associated uncertainties and biases. The current Aquatic BERA provides an objective overview of risks in which specific river reaches or exposure units (EUs) can be comparatively evaluated. This information is useful during the beginning or scoping stages of the RI/FS process for such a large and complex site. While information provided herein supports the formal RI/FS process, the scale of the assessment area limits application of results to individual sources of contamination in the BPMD. EPA plans to use risk information in conjunction with long-term surface water and sediment data, collected from monitoring stations throughout the BPMD, to prioritize and evaluate potential remedial actions at individual NPL mine features.

The Aquatic BERA characterizes ecological risks to benthic macroinvertebrates (BMIs), fish, and aquatic wildlife receptors exposed to sediments, water, and dietary items potentially contaminated by mine wastes and naturally mineralized materials within select BPMD watershed river reach EUs. The Aquatic BERA builds on the previous Upper Animas BERA that was originally posted as a draft in April 2015. The Upper Animas BERA assesses risks to aquatic ecological receptors in lower Mineral Creek, Cement Creek, and the Animas River just up- and downriver of Silverton, through the Animas Canyon to Bakers Bridge. The current Aquatic BERA assesses risks to aquatic-dependent ecological receptors throughout the Mineral Creek watershed, the Animas River watershed above the town of Silverton, and an approximate 20-mile reach of the Animas River downriver from Bakers Bridge that extends through the City of Durango (Durango Reach). The Upper Animas BERA was finalized and is attached to this Aquatic BERA (**Attachment 1**). Together, these two assessments provide continuous characterization of aquatic receptor risks from exposure to mine-related and natural sources of

contamination from the headwaters of the BPMD to about 70 river miles down the Animas River through the City of Durango.

A total of 27 separate EUs are evaluated in the Aquatic BERA (**Figure ES-1** and **ES-2**). Environmental data collected from one or two fixed, long-term environmental sampling locations in each BPMD EU are used to estimate exposures. The two longer Durango Reach EUs are represented by four to five sampling locations. Environmental chemistry data collected at these locations are used for estimating exposure to mine-related and natural sources of contaminants (metals and acidity) by aquatic receptors. EUs were selected to represent unique local exposure conditions that occur up- or down-gradient from major tributaries or other environmental features that could affect exposure. EUs were selected in the Aquatic BERA work plan with input from the biological technical assistance group (BTAG) members. The following are brief descriptions of the EUs evaluated in the Aquatic BERA organized by major watershed features:

Mineral Creek watershed: A total of eight EUs are established in the Mineral Creek watershed (**Figure ES-1**). These EUs include four mainstem reaches from the Animas River confluence to its headwaters (EU-01 through EU-04 going in an upstream direction) and four Mineral Creek tributaries; two of which are considered reference reaches (EU-R1 and -R2) that are expected to have limited mining influence. The two non-reference tributaries are South Fork Mineral Creek (EU-05) that enters mainstem Mineral Creek at the upstream end of EU-01 and Middle Fork Mineral Creek (EU-06) that enters mainstem Mineral Creek at the upstream end of EU-02. The two reference tributaries are Bear Creek (EU-R1) and Mill Creek (EU-R2) located at the approximate bottom and top of the Mineral Creek watershed, respectively.

Animas River watershed above Silverton: A total of 16 mainstem and tributary EUs are established in this portion of the Animas River watershed (**Figure ES-1**). Working in an upriver direction, EU-07 begins near the Arrastra Creek confluence, ends at the Cunningham Creek (EU-08) confluence, and continues upriver with EU-09 just above the Maggie Gulch confluence. The next mainstem EU is EU-10 which extends from Maggie Gulch up to the South Fork Animas River confluence in Eureka. The South Fork Animas River sub-watershed has three EUs. The upper South Fork Animas River (EU-11) starts at the confluence with Eureka Gulch (EU-12) and South Fork Animas River and continues upstream to the headwaters of South Fork. EU-13 is the reach between mainstem Animas River and Eureka Gulch. EU-14 is on the mainstem Animas River and starts at the South Fork Animas River confluence. EU-14 ascends out of the Animas valley up to the West Fork Animas River at Animas Forks. The West Fork Animas River sub-watershed contains three EUs starting with EU-15 which begins at the Animas River confluence and continues up to the Placer Gulch (EU-16) confluence. EU-17 (California Gulch) is on the West Fork Animas River above Placer Gulch. EU-18 is on the North Fork Animas River, that begins at Animas Forks and continues up to the Burrows Gulch confluence. EU-19 is on Burrows Gulch from its confluence with the North Fork Animas River upstream to its source. Three reference EUs are also located in the Animas River watershed above Silverton, namely Maggie Gulch (EU-R3), Picayne Gulch (EU-R4), and Upper North Fork Animas River (EU-R5).

Animas River - Durango Reach: The Durango Reach is evaluated using two separate mainstem EUs and one reference EU; EU-DR01, EU-DR02, and EU-R6 (**Figure ES-2**). The upper, EU-DR01 reach begins at James Ranch and continues downriver to 32nd Street Bridge at the northern edge of the City of Durango. The lower, EU-DR02 reach continues from 32nd Street Bridge, downriver through Durango to Purple Cliffs which is located at the southern edge of the city. One reference EU is located in the Durango Reach, namely lower Hermosa Creek (EU-R6) which enters the Animas River about 1 river mile downstream from James Ranch (the upriver boundary of EU-DR01).

ES.2 Assessment and Measurement Endpoints

Assessment endpoints represent explicit expressions of the key ecological resources to be protected from site contamination. Measurement endpoints represent measurable ecological characteristics, quantified through predictive exposure/effects analyses and laboratory and field studies, which can be related back to the valued ecological resources chosen as the assessment endpoints. Respective endpoints are selected after developing and evaluating a conceptual site model (CSM).

The CSM identifies major sources of contamination in the BPMD which are associated with natural sources and past mining activities in the watersheds of Mineral Creek, Cement Creek, and the Animas River above Silverton. Soils and mineralized rock within the BPMD naturally contain high levels of metals and represent non-mining related sources of contamination in local drainages. While mining has not occurred in the BPMD since 1991, mine wastes associated with past mining activities are scattered throughout the environment.

Potential contaminants at this site include 20[a] heavy and essential metals, metalloids, and low pH. These contaminants are either directly or indirectly related to historic mining and waste-management activities. Contaminants are released from natural and mine-impacted areas into downgradient surface water features and ultimately accumulate in bed sediments and plant and animal tissues. As such, ecological receptors can be directly exposed to contaminants in surface water, sediment, streambed pore water, and contaminants incorporated into the tissues of wildlife dietary items. The CSM identifies the following complete exposure routes:

- Direct contact of BMIs with sediment,
- Direct contact of BMIs with pore water,
- Direct contact of fish and water-column invertebrates with surface water,
- Ingestion of surface water by aquatic wildlife receptors,
- Incidental ingestion of sediment by wildlife receptors, and

[a] Contaminants of interest (not including low pH) include; aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc.

- Ingestion of contaminated prey items by wildlife receptors.

Seven assessment endpoints are selected, and one to four measurement endpoints are evaluated for each assessment endpoint. Multiple measurement endpoints are evaluated for some assessment endpoints and in these cases, this BERA did not attempt to prioritize endpoints with respect to one another since each endpoint provides an independent evaluation of risks and has uniquely inherent strengths and weaknesses. The following are descriptions of assessment endpoints and associated measurement endpoints that are evaluated in the Aquatic BERA:

- Assessment Endpoint #1: Maintain a stable and healthy BMI community

Four measurement endpoints are evaluated to assess the potential impacts of metals and pH to BMI communities. These endpoints consist of 1) comparing concentrations of metals in EU sediment samples to no- and low-effect sediment ecological screening values (ESVs); 2) comparing concentrations of metals and pH in EU pore water samples to acute and chronic water ESVs (hardness-adjusted as needed); 3) assessing the toxicity of field-collected sediment samples using the freshwater amphipod *Hyalella azteca* exposed for 10 days in the laboratory; and 4) assessing the BMI communities and associated habitats in the field.

Sediment chemistry data were obtained from field samples collected between October 2012 to September 2017. Pore water chemistry data were obtained from field samples collected between April 2014 to October 2016. The sediment samples used for the 10-day amphipod toxicity tests were collected in October and November 2012, September 2014, October 2016, and September 2017. BMI community surveys were conducted in the fall of 2015 and 2016. All data were generated using EPA-approved sampling and analysis plans and quality assurance/project plans.

- Assessment Endpoint #2: Maintain a stable and healthy water-column invertebrate, fish, and amphibian community

Three measurement endpoints are evaluated to assess the potential impacts of metals and pH to water-column communities, namely: 1) comparing concentrations of metals in EU surface waters to acute and chronic surface water ESV, 2) assessing the acute toxicity of field-collected surface water samples to juvenile rainbow trout exposed for 96 hours in the laboratory, and 3) assessing the presence or absence of fish and the quality of fish habitats in the field.

Surface water chemistry data were obtained from field samples collected between February 2010 to September 2017. Surface water samples were analyzed for total recoverable metals (TRMs) and dissolved metals (DMs). DM results for calcium and magnesium were used to determine water hardness for each surface water sample. Field-measured surface water pH data was also collected when collecting surface water samples. The surface water samples used in the juvenile rainbow trout toxicity tests were collected in October 2012, November 2012, April 2013, and October 2016. The majority of field-based fish habitat and fish community surveys were

conducted during fall 2016 Historic fish survey information collected since 1975 supplemented fall 2016 surveys.

- Assessment Endpoint #3: Maintain stable and healthy aquatic-dependent invertivorous bird populations

One measurement endpoint is evaluated to assess the potential impacts of metals to American dipper (*Cinclus mexicanus*). This evaluation uses metal concentrations measured in surface water, sediment and BMI tissue in a food chain model to calculate metal-specific estimated daily doses (EDDs) for comparison against avian no- and low-effect dietary toxicity reference values (TRVs). The American dipper is selected as a surrogate receptor for the aquatic-dependent invertivorous bird populations, but also to represent the southwestern willow flycatcher (*Empidonax traillii extimus*) which is a federal- and state-endangered bird species that may occur in the study area.

The EDDs are calculated using a standard food chain model based on measured metal concentrations in sediment and surface water and measured or estimated metal concentrations in dietary items. BMI tissue chemistry data are obtained from samples collected between October 2012 to October 2016, but the majority of BMI tissue samples are collected during the fall 2016 BMI community survey. BMI tissue chemistry data are available for most EUs. When BMI tissue data are unavailable, concentrations of metals in tissue are estimated using site-specific or literature-sourced sediment-to-invertebrate bioaccumulation models or uptake factors (UFs). Literature-sourced ingestion rates are used to develop exposure estimates specific to the American dipper.

- Assessment Endpoint #4: Maintain stable and healthy aquatic-dependent omnivorous bird populations

One measurement endpoint is evaluated to assess the potential impacts of metals to the mallard (*Anas platyrhynchos*). This evaluation uses metal levels in surface water, sediment, BMI tissues, and plant tissues in a food chain model to calculate metal-specific EDDs for comparison against avian no- and low-effect dietary TRVs.

EDDs are calculated using a standard food chain model, measured metal concentrations in surface water and sediment, and measured or estimated metal concentrations in dietary items as described for American dipper. Plant tissue chemistry samples were not collected. Therefore, all plant tissue metals concentrations are estimated using literature-sourced soil-to-plant bioaccumulation models or UFs (note: soil-to-plant bioaccumulation models or UFs are used because sediment-to-plant bioaccumulation models or UFs are not available).

- Assessment Endpoint #5: Maintain stable and healthy aquatic-dependent piscivorous bird populations

One measurement endpoint is evaluated to assess the potential impacts of metals to the belted kingfisher (*Ceryle alcyon*). This evaluation uses metal levels in surface water, sediment, and fish tissue in a food chain model to calculate metal-specific EDDs for comparison against avian no- and low-effect dietary TRVs.

The EDDs are calculated using a standard food chain model and measured metal levels in surface water and sediment and measured or estimated concentrations in dietary items as described for other wildlife receptors. Not all BPMD EUs support fish (United States Geological Survey [USGS], 2018). However, the Aquatic BERA assumes that fish are present everywhere so that piscivorous wildlife risks could be evaluated for each of the 27 EUs. Forage fish tissue chemistry data are only available for four EUs, namely Mineral Creek below Mill Creek (EU-03), South Fork Mineral Creek (EU-05), Mill Creek (EU-R2), and in the Animas River between Cunningham Creek and Maggie Gulch (EU-09). Therefore, fish tissue metals concentrations are estimated for the remaining EUs using site-specific or literature-sourced sediment-to-fish bioaccumulation models or UFs.

- Assessment Endpoint #6: Maintain stable and healthy aquatic-dependent herbivorous mammal populations

One measurement endpoint is evaluated to assess the potential impacts of metals to the muskrat (*Ondatra zibethicus*). This evaluation uses metal levels in surface water, sediment, and aquatic plants in a food chain model to calculate metal-specific EDDs for comparison against mammal no- and low-effect dietary TRVs.

The EDDs are calculated using a standard food chain model and measured metal levels in surface water and sediment, and estimated concentrations in dietary items as described for other wildlife receptors.

- Assessment Endpoint #7: Maintain stable and healthy aquatic-dependent piscivorous mammal populations

One measurement endpoint is evaluated to assess the potential impacts of metals to the raccoon (*Procyon lotor*). This evaluation uses metal levels in surface water, sediment, and fish in a food chain model to calculate metal-specific EDDs for comparison against mammal no- and low-effect dietary TRVs.

The EDDs are calculated using a standard food chain model and measured metals levels in surface water and sediment, or estimated concentrations in dietary items as described for piscivorous birds.

ES.3 Assessment Methods

The Aquatic BERA follows EPA guidance for conducting ecological risk assessments (EPA, 1997; 1998). This process includes identifying contaminants of potential ecological concern (COPECs) for all environmental media prior to being evaluated in the risk characterization phase. COPECs are identified by calculating hazard quotients (HQs) based on dividing the maximum-detected concentrations (or ½ the maximum detection limit for non-detects) for each of the 20 contaminants of interest and pH (when applicable) measured in sediment, pore water, and surface water by the most conservative no-effect sediment ESVs or chronic surface water ESVs for each EU. HQs are not derived using pH data but instead, pH measurements are compared to the lower Colorado Department of Public Health and the Environment ([CDPHE], 2017c) Class 1 cold-water biota pH range threshold of 6.5. A contaminant of interest is selected as a COPEC when the HQ is equal to or greater than 1.0, or if pH is lower than 6.5. All bioaccumulative contaminants of interest are automatically retained as wildlife COPECs for evaluation in food chain modeling.

Individual COPEC risks are quantified using the HQ method. HQs are derived by comparing the exposure estimates to no- and low-effect sediment ESVs, acute and chronic surface water ESVs, pH toxicity benchmarks, or dietary-based bird and mammal no- and low-effect TRVs. The exposure estimates consist of reasonable maximum exposure [RME] and central tendency exposure [CTE] exposure point concentrations [EPCs] for sediment, pore water, and surface water, or estimated wildlife exposures from ingesting dietary items, sediment, and surface water. EPCs are calculated using ProUCL software. RMEs consist of 95% upper confidence limit (UCL) of the mean, or maximum values if UCLs cannot be calculated. CTEs are average COPEC concentrations measured in environmental samples collected from each EU.

HQs are calculated using the following general equations:

$$HQ = EPC/ESV \text{ (for BMIs, water-column invertebrates, and fish)}$$

or

$$HQ = EDD/TRV \text{ (for the wildlife receptor species)}$$

Where:

HQ = Hazard quotient (unitless)
EPC = RME and CTE exposure point concentration (µg/L or mg/kg)
EDD = RME and CTE estimated daily doses (mg/kg body weight [BW]-day)
ESV = No- or low-effect sediment ecological screening value and acute or chronic surface water ESV (mg/kg or µg/L, respectively)
TRV = No- or low-effect bird or mammal toxicity reference value (mg/kg BW-day)

Risks are evaluated by generating four HQs for each COPEC and receptor group: (1) RME/no-effect ESV or TRV, (2) RME/low-effect ESV or TRV, (3) CTE/no-effect ESV or TRV, and (4) CTE/low-effect ESV and TRV. A similar set of HQs are generated for surface water COPECs,

except HQs are derived using acute and chronic surface water ESVs. HQs are not used to quantify pH risks. Risks from pH exposure are assessed by determining if the pH falls above or below the CDPHE (2017c) threshold of 6.5 and other literature-based toxicity thresholds.

The Aquatic BERA evaluates surface water risks of each surface water COPEC by hydrologic period (i.e., pre-runoff [January to April], runoff [May and June], and post-runoff [July to December]) which includes calculating hydroperiod-specific hardness-dependent water ESVs for those metals whose toxicity vary depending on surface water hardness (CDPHE, 2017c; Michigan Department of Environmental Quality ([MDEQ], 2015). This approach allows for a comprehensive evaluation of risks associated with water quality and chemistry attributes unique to each hydrologic period.

ES.4 Risk Characterization

The risk characterization of the Aquatic BERA integrates exposure and effects to determine the likelihood of adverse effects for each assessment endpoint, receptor group, and COPEC. The final HQ-based risk characterization focuses on CTE-based low-effect ESV or TRV HQs and chronic water ESV HQs. Even though it is understood that risk does not increase in a linear fashion with increasing HQs, HQs are described in the context of relative risk as follows;

- CTE low-effect ESV or TRV HQs >1.0 but <5.0, which to corresponds to low risk;
- CTE low-effect HQs >5.0 but <10.0, which to corresponds to moderate risk; or
- CTE low-effect HQs >10.0, which to corresponds to high risk.

Since pH is not quantifiable using HQs, respective risks are based on the series of low pH ESVs obtained from Robertson-Bryan, Inc. (2004). These ESVs are;

- pH of 5.5 (low risk threshold), which corresponds to the lower pH limit for general fish protection;
- pH of 5.0 (moderate risk threshold), which corresponds to mortality of some life stages of certain fish species and reduced primary productivity of freshwater aquatic ecosystems, and;
- pH of 4.4 (high risk threshold), which corresponds to the lower toxic limit for trout.

The Aquatic BERA also uses information obtained from laboratory toxicity tests, aquatic community surveys (fish and BMIs), and habitat surveys to assess risk measurement endpoints. Toxicity testing provides an opportunity to assess risks associated with complex mixtures of metals found in BPMD sediments and surface water to sensitive organisms under controlled conditions. Field surveys provide an integrated health measure of the current aquatic community in each EU with respect to population (fish) and community (BMIs) structure, and habitat quality. **Table ES-1** summarizes the risk characterization results for the 12 endpoints at the 27 EUs, including reference reaches. Note that this table also incorporates risk characterization

results from previously assessed Cement Creek and Animas River reaches from the EPA (2015c) Upper Animas BERA (Attachment 1). These results are included so that risks could be easily compared among all EUs and risk measurement endpoints.

BMI risk characterization summary:

- The highest sediment HQs are lead, manganese, and zinc. Silver, iron and arsenic CTE low-effect HQs are comparably lower, but still above 1.0 in a few EUs. Cadmium and copper HQs are relatively low, except in Placer Gulch (EU-16).
- Toxicity tests show that sediments collected from most of the BPMD EUs are toxic to amphipods after 10 days of exposure. Amphipods exposed to the Durango Reach sediments have generally higher survival and biomass than those exposed to the BPMD EU sediments.
- Analysis of sediment and pore water samples collected during the sediment toxicity tests indicate that amphipods are exposed to high levels of aluminum, cadmium, iron, lead, manganese, and zinc which exceed their respective low-effect and chronic ESVs. Low pH in the overlying test water is also present in tests with high metals concentrations and low amphipod survival.
- Instream habitat assessments found that most BPMD BMI survey locations are dominated by cobble-sized substrates. Higher-elevation and higher-gradient EUs have abundant boulder-sized substrates. Many of the BPMD EUs have embedded substrates that are cemented or covered with metal precipitates and biofilm mats. The Durango Reach instream habitats are very diverse and ranged from large fast-flowing stretches of river dominated by cobble and gravel substrates near James Ranch, slower meandering stretches dominated by sand and silt near Oxbow Park and 32nd Street Bridge, to urban stretches in the City of Durango with diverse substrates near Rotary Park and the Lightner Creek confluence. The diversity of BPMD and Durango Reach instream habitats is expected given that the assessments spans a very large geographical area from high-elevation erosional headwater to low-elevation depositional reaches.
- BMI community surveys show that a high proportion of upper Animas River watershed and Mineral Creek EUs are impaired as shown by low multi-metric index (MMI) scores (CDPHE, 2010). Aquatic life use designation impairment is not seen in any of the six reference EUs. The Durango Reach surveys indicate that BMI communities in this reach are also impaired. While found in low densities, some EUs support relatively sensitive Plecoptera and Tricoptera taxa that can be valued forage for invertivorous fish and wildlife.

Water-column invertebrate, fish, and amphibian risk characterization summary:

- The highest acute surface water HQs are associated with zinc, cadmium, aluminum, copper, and manganese. The highest chronic surface water HQs are associated with aluminum,

cadmium, zinc, iron, copper, lead, and manganese. Low pH is also a potential risk driver but generally occurred together with high metals concentrations.

- Zinc and cadmium risks are highest in the mainstem Animas River reaches, tributaries and gulches located upgradient from the South Fork Animas River confluence; specifically, in EU-14 through EU-19. Zinc and cadmium risks in Mineral Creek are generally an order of magnitude lower than those observed in the upper Animas River EUs. Risks from aluminum exposure are greatest in Animas River reaches above South Fork Animas River confluence, as well as Middle Fork Mineral Creek (EU-06) and in mainstem Mineral Creek, downstream from the confluence with Middle Fork Mineral Creek (EU-01 through EU-03). Localized moderate- and high-level risks associated with cadmium, zinc, and aluminum are observed in the upper North Fork Animas River reference EU (EU-R5). However, exposure to metals in surface water from the BPMD reference reaches generally result in low-level risk.
- Analysis of the surface water HQs derived for the two Durango Reach EUs do not identify risks from acute surface water exposures. However, chronic surface water HQs suggest that aquatic communities in these two EUs may experience some low- to moderate-level risks from TRMs, particularly aluminum and iron, during runoff conditions. The combination of high concentrations of metals and low surface water hardness during runoff in the Durango Reach indicate that seasonal risk to aquatic communities might occur.
- Hydroperiod-based HQ analyses indicate that surface water risks to aquatic communities in the BPMD EUs are highly dependent on water hardness and pH (for aluminum only) which modify the respective water ESVs.
- Toxicity testing results show that surface water samples collected from the most-contaminated EUs are acutely toxic to juvenile rainbow trout. Test waters collected from EUs with the highest acute water HQs and the lowest pH measurements also show the lowest trout survival. These EUs are located in the upper Animas River tributary reaches above Animas Forks (EU-15 through -19), Middle Fork Mineral Creek (EU-06), and lower mainstem Mineral Creek (EU-02). The most recent lower mainstem Mineral Creek (EU-01) test conducted in October 2016 had higher survival (73%), more natural pH water, and lower HQs than seen in November 2012 and April 2013 tests.
- Fish habitat surveys assessments indicate that not all BPMD aquatic habitats would be able to support all trout life history stages (from eggs to adults) or native cutthroat trout recruitment due to physical habitat limitations and/or low water temperatures. The lowest-quality habitats occur in upper Animas River and Mineral Creek watershed EUs. However, the most optimal instream habitat within these EUs is of sufficient quality to support larger juvenile and adult brook trout. Lower-elevation EUs should be able to support all trout species if not impacted by past mining activities, weathering of mineralized rock and soil, or other uncharacterized impacts.
- The fall 2016 and historic fish surveys show that large areas of the BPMD do not support trout. The Animas River EUs above the South Fork Animas River confluence are devoid of

fish (except for the North Fork Animas River reference EU-R5 above Burrows Gulch). Fishless reaches also have typically the highest surface water acute and chronic HQs for cadmium, zinc, and aluminum and the lowest juvenile rainbow trout toxicity test survivals.

- The Durango Reach fish community is comprised of at least three trout species (i.e., rainbow trout, brook trout, and brown trout) and native sculpin, sucker, and dace species (Colorado Parks and Wildlife, 2014; 2015; 2016). Although this reach is subject to frequent and heavy trout stocking events, available age-length frequency analyses data indicate that trout and sensitive native fish species are naturally reproducing in both Durango Reach EUs. These observations suggest that risks to the Durango Reach fish community are relatively lower when compared to those observed in most of the BPMD EUs located further upriver in the BPMD.

Wildlife receptor risk characterization summary:

- Lead risks are identified for the American dipper foraging in most of the EUs evaluated in this BERA, including the two Durango EUs and two reference EUs (Mill Creek EU-R2 and upper North Fork Animas River EU-R5). The greatest lead risks are observed in Placer Gulch (EU-16) and lead exposure risks continue into the downgradient West Fork (EU-15) and mainstem Animas River reaches. Lead risks are also elevated in the mainstem Mineral Creek EUs. Copper risks are identified for dipper in many of the BPMD EUs but are substantially lower than those for lead. Copper risks do not follow a discernable spatial pattern and are not identified in any of the Durango Reach EUs or reference EUs.
- The risks from dietary exposure to metals in the mallard are generally low and only identified for lead in a few highly contaminated BPMD EUs, specifically in Placer Gulch (EU-16), upper mainstem Mineral Creek (EU-04), and mainstem Animas River between Arrastra Gulch and Cunningham Creek (EU-07).
- The belted kingfisher may be at high risk from lead exposure in Placer Gulch (EU-16). Low to moderate lead risks occur in the West Fork and mainstem Animas River EUs, as seen with the American dipper. Low-level lead risks are also observed in upper and lower mainstem Mineral Creek (EU-02 and -04), but not in the two Durango Reach EUs or any of the six reference EUs. Low-level risks to kingfisher are also identified for selenium exposure in various Mineral Creek and most Animas River mainstem and tributary reaches. Selenium risks are also observed in the upper Durango Reach (EU-DR01) and Hermosa Creek reference EUs.
- Moderate lead risks are observed for muskrat foraging in Placer Gulch (EU-16). Low-level lead risks are observed in EUs downgradient from Placer Gulch (EU-15 and -14). No lead risks are identified for muskrat in any Durango Reach or reference EUs. Low-level risks are observed for copper in Placer Gulch (EU-16) and for selenium in lower mainstem Mineral Creek (EU-01).

- Risks to raccoon are limited to lead and selenium in a few EUs. These include low-level risks from lead exposure in Placer Gulch (EU-16) and lower West Fork Animas River (EU-15) and low-level selenium risk in lower Mineral Creek (EU-01).

Summary of major uncertainties

Uncertainty is an inherent feature of any BERA because many assumptions must be made in order to proceed with the evaluation. These assumptions can affect all or some aspects of an assessment, including the CSM development, effects analyses, exposure analyses, and risk characterization. The Aquatic BERA contains an uncertainty analysis that identifies and discusses the major assumptions and potential biases associated with them. Below are summaries of the major uncertainties;

- The upper Animas River watershed reaches above the Mineral Creek confluence may never have supported healthy and diverse aquatic life communities, even before mining activities started in the 19th century (Church *et al.*, 1999). Since these habitats may have always been naturally impaired, risks identified in this BERA may not reflect negatively on current conditions in affected waterways. This situation represents a major uncertainty, which will be considered as part of any future risk management decision-making and likely require site-specific evaluation of background conditions and respective impacts to aquatic receptors. Despite this uncertainty, it appears highly likely that BPMD mining activities have substantially increased aquatic receptors exposure to metals at levels beyond those that would have occurred without mining.
- Many of the EUs in this BERA are represented by environmental chemistry data collected at a single monitoring location. While many of these locations are situated towards the downstream end of each EU, sampling results may not reflect the EU as a whole and could fail to identify variability in risks associated with contamination hot spots within an individual EU. This scenario represents an unknown but significant uncertainty, especially in the large heterogeneous EUs such as upper South Fork Animas River (EU-11) and Middle Fork Mineral Creek (EU-06) that have discrete sources of metals contamination. In these cases, exposure estimates obtained from a single downgradient monitoring location may be biased high when compared to locations situated above contamination sources. It should be recognized that over 200 additional surface water and sediment monitoring locations are located throughout the BPMD and not assessed herein. These monitoring locations are strategically situated to characterize various mine features, contaminant sources, and tributary influences and will be used to support future RI/FS planning activities.
- The exposure estimates for surface water, pore water, sediment, and dietary items are derived from relatively small datasets for select EUs. Small EU-specific datasets are particularly pervasive in pore water exposure assessments. For EUs with small datasets (three to five data

points), a UCL-based RME cannot always be derived and maximum values are used instead. The RME and CTE exposure estimates are the same for the EU datasets that contain only one observation. Assessing risks based on limited datasets reduces the level of inference that can applied to the affected EUs. Co-evaluation of multiple lines of evidence associated with each risk assessment endpoint can greatly reduce this uncertainty.

- Silver in surface and pore water is retained as a COPEC for community-level aquatic receptors for many EUs even though this metal was not measured above its detection limits in all but a single surface water sample. When silver is not detected, the screening-level HQs are calculated using half of the highest maximum detection limit (MDL) divided by the hardness-dependent chronic benchmark. Chronic benchmarks are often lower than half of the MDL which result in elevated HQs (>1.0). It is not known whether or not risks from chronic silver exposure exist since the actual concentrations of silver in these samples are not available. Again, co-evaluation of multiple lines of evidence associated with each risk assessment endpoint can greatly reduce this uncertainty.
- The risk characterization does not identify COPECs or assess aquatic community-level risks to BMIs and fish from exposure to aluminum, antimony, barium, beryllium, cobalt, iron, molybdenum, and vanadium in pore water for the two Durango Reach EUs because pore water samples collected in this reach were not analyzed for TRM. Therefore, it is unknown if exposure to these metals pose any risks to the aquatic communities in these two EUs. However, other lines of evidence suggest that the pore water in the Durango EUs might not be significantly impacted by metals. For example, high pore water HQs are only identified for copper and manganese in these EUs. Also, only a few of these metals (barium, iron, and vanadium) are identified as sediment COPECs in the two Durango EUs and all sediment-based low-effect HQs are low (<2.0). In summary, the lack of TRM analytical data in pore water from the two Durango EUs potentially represents an uncertainty although it does not appear that the missing data would substantially change the conclusions of this BERA for these reaches.
- Risk to community-level and wildlife receptors is assessed using a metal-by-metal HQ analysis. The HQs are not summed to calculate a hazard index (HI), because this approach would assume that metals toxicity is additive. It is not anticipated that all of the COPECs evaluated in the Aquatic BERA would exert their toxic effects on one and the same biological function, which is a basic requirement for calculating HIs. Therefore, risks associated with mixed metal exposures are not evaluated using individual HQ-based risk endpoints. Note, however, that this BERA considers toxicity testing and field survey-based endpoints which provide a way to characterize integrated (i.e., cumulative) risks for BMIs and fish.
- Only one benthic species (the amphipod *H. azteca*) was used for the sediment toxicity tests. Even though this species is considered sensitive to metals exposure, it is not known how much more or less sensitive it is compared to the benthic invertebrate species expected to be

present in the EUs evaluated in this BERA. At a minimum, the fact that the amphipods detected significant toxicity in all but eight of the 41 field-collected sediment samples show that the test species is sensitive to the chemical conditions found in those samples.

- All of the sediment toxicity tests lasted for 10 days, which is not long enough to represent the longer-term chronic exposures expected to be experienced by the BMIs in the field. In addition, the two toxicity endpoints evaluated in the tests (i.e., survival and biomass) do not assess reproductive effects, which can be quite sensitive. Because reproductive effects can occur at lower exposures, and more severe effects were found at the majority of the tests, it is not expected that additional toxicity testing for chronic and reproductive effects would provide additional information about incidence of toxicity, except potentially in the eight EUs where 10-day toxicity tests failed to identify toxicity.
- Sediment toxicity tests exposed amphipods to field-collected sediments and clean overlying laboratory water. This exposure scenario does not reflect actual field conditions where overlying surface waters can influence sediment chemistry. This scenario has potential to influence sediment, overlying water, and pore water chemistry and contaminant bioavailability during the tests. It is uncertain whether laboratory test exposure conditions were more or less stressful than what would occur in the field. If exposure to native overlying water (in addition to sediments) result in higher pore water metals concentrations, then current tests results may be biased low due to lower metals exposures laboratory-based tests. This uncertainty may be relatively small since other lines of evidence, such as the Mountain Studies Institute ([MSI] 2017b) BMI survey results identify BMI community impairment at sites that have low amphipod survival and biomass.
- Juvenile rainbow trout were used in the surface water toxicity tests. This species is directly relevant to the fish populations found in the Animas River. Rainbow trout (and particularly juvenile life stages) are considered quite sensitive to the presence of metals in surface water. However, 96-hour acute toxicity tests do not assess toxicity from chronic exposures expected to be experienced by fish populations in the Animas River. The lack of an acute response in juvenile rainbow trout at many of the EUs does not imply that a toxic response would not be expected under longer-term chronic exposures in the laboratory. This data gap would have represented a large uncertainty by itself but is partially negated by the results of fisheries surveys, which provides an integrated measure of risks to trout based on real-world exposure conditions. As a result of these two supporting lines of evidence, the uncertainty associated with the lack of chronic toxicity information for juvenile rainbow trout exposed to surface water in the laboratory is considered minimal. Nevertheless, current risks associated with 96-hour acute toxicity tests results are biased low when compared to longer tests or real-world exposure regimens.
- No juvenile trout acute toxicity tests were conducted using surface water samples collected from the two Durango EUs. Therefore, the acute trout toxicity measurement endpoint could not be evaluated in these EUs. This uncertainty is likely minor since other lines of evidence

suggest that the surface water from the Durango EUs is unlikely to be acutely toxic to juvenile trout. A strong supporting line of evidence came from the Colorado Parks and Wildlife (2010; 2014; 2015; 2016a) fish surveys, which have routinely observed trout early life stages and sensitive native fish species throughout the two Durango Reach EUs. Their presence would not likely occur if the surface water was toxic to fish. However, some uncertainty remains as to the health of the native fish species and the role of augmentation of communities from stocking fish in these two EUs.

- Wildlife exposure food chain models rely in part on published sediment-to-biota accumulation regression equations or UFs, instead of field-collected tissue samples, to estimate COPEC levels in BMI, fish, and plant tissues. The evidence presented in this BERA suggests that the literature-derived values for BMIs poorly predict site-specific tissue levels and overestimates tissue concentrations. Fortunately, site-specific sediment-to-invertebrate and sediment-to-fish modeling is possible for some COPECs. When applied, these models greatly reduce this uncertainty. Sediment-to-plant regression models and UFs are derived from soil-to-plant studies because no reliable data have been published to measure sediment-to-plant contaminant uptake. It is not known if or how metals uptake in plants differs between soil and sediment, which results in uncertainty about actual risk to the omnivorous birds and the herbivorous mammals feeding on aquatic plants.
- BMIs were primarily collected for residue analysis in September 2016. These samples provide measured (versus estimated) tissue data for use in the food chain modeling for the American dipper and mallard for most of the EUs evaluated in this BERA. It is not known how much or whether metal levels fluctuate in benthic tissue intra- or inter-annually. Also, with only a single sample to work from within each EU, most of the EU RME and CTE concentrations used in EDD calculations are identical to each other. While exposure estimates based on measured site-specific sampling reduces uncertainty associated with modeled concentrations, the scale of inference is limited to a single point in time and does not provide a range of possible EPCs. Since the dynamics of BMI metals accumulation is unknown at this time, biases associated with using data from a single point in time is unknown.
- All wildlife exposure modeling assumes that each EU is a wildlife receptor's entire home and forage range (i.e., area use factor [AUF] = 1.0). This assumption may be realistic, given that most EUs are about 1 to 2 river miles in length which is within reasonable home ranges for most of the studied receptors (EPA, 1993). In reality, receptors may migrate from the BPMD to lower elevations during winter months, and wildlife receptors are likely only exposed when rivers and creeks are ice-free. Given the short ice-free season, wildlife exposure may be overestimated. However, it is likely that the length of environmental exposures are longer than those used in toxicity tests used to generate TRVs which may reduce this uncertainty.
- The current exposure estimates assume that enough fish are present throughout the entire study area and available to support piscivorous wildlife receptors. This assumption is not

supported by site-specific fish community survey data, which shows that fish are nonexistent in many EUs and would not be available for consumption by wildlife receptors. As such, risks to piscivorous wildlife in affected EUs may be more hypothetical than real and biased high since they would not be exposed via dietary pathways.

- Wildlife exposure modeling includes sediment ingestion which is often the largest contribution to EDD estimates. The substrate composition of the Animas River above Silverton includes large fractions of gravel, pebble, and small cobble, instead of the fine sands and silts that were targeted during sampling and expected to be accidentally ingested by wildlife receptors during feeding. The actual incidental sediment ingestion may be substantially lower than assumed in the food chain models when site-specific conditions are considered. Given that most wildlife receptor risks estimates are based on fine fraction sediments, this uncertainty may be significant. Therefore, wildlife risks that are driven by sediment contamination may be biased high.
- The wildlife TRVs applied to all birds or mammals are not specific to any particular species. This means that the same COPEC-specific TRVs are used to evaluate risks to the American dipper, mallard, and belted kingfisher. It is unknown how much more, or less, sensitive these three receptors might be compared to the test species employed to generate the TRVs used in this BERA. Using "one-size-fits-all" TRVs creates uncertainty about the actual toxicity of a COPEC to the target wildlife receptor. However, the TRV-derivation process is conservative by design, such that it appears more likely that the wildlife risks are overestimated rather than underestimated. Use of conservative TRVs is justified since the sensitivities of wildlife receptors to site contaminant exposures are largely unknown and any remedial actions based on wildlife risks presented herein should be protective all wildlife species.
- This BERA uses a highly conservative avian low-effect TRV for lead that is the second to lowest bounded dose rate observed among EPA (2005c) toxicity studies that affected bird reproduction. The use of this TRV is justified since the sensitivity of the ecologically important and endangered southwestern willow flycatcher and other avian species is unknown and the use of a conservative TRV is likely protective of any sensitive bird species. However, lead exposure risks to avian receptors are likely biased high for most, if not all, species that occur in the study area.
- The consistent use of conservative assumptions, such as assuming 100% of contaminant bioavailability in food items, assuming that all EUs support wildlife prey, relying on TRVs derived from toxicity tests using soluble or other highly bioavailable fractions of the test chemical, and using conservative sediment-to-biota uptake factors most likely overestimate exposure and risks to the wildlife receptors evaluated in this BERA. As a result, the actual risks to wildlife receptors may be substantially lower than those presented herein.

In summary, the Aquatic BERA assesses community-level risks for invertebrates, fish, amphibians, and species-specific risks for five representative model wildlife species. Risk characterization uses exposure data obtained from sediment, pore water, surface water, and BMI

and fish tissue samples collected from the BPMD and Durango Reach EUs from spring 2009 to fall 2017. Field collected sediments and surface waters were used in laboratory toxicity tests to further assess BMI and fish risks. Together these lines of evidence indicate that BPMD aquatic ecological receptors are at risk from low pH and elevated metals concentrations.

The greatest risks to aquatic community receptors occur in reaches that are directly downgradient from mine features and highly mineralized watersheds. In the Mineral Creek watershed, the greatest risks are associated with high concentrations of lead and zinc in sediments and aluminum and low pH in surface water. Risks are observed in all Mineral Creek EUs but are generally lowest in Mill and Bear Creek reference EUs and highest in EUs downgradient from and in Middle Fork Mineral Creek. In the Animas River watershed above Silverton, sediment risks are driven by lead, manganese, zinc and surface water risks by aluminum, cadmium, zinc, and low pH. The greatest Animas River risks are in the West Fork Animas River watershed followed by respective downgradient EUs downriver to the South Fork Animas River confluence near Eureka. The Durango Reach aquatic receptor risks are substantially lower than those observed in the BPMD EUs but still elevated for lead, manganese, and zinc and aluminum exposure in sediment and surface water, respectively. Wildlife risks are primarily associated with lead exposure and to a lesser extent, copper and selenium.

Toxicity testing generally agrees with HQ-based risk estimates and show that sediment and surface water collected in the most metals-contaminated EUs correspond with low amphipod and juvenile trout survival in laboratory test exposures. BMI community surveys show that all Mineral Creek and Animas River watershed EUs above the South Fork confluence are impaired with low density and diversity metrics. The most impoverished BMI communities are observed in reaches with embedded substrates that are cemented or covered with metal precipitates and biofilm mats. Fish habitat assessments and community surveys targeted the most ideal habitats located in surveyed EUs. Habitat assessments indicate that some BPMD aquatic habitats will not be able to support all trout life history stages and/or native cutthroat trout due to physical habitat limitations and/or low water temperatures. However, the most optimal instream habitat within these BPMD EUs is of sufficient quality to support larger juvenile and adult life-stage brook trout. Lower elevation Durango Reach EUs should be able to support all trout species.

In conclusion, the Aquatic BERA provides a thorough evaluation of aquatic receptor risks associated with natural sources of contamination and mine features within the BPMD using multiple, independent lines of evidence. The BERA also evaluates aquatic community risks in two Durango Reach EUs which are located about 30 miles downriver from the BPMD. This BERA and the attached final Upper Animas BERA (**Attachment 1**) provide a comprehensive assessment of aquatic ecological risks from BPMD contamination throughout the BPMD and the Animas River to about 50 river miles downriver from Silverton, CO.

SECTION 1 GENERAL INTRODUCTION

1.1 Scope

This aquatic baseline ecological risk assessment (Aquatic BERA) assesses risks for aquatic ecological receptors potentially impacted by natural sources and historic mining activities within the Bonita Peak Mining District (BPMD) located in unincorporated San Juan County, Colorado (CO). The BPMD refers to an approximate 150 square mile mining district located in and just outside of the extensively mineralized Silverton Caldera basin near the town of Silverton, CO. The basin was subject to both large and small mining operations in boom and bust fashion from 1871 to 1991. Years of mining and mine waste disposal practices contaminated aquatic habitats in and around the BPMD. In April 2016, the United States Environmental Protection Agency (EPA) added 48 BPMD mine features to the National Priorities List ([NPL]; **Figure 1-1**). Select mine features were added due to their potential for ongoing releases of hazardous substances into the environment and impacts to human and ecological health (EPA, 2016b). Designated as a Superfund site, EPA assumed the authority to investigate and remediate contamination sources to lessen or eliminate impacts to human health and the environment through the remedial investigation/feasibility study (RI/FS) process.

EPA uses information obtained from human health and ecological risk assessments to help guide risk management decisions when selecting and implementing cleanup actions as part of the RI/FS process. Decisions are, in part, made after considering risk characterization information which is documented in BERA reports. Final risk characterization steps integrate exposure and effects data to derive risk estimates for relevant receptors. It is the task for risk managers to objectively assimilate all available risk information and associated uncertainties when evaluating the timing and scope of remediation actions. It is important to recognize that this BERA is not the only source of RI/FS supporting information available to site remediation managers. For example, there's a wealth of environmental data from many more monitoring stations than what's evaluated herein that can be used to assess contamination sources, including background, on a site-by-site basis. This Aquatic BERA provides risk information over a large geographic area in which BPMD NPL mine features reside. It provides an objective overview of risks in which specific river reaches can be comparatively evaluated. This information is useful during the beginning or scoping stages of the RI/FS process for such a large and complex site. In summary, information provided herein supports the formal RI/FS process. However, it should be recognized that the scale of the assessment area limits wholesale application of results to individual sources of contamination in the BPMD.

The current Aquatic BERA characterizes ecological risks to benthic macroinvertebrates (BMIs), fish, amphibians and aquatic wildlife receptors potentially exposed to naturally- and mine waste-contaminated water, sediments, and wildlife dietary items within select BPMD river reaches. This Aquatic BERA builds upon previous risk assessment documents, including the Upper Animas screening-level ecological risk assessment (SLERA) work plan (EPA, 2012b), the Upper Animas SLERA (EPA, 2013b), and the Upper Animas BERA (EPA, 2019). The Upper Animas

BERA remained as a draft, until being finalized with and attached to this BERA. Note that this Aquatic BERA identifies these reports as Upper Animas SLERA and BERA although they do not evaluate risks in the uppermost reaches of the BPMD. This BERA, in conjunction with the attached Upper Animas BERA, provides a complete assessment of aquatic ecological risks from natural and mining-related BPMD contamination sources.

The geographic scope of aquatic risk assessment activities at this site has steadily increased since the first SLERA was released in 2013. This expansion is in part due to the April 2016 BPMD Superfund site designation and the addition of contaminated habitats associated with respective NPL mining features. This Aquatic BERA slightly overlaps with previous assessments but adds over 40 linear miles of aquatic BPMD habitats that had not been previously assessed. Most of these river miles are in the upper Animas River watershed tributaries, gulches, and mainstem reaches upgradient of Silverton, CO, and mainstem Mineral Creek tributaries from the Animas River confluence to its headwaters (**Figure 1-2; Figure 1-3**). While this Aquatic BERA does not specifically assess risks from the Cement Creek watershed and the Animas River between Arrastra Gulch and Bakers Bridge, it does incorporate Upper Animas BERA risk characterization results when summarizing BPMD watershed risks. The final EPA (2019) Upper Animas BERA used very similar risk characterization methods as those used herein and is included in **Attachment 1**. The Upper Animas BERA was drafted using environmental data collected before the August 2015 Gold King Mine (GKM) release. The release was upgradient to most of the river reaches evaluated in the Upper Animas BERA. However, EPA incident reports (2017a; 2018a) indicate that, except for a relatively short period of time, aquatic receptor exposures and invertebrate and fish communities in reaches downgradient from the GKM were not substantially different from those that existed before the release. More information regarding the Upper Animas BERA and EPA's assessments of GKM impacts (EPA, 2017a; 2018a) are summarized in Section 3 of this BERA.

At the request of biological technical assistance group (BTAG), metals exposure and associated risks in the approximate 20-mile Durango Reach of the Animas River below Bakers Bridge through the town of Durango, CO are also evaluated (**Figure 1-4**). Therefore, the current downgradient extent evaluated in this BERA is on the Animas River just downriver from downtown Durango. Below Durango the amount of information on surface water and sediment quality and chemistry in the Animas River is relatively sparse when compared to upriver reaches. Further, the aquatic community changes below Durango to an aquatic community that includes more warmer water species (Zimmerman, 2013). Lastly, the lower section of the Animas River is subject to additional stressors not related to BPMD contamination, including large water diversion withdraws, high water temperatures, and agricultural contaminants (Rodriguez-Freire *et al.*, 2016; San Juan Watershed Group, 2016). All of these attributes complicate the assessment of BPMD-related risks in the Animas River downgradient from Durango.

Risk assessment analysis steps and procedures employed in this Aquatic BERA were developed and refined in the BPMD and Durango Reach BERA work plan and were informed by the technical input of the BPMD BTAG (EPA, 2016d). The work plan relied on information that was available at the time to refine SLERA risk estimates and characterize current and potential

threats to aquatic ecological receptors. The scope of the current Aquatic BERA changed slightly since drafting the work plan. As such, this Aquatic BERA uses assessment methods that slightly deviate from those described in the work plan. Most of these changes increased the scope of this BERA. These deviations are clearly identified throughout this BERA where they occur.

1.2 General ecological risk assessment approach

In addition to the BPMD and Durango Reach BERA work plan (EPA, 2016d), the following standard guidance and reference documents were used to prepare this Aquatic BERA:

- EPA, 1997. *Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final*. Environmental Response Team, Edison, NJ.

- EPA, 1998. *Guidelines for Ecological Risk Assessment*. EPA/630/R-95/002F.

- EPA, 1994. *Selecting and Using Reference Information in Superfund Ecological Risk Assessments*. EPA 540-F-94-05.

- EPA, 2002a. *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites*. OSWER 9285.7-41.

- EPA, 2002c. *Role of Background in the CERCLA Cleanup Program*. OSWER 9285.6-07P

- EPA. 2018e. *Frequently Asked Questions About the Development and Use of Background Concentrations at Superfund Sites: Part One, General Concepts*. 9200.2-141.

EPA protocols (1997) provides the general framework for planning and conducting this risk assessment. Additional EPA protocols (1998) provides guidance on improving the interaction among risk assessors, risk managers, and interested parties during the planning, problem formulation, and risk characterization steps of the risk assessment process to ensure that the final risk assessment will support the RI/FS and future environmental decision-making. This process includes, and is not limited to, engaging and soliciting comments from BTAG members throughout the risk assessment process and expressing risk characterization results in the context of major assumptions, uncertainties, and alternative interpretations. **Attachment 2** of this BERA provides a list of BTAG member comments associated with the complete June 2018 draft Aquatic BERA and EPA's respective responses. Lastly, EPA (1994; 2002a,c; 2018e) provides guidance on how to interpret and report risk results from reference EUs and general background conditions throughout the BPMD.

1.3 Goals and objectives

BMIs, fish, amphibians, and aquatic wildlife represent valued ecological resources to be protected from contamination currently present in the BPMD assessment area. Identification of potential risks to these community-level and specific wildlife receptors provided the basis used to develop goals, objectives and select assessment endpoints for this Aquatic BERA (EPA 2013c; 2016d).

The overarching ecological risk management goal for the aquatic portion of the BPMD site is defined as follows:

> "*Promote the health of aquatic community-level receptor groups and aquatic wildlife species that live or forage in the waterways affected by site-related contamination.*"

Four ecological risk assessment objectives were identified to accomplish this goal:

- Identify the presence of site-related contaminants of potential ecological concern (COPECs) that may pose a threat to one or more of the receptor groups;
- Estimate potential exposure to aquatic ecological receptors using the available analytical datasets;
- Develop risk estimates by comparing exposure profiles to toxicological benchmarks and discuss major uncertainties associated with the assessment approaches; and
- Provide risk managers a thorough determination of potential ecological risk to support the risk management decision-making process.

Note that this Aquatic BERA focuses specifically on characterizing risks to aquatic ecological receptors. Risks to terrestrial ecological receptors will be evaluated in a separate terrestrial risk assessment (EPA, 2017g, h, i). Although the future BPMD terrestrial BERA will focus on upland terrestrial ecological receptors, it will also assess risks to a few aquatic wildlife and terrestrial wildlife species that use aquatic habitats. However, in that case, the target wildlife species and their associated exposure pathways will not be the same as those evaluated herein. This assessment strategy enables most of the aquatic receptors for which aquatic exposure data are available to be evaluated now, with an evaluation using terrestrial and semi-aquatic exposure data occurring later. In total, this Aquatic BERA and the future terrestrial BERA will provide complementary assessments of risks for all important ecological receptors or their surrogates potentially impacted by contaminants and other environmental conditions related to BPMD Superfund site mine features.

1.4 Exposure units

This Aquatic BERA assesses risks in 27 separate exposure units (EUs). These EUs are specific river, creek, and gulch reaches located throughout the BPMD and the lower Animas River Durango Reach (**Figures 1-3** and **1-4**). The following BPMD EUs were used in this BERA to facilitate sample collection, exposure calculations, toxicity testing, aquatic community evaluations, data interpretation, and risk characterization. Each of the upper BPMD watershed EUs are described below:

Mineral Creek watershed

- *EU-01 Mineral Creek* - from the confluence with the Animas River upstream to the confluence with South Fork Mineral Creek; represented by sampling locations M34 and M29A
- *EU-02 Mineral Creek* - from the confluence with the South Fork Mineral Creek upstream to the confluence with the Middle Fork Mineral Creek; represented by sampling locations M27 and M27A
- *EU-03 Mineral Creek* - from the confluence with the Middle Fork Mineral Creek upstream to the confluence with Mill Creek; represented by sampling locations M14B and M11
- *EU-04 Mineral Creek* - from the confluence with Mill Creek upstream to the source; represented by sampling location M10A
- *EU-05 South Fork Mineral Creek* - from the confluence with Mineral Creek upstream to the source; represented by sampling location M28
- *EU-06 Middle Fork Mineral Creek* - from the confluence with Mineral Creek upstream to the source; represented by sampling location M20
- *EU-R1 Bear Creek Reference Reach* – Tributary to the Mainstem Mineral Creek entering between mainstem Animas River and South Fork Mineral Creek; represented by sampling location M30.
- *EU-R2 Mill Creek Reference Reach* – Tributary to the Mainstem Mineral Creek entering upstream of Middle Fork Mineral Creek confluence; represented by sampling location M08.

Animas River and tributaries above Silverton, CO

- *EU-07 Animas River* - from the confluence with Arrastra Creek upstream to the confluence with Cunningham Creek in Howardsville; represented by sampling locations A55 and A56
- *EU-08 Cunningham Creek* - from the confluence with the Animas River upstream to the source; represented by sampling location A48
- *EU-09 Animas River* - from the confluence with Cunningham Creek in Howardsville upstream to the confluence with Minnie Gulch; represented by sampling locations A41A and A45

- *EU-10 Animas River* - from the confluence with Minnie Gulch upstream to the confluence with mainstem South Fork Animas River in Eureka; represented by sampling locations A35 and A40
- *EU-11 Upper South Fork Animas River* - from the confluence with Eureka Gulch upstream to the source; represented by sampling location A36
- *EU-12 Eureka Gulch* - from the confluence with the Upper South Fork Animas River upstream to the source; represented by sampling location A37
- *EU-13 Mainstem South Fork Animas River* - from the confluence with the Animas River in Eureka upstream to the confluence of Eureka Gulch and the Upper South Fork Animas River; represented by sampling location A34
- *EU-14 Animas River* - from the confluence with mainstem South Fork Animas River in Eureka upstream to the confluence with mainstem West Fork Animas River in Animas Forks; represented by sampling locations A14 and A33
- *EU-15 Lower West Fork Animas River* - from the confluence with Placer Gulch downstream to the Animas River; represented by sampling location A10
- *EU-16 Placer Gulch* – from the confluence with the Upper West Fork Animas River upstream to the source; represented by sampling location A20
- *EU-17 Upper West Fork Animas River (California Gulch)* - from the confluence with the with Placer Gulch up to its source; represented by sampling location A15
- *EU-18 North Fork Animas River* - from Animas Fork upstream to the confluence with Burrows Gulch; represented by sampling locations A08 and A09
- *EU-19 Burrows Gulch* - from the confluence with the North Fork Animas River upstream to its source; represented by sampling location A07
- *EU-R3 Maggie Gulch Reference Reach* – Tributary to the Mainstem Animas River entering between Cunningham Creek and South Fork Animas River confluences; represented by sampling location A43
- *EU-R4 Picayne Gulch Reference Reach* – Tributary to the Mainstem Animas River entering downriver from Animas Forks; represented by sampling location A26
- *EU-R5 Upper North Fork Animas River Reference Reach* - North Fork Animas River above Burrows Gulch confluence at the headwaters of the Animas River watershed; represented by sampling location A05

The Durango Reach is about a 20-river mile stretch of the Animas River flowing between James Ranch and Purple Cliffs. The beginning of the Durango Reach is near Bakers Bridge which was the most downriver monitoring site evaluated in the Upper Animas BERA (EPA, 2019). Inclusion of this reach provides continuous characterization of aquatic risks from the Animas River headwaters of the BPMD downriver about 50 river miles through Durango, CO when this and previous risks assessments are considered. The Durango Reach is split into two mainstem Animas River and one tributary reference EUs (**Figure 1-4**). The two mainstem reaches bracket unique lower Animas River habitats; a rural low gradient, sinuous reach and an urban river corridor reach.

The Durango Reach consisted of the following three EUs:

- *EU-DR01 Animas River* - James Ranch just upriver from the Hermosa Creek confluence downriver to the 32nd Street Bridge in Durango; represented by sampling locations James Ranch, 9426, Oxbow Park, and 32nd Street Bridge
- *EU-DR02 Animas River* - 32nd Street Bridge in north Durango to Purple Cliffs, just upriver from the River Road Bridge in south Durango; represented by sampling locations Rotary Park, GKM05, Lightner Creek, AR19-3, and Purple Cliffs.
- *EU-R6 Hermosa Creek Reference Reach* – Tributary to the lower section of Mainstem Animas River entering within the town of Hermosa, CO near James Ranch; represented by sampling locations HC01 and HC02

1.5 Reference and background

Reference EUs (EU-R1 through -R6) were evaluated herein to investigate aquatic receptor risks in areas that were expected to have little to no mining impacts. Reference EUs were selected in cooperation with the BPMD BTAG to represent creek and river reaches that could be reasonably compared to EUs known to be impacted by BPMD NPL sources (EPA, 2016d). Reference EUs represent the most applicable aquatic habitats available in the study area that can be used for this purpose. A few of the Aquatic BERA reference reaches were also assessed by Mast *et al.* (2007) in a background water quality characterization study for the BPMD watershed.

Reference reach receptor exposure and risk assessment information is used to characterize potential background conditions with respect to assessment EUs risks. EPA (2018e) defines reference locations as potential background areas that are not hydrologically connected to the site of interest. In other words, reference areas do not need to be upstream or upgradient from the site being assessed. Given the large assessment area, myriad of mine features within it, and complex underlying geology, characterization of background conditions within EUs is highly uncertain, is highly variable, and best accomplished using location specific analysis (Mast *et al.*, 2007). As such, quantitative analysis of background conditions will be conducted on a site-by-site basis later during the RI/FS process using environmental data collected on a finer geographic scale that used herein. Nevertheless, this Aquatic BERA analyzes reference EU risks using the same methodology as all other BPMD and Durango Reach EUs. This assessment methodology provides a comparative evaluation of potential background risks to cumulative site risks; including discussing and identifying naturally occurring elements that exceed risk-based screening levels. This type of evaluation is in line with EPA (1994; 2002a,c; 2018e) guidance on how background risks are incorporated into ecological risk assessments. A generalized background evaluation is presented in the final risk characterization Section 10 of this BERA and should provide risk managers enough information to begin evaluating their statutory authority under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). As stated above, the geographic scope of this BERA and complexity of natural and anthropogenic contamination sources support a site-by-site evaluation of background contamination which will be conducted later in the RI/FS process.

1.6 Aquatic BERA organization

The remainder of this BPMD Aquatic BERA is organized as follows:

- Section 2: Baseline problem formulation
- Section 3: Summary of previous risk assessments
- Section 4: Conceptual site model (CSM)
- Section 5: Assessment and measurement endpoints
- Section 6: Data processing and baselines ecological effects methods
- Section 7: COPEC selection
- Section 8: Baseline exposure estimates
- Section 9: Risk characterization
- Section 10: Summary and conclusions
- Section 11: References

SECTION 2 BASELINE PROBLEM FORMULATION

2.1 Brief site description and history

The BPMD Superfund site consists of 48 historic mine features (**Figure 1-1**). These mine features are in the upper reaches of the Animas River watershed near Silverton in San Juan County, CO. All NPL features are in or just outside of the extensively mineralized Silverton Caldera basin. Geologic resources in this basin contain large amounts of metals (Storosh, 2013). As such, the area was subject to both large and small mining operations in boom and bust fashion from 1871 to 1991. Ore extraction activities ended after 1991, after which time, numerous reclamation and restoration projects were implemented. However, aquatic receptors may still be at risk from contaminants in and downgradient from BPMD sources. The remainder of this section provides a brief history of mining activities that occurred in the BPMD and summarizes recent events relevant to aquatic risks and site management.

The discovery of gold and silver brought miners to the area in the early 1870s. The discovery of silver in the base-metal ores was the major factor in establishing Silverton, CO as a permanent settlement. Between 1870 and 1889, rich lead-silver galena ore deposits were discovered and mined, mostly using hand tools (Jones, 2007). During this period, all but the highest-grade ores were cast aside in surface mine waste dumps or left in underground mine workings in a process called high grading. High grading was conducted in part due to the difficulties with bringing ore up from and out of the mine workings. The Greene & Co. Smelter opened in Silverton in 1875, which stimulated additional mining activities in the area. The Denver & Rio Grande Railway's San Juan Extension arrived in Durango in July 1881 and Silverton in July 1882. Mining operations greatly expanded with the introduction of rail transportation which allowed ore to get out of, and supplies to get into, the BPMD.

A serious attempt was made during the 1880s and 1890s to mine and concentrate the low-grade ore bodies (Jones, 2007). This was a time when gravity milling became widespread to process low-grade ores into high-grade concentrates. Stamping presses and gravity mills were built across the mining district. Mills used water to separate ores, whereas untreated metal-laden wastes were discharged into streams, rivers, and lakes of the region. Use of aerial trams and new rail lines greatly improved the efficiency of mine-to-mill ore transportation. By 1897, more than 160 mines were documented to be operating in San Juan County (Jones, 2007).

Mining and milling operations slowed down around 1905 and many mines were either permanently closed or consolidated into fewer and larger operations. This is the time when mines, such as Silver Lake and Sunnyside, grew into very large operations and employed up to 400 laborers who worked several thousand linear feet of underground drifts and tunnels. These large, complex mines also excavated long haulage tunnels in lower-elevation mine workings to alleviate water infiltration issues. Haulage tunnels, such as the Unity and Terry tunnels, intercepted and discharged groundwater and left higher-elevation mining workings relatively dry.

The next major expansion in the BPMD occurred during World War I in response to increased war-time demand for zinc. This is also the time when new ball-mill grinding and floatation milling technologies were developed to more efficiently process ores of the region. Sunnyside Mine was the largest zinc ore producing mine in the country and by 1918 produced 600 short tons per day. The postwar recession hit in 1921, causing most mines and mills in the district to close by 1925. The Shenandoah-Dives Mine and Mayflower Mill in Silverton were the only major and consistent ore producers in the BPMD by the end of 1930. The mid-1930s also brought on new regulations that required mill tailings to be impounded and water to be clarified before it could be discharged (Storosh, 2013). Many of these tailings impoundments were poorly constructed and often breached, releasing metals-contaminated water and tailings into local waterways (Thompson, 2015).

From 1942 to 1953, wars and government strategic metal reserve programs periodically increased demand for base-metals. During this time frame, the Shenandoah-Dives Mining Company and other small mines began to re-mine old underground waste rock and surface dumps left by previous mine operators. A substantial volume of ore was recovered, which likely reduced the amount and footprint of potentially toxic materials in the environment. In 1958, the Shenandoah-Dives Mining Company became the Marcy-Shenandoah Corporation and obtained the leases for the Gold King Mill and the Sunnyside Mine. In 1960, the Marcy-Shenandoah-Dives Mining Company was purchased by Standard Metals Corporation which assumed its leases and the Mayflower Mill. Soon thereafter, Standard Metals Corporation renovated and expanded the Gold King Mill level tunnel at Gladstone toward and under the existing Sunnyside Mine workings. The haulage tunnel, which was renamed the American Tunnel, successfully drained underground mine workings in the area. The American Tunnel discharged water into Cement Creek while Sunnyside Mine workings were expanded.

Continuous mining occurred at the Sunnyside Mine from 1960 to 1991. However, additional mining and mineral explorations occurred during periods of high metals prices; most notably at Old Hundred Mine/Pride of the West Mill site where more than 15,000 linear feet of new tunnels were excavated. The waste dump from this venture was processed at the Pride of the West Mill periodically from 1970 to 1990 at times when metals prices were high. The Sunnyside Mine undermined Lake Emma and broke through in June 1978, catastrophically flooding mine workings with an estimated 5 to 10 million gallons of water and black metals-laden mud. Most of the muddy water exited from the Gladstone portal of the American Tunnel before flowing into Cement Creek and the Animas River. By 1991, about 1,500 mining related sites and deeded mining claims came to be located in the area (Lyon *et al.*, 2003).

Sunnyside Gold Corporation (SGC) ended production in August 1991 after exhausting all of the higher-grade ore deposits and recovery of milled mine-waste dumps. This event marked the end of mining activities in the BPMD. However, SGC continued with reclamation work that is still occurring at many sites in the BPMD, including sites where SGC never owned or operated. This effort includes but is not limited to removing tailing deposits along the Animas River between Eureka and Howardsville, removing mine dumps at Longfellow Mine and Koehler Tunnel, rerouting surface water runoff around tailings piles and plugging numerous portals and adits.

SGC also operated a water treatment plant at the Gladstone portal on Cement Creek up until the winter of 2004. At this time, SGC installed 12 bulkheads at various sites within the BPMD as part of a court-ordered consent decree to terminate their discharge permit.

On August 5, 2015, EPA contactors triggered a release of about 3 million gallons of metals-laden water from the GKM adit in Cement Creek near Gladstone (EPA, 2015b). The accidental release occurred when an excavator was used to assess the on-going release of water from the GKM. While excavating above an old adit, pressurized water began leaking above the mine tunnel (EPA, 2016f). The release quickly inundated Cement Creek and downriver reaches of the Animas River. A plume of yellow-orange, metals-laden water flowed down the Animas River to the San Juan River over about an 8-day period. The plume ultimately crossed three states (CO, New Mexico, and Utah) and three reservations (Southern Ute Indian Tribe, Ute Mountain Ute Tribe, and Navajo Nation) triggering temporary river water use restrictions.

By August 16, 2015, most of the Animas and San Juan River raw water intakes were reopened and recreational and agricultural uses resumed. By October 15, 2015 all remaining lower San Juan River water use restrictions were lifted (EPA, 2015b). Since the GKM release, EPA has responded by monitoring downstream water chemistry and quality, installing an interim water treatment plant in Gladstone, and working with various stakeholders to develop monitoring and preparedness plans (EPA, 2016e). GKM release monitoring included, but was not limited to, collecting and analyzing over 1,000 water samples, estimating metal loading, and assessing impacts to downriver biota. Although most of the BPMD watershed reaches evaluated in this BERA were upgradient from reaches impacted by the GKM release, the Durango Reach was downgradient. Most Durango Reach exposure data evaluated herein was collected in the months and years after the GKM release. A summary of potential aquatic risks associated with the GKM release is provided in Section 3 of this Aquatic BERA. This summary focuses on the Animas River reaches downgradient from the release that were evaluated in the Upper Animas BERA (EPA, 2019).

EPA listed 48 BPMD mine features on the NPL after the GKM release in April 2016. Listing made the BPMD eligible for additional assessment and cleanup resources under the EPA Superfund program. This action designated the group of BPMD mine features as a Superfund site and initiated the 8-step ecological risk assessment process and the development of this Aquatic BERA.

On December 8, 2017, the EPA Administrator released a list of 21 Superfund sites located across the United States to be targeted for immediate and intense attention (EPA, 2017b). The BPMD Superfund site was one of the 21 sites, signaling EPA's commitment to improving public health and the environment stemming from BPMD impacts. To support this effort, EPA initiated an adaptive management approach that included implementing early actions to improve water quality, stabilizing mine features, and addressing priority areas that pose greatest risks to human and environmental health. This Aquatic BERA will be used to inform site managers of potential ecological risks associated with current BPMD impacts to support adaptive management actions.

2.2 Environmental setting

The BPMD is located in the headwaters of the Animas River watershed in the San Juan Mountain range in San Juan County. This mountain range is dominated by rugged peaks and hanging valleys carved out during the last glaciation. The highest elevations are treeless and contain alpine habitats with numerous feeder streams, springs, seeps, and gulches. Alpine areas quickly drop into steep valleys with extensive areas of exposed rock and talus supporting sparse vegetation. Sub-alpine Engelmann spruce and fir forests and high-altitude meadows are common as valley walls widen and become less steep. In most high-elevation BPMD locations, valley bottoms contain relatively narrow riparian floodplain habitats with high-gradient creeks and draining gulches. Lower-elevation Animas River and major tributary reaches have lower gradients and contain relatively wide and diverse riparian habitats. The Durango Reach, which traverses farmland and the City of Durango, contains natural and manmade habitat features (e.g. armored banks, whitewater park rapids, and fishing access points/pools). The diversity of the in-river and riparian habitats found throughout the BPMD and Durango Reach have the potential to support diverse aquatic ecological communities.

Past surveys of fish and benthic invertebrate communities show that the headwaters of the Animas River above Silverton, the mainstems of Cement and Mineral Creeks, and several smaller tributaries supported little aquatic life due to the presence of natural and mine-related contamination (Animas River Stakeholders Group [ARSG], 2000). On the other hand, South Fork Mineral Creek and several tributaries and mainstem reaches of the upper Animas River watershed provided substantial acid-neutralizing capacity and had low-enough metals contamination to support viable brook trout (*Salvelinus fontinalis*) populations (Besser and Brumbaugh, 2007 Chapter E18 in Church *et al.*, 2007). Recent surveys conducted to support this Aquatic BERA also found diverse BMI communities and trout in select BPMD reaches. Information from these surveys are evaluated herein (United States Geological Survey [USGS], 2018; Mountain Studies Institute [MSI], 2017b).

2.3 Special status species

A federally listed threatened and endangered (T&E) species list for the upper Animas River watershed above the Mineral Creek confluence was obtained from the United States Fish Wildlife Service ([USFWS]; 2017) iPAC environmental conservation online system. State T&E species information was obtained from CO Parks and Wildlife ([CPW]; 2016b). The Canada lynx (*Lynx canadensis*) and North American wolverine (*Gulo gulo*) are two mammal species identified in the iPAC list for the Animas River watershed. The Canada lynx is listed as federally threatened and state endangered, while the North American wolverine is listed as state endangered. The North American wolverine federal listing under the Endangered Species Act (ESA) is currently under review at the time this BERA was drafted (USFWS, 2016). The southwestern willow flycatcher (*Empidonax traillii extimus*) is identified in the iPAC list and is a federal- and state-endangered bird species. The iPAC list also contains the Uncompahgre fritillary butterfly (*Boloria acrocnema*). This butterfly is a highly-endemic and federally-endangered insect species. The boreal toad (*Bufo boreas boreas*) is not identified in the iPAC

list, but is listed as a state-endangered amphibian species. USFWS is currently reviewing the listing status of the boreal toad under the ESA (USFWS, 2011).

Lynx were observed near Silverton over the last couple years, even though this species is considered rare in CO. Given these sightings and availability of late-succession forest habitat, it is likely that lynx occur within the BPMD. The wolverine has rarely been seen in CO since 1919 and is reported to be extirpated from San Juan County at the time this BERA was drafted (CPW, 2017a). The chance that the wolverine exists in the BPMD is considered highly unlikely given the current distribution and status of this species. The southwestern willow flycatcher is a small passerine bird which breeds in dense riparian habitats along rivers, streams, or wetlands and feeds on insects. Preferred flycatcher habitat is riparian corridors dominated by dense growths of willows (*Salix* sp.), seepwillow (*Baccharis* sp.), or other shrubs and medium-sized trees. A key characteristic of flycatcher habitat is the presence of dense vegetation, usually throughout all vegetation layers. These associations suggested that suitable flycatcher habitat is available along the shoreline of the Animas River, especially downstream of Silverton and the Canyon Reach. This BERA conservatively assumes that the species could be present throughout the BPMD and Durango Reach.

The only known Uncompahgre fritillary butterfly colonies known to exist in San Juan County occur on Mount Uncompahgre and Redcloud Peak. Both areas are located just to the northeast of the BPMD (USFWS, 2009). As such, this highly endemic species is not expected to occur in the BPMD or Durango Reach aquatic habitats. Although the boreal toad was documented to occur in nearby Mineral, Saguache, western Rio Grande and Conejos Counties, a dedicated survey did not report any sightings of this species in San Juan County watersheds (Keinath and McGee, 2005). Note that the historic range of boreal toad may have extended into San Juan County and the BPMD; see *Figure 1 Boreal toad distribution in United States Department of Agriculture Forest Service Region 2* in Keinath and McGee (2005). The Bureau of Land Management (2006) suggested that, although suitable habitat may exist within portions of the BPMD, boreal toads are not found in the area due to chemical and physical impacts of metals and acidity.

Of all the T&E listed species discussed above, only Canada lynx and southwestern willow flycatcher are plausibly associated with the BPMD. Although boreal toad has not been found in the study area, it occurs in nearby watersheds and the BPMD contains habitat utilized by this species. As such, the Aquatic BERA will evaluate aquatic exposure risks to boreal toad. The Canada lynx is primarily a terrestrial species and will be evaluated in the future terrestrial BERA (EPA, 2017h). The southwestern willow flycatcher is an aquatic-dependent species and is assessed in the Upper Animas BERA (EPA, 2019; **Attachment 1**). The southwestern willow flycatcher is also evaluated in this Aquatic BERA using the American dipper (*Cinclus mexicanus*) as a surrogate species. The American dipper uses the same general habitats as the flycatcher (Sedgwick, 2000; Willson and Kingery, 2011) but has readily-available morphometric and dietary profile information which were required to model dietary exposure. Therefore, southwestern willow flycatcher aquatic exposure risks are evaluated using American dipper as a reasonable surrogate species. Boreal toad risks are assessed as a member of the aquatic community; additional assessment endpoint details provided in Section 5.1.1.

SECTION 3 PREVIOUS BMPD RISK ASSESSMENTS

As stated in Section 1, the geographic scope of aquatic risk assessment activities associated with the BPMD have steadily increased since the Upper Animas SLERA was drafted in 2013. This section summarizes the major findings of the Upper Animas SLERA and BERA. GKM release water quality, sediment, and aquatic community impacts are also summarized in the context of how exposure might have changed post-release in downgradient EUs evaluated in the Upper Animas BERA.

3.1 Upper Animas SLERA

The Upper Animas SLERA was finalized in February 2013 (EPA, 2013b). The goal of this SLERA was to identify COPECs and conservatively assess ecological risk to different receptor groups exposed to contaminated surface water, sediment, and aquatic dietary items to determine whether a BERA was needed. The SLERA evaluated three impacted creek and river reaches, namely: 1) Cement Creek, 2) Mineral Creek, and the 3) Animas River at and below Silverton, CO.

The Upper Animas SLERA evaluated risks to community-level BMIs and fish, and four select wildlife species; namely American dipper (*C. mexicanus)*, mallard (*Anas platyrhynchos*), belted kingfisher (*Ceryle alcyon*), and muskrat (*Ondatra zibethicus*). COPECs and community-level risks were evaluated using surface water chemistry data from May 2009 and May 2012. A limited sediment chemistry dataset from samples collected from the Silverton reach in May 2012 was also used to identify COPECs and assess BMI and wildlife risks. Wildlife dietary item exposure was estimated from sediment and water using readily-available media-to-prey item bioconcentration factors and species-specific food chain modeling parameters.

Surface water and sediment COPECs for BMIs and fish were selected using a hazard quotient (HQ) approach. HQs were derived using maximum-measured metals concentrations among all three EU reaches and conservative chronic surface water, screening-level sediment, and no-effect wildlife toxicity benchmarks. The same community-level receptor COPECs were retained as COPECs for the wildlife receptors assumed to be feeding in the Animas River. Risk was also quantified using the HQ approach and conservative toxicity benchmarks. Three separate surface water exposure point concentrations (EPCs) were derived for each EU to represent the three hydroperiods (pre-runoff, runoff, and post-runoff). Due to availability of sediment exposure data, wildlife risks were only characterized for the Animas River at and below the Silverton reach.

3.1.1 Upper Animas SLERA results

Below are brief summaries of the results of the Upper Animas SLERA risk characterization for each of the three EUs:

Cement Creek: The chemical conditions in the surface water in mainstem Cement Creek near its mouth were expected to be highly toxic to BMIs and fish, particularly due to high levels of

acidity and dissolved aluminum, but also due to cadmium, copper, iron, and zinc. The results of the analysis strongly suggested that a diverse BMI community and fish would not be able to survive in this creek under current conditions.

Mineral Creek: The chemical conditions in mainstem Mineral Creek near its mouth were less severe than in mainstem Cement Creek for BMIs and fish. However, low pH and high levels of dissolved aluminum during the pre-runoff period suggested that aquatic communities may experience high stress in the winter but could possibly recover during the rest of the year. The results suggested that the BMI and fish communities in mainstem Mineral Creek would likely experience high stress under current conditions.

Animas River at and below Silverton: The metal concentrations (particularly cadmium, copper, lead, manganese, and zinc) measured in the substrate of the Animas River at and below Silverton were expected to be highly toxic to BMIs and fish. The chemical conditions in surface water reflected input and associated risks from the Animas River above Silverton (cadmium and zinc) and more local input from mainstem Cement Creek and mainstem Mineral Creek (low pH and aluminum, with lower inputs of iron and copper compared to aluminum). The levels of metals in surface water, sediment, and food items ingested by the four wildlife receptor species foraging in the Animas River at and below Silverton had the potential to cause significant population-level risks, based on the prevailing (but conservative) assumptions used in the SLERA. These results suggested that the BMI and fish communities and aquatic wildlife in the Animas River at and below Silverton would likely experience high stress under current conditions.

3.1.2 Upper Animas SLERA summary

In summary, the Upper Animas SLERA showed that the current conditions in mainstem Cement Creek, mainstem Mineral Creek, and the Animas River at and below Silverton have high potential to generate high levels of ecological risk to community-level and wildlife receptors that might reside in these three reaches. As such, it was recommended that additional environmental data be collected from these reaches and a BERA be drafted to refine the SLERA.

3.2 Upper Animas BERA

The Upper Animas BERA was prepared in response to the high likelihood for ecological risks identified in the Upper Animas SLERA. The Upper Animas BERA provided a refined exposure and risk analyses from that used in the SLERA. The Upper Animas BERA also expanded the geographical scope to include more EU river reaches and respective sampling locations than those evaluated in the SLERA (**Figure 3-1** and **3-2**). Prior to now, the latest Upper Animas BERA draft report was published in April 2015 (EPA, 2015c). This draft was made available to the public for technical review. The review process was interrupted by the August 2015 GKM release that occurred, influencing most of the EUs evaluated in the Upper Animas BERA. Due to the potential for the GKM release to change previously-characterized exposure conditions, the Upper Animas BERA was not finalized until now (**Attachment 1**). Although the GKM release

flowed through most of the EUs evaluated in the Upper Animas BERA, the final version of the Upper Animas BERA was not substantially updated from the April 2015 draft. This was primarily due the results of several evaluations of the magnitude and duration of aquatic community impacts to the release. Specifically, recent studies have demonstrated a lack of long-term changes in aquatic receptor exposures that would be expected to change risk outcomes from those characterized before the release. GKM release impacts are summarized following this section and support this assessment methodology (Section 3.3). The Upper Animas BERA EUs included:

- *Mainstem Cement Creek*: This reach was represented by sampling locations CC48 and CC49 found within one mile upstream of the confluence with the Animas River (**Figure 3-1)**. Sampling results from both sampling locations were combined into one EU.

- *Mainstem Mineral Creek*: This reach was represented by sampling location M34 found on the creek just upstream of the confluence with the Animas River (**Figure 3-1)**.

- *The Animas River above mainstem Cement Creek*: This reach of the Animas River covered about two river-miles between sampling locations A60 and A68, with sampling results combined into a single EU (**Figure 3-1)**.

- *The Animas River between mainstem Cement Creek and mainstem Mineral Creek (a.k.a. Silverton Reach)*: This reach of the Animas River covered about one river-mile between the confluences of the two creeks adjacent to the town of Silverton. Sampling results from sampling locations A69A and A70B were combined into one EU (**Figure 3-1)**.

- *The Animas River below mainstem Mineral Creek (a.k.a. Canyon Reach)*: This reach of the Animas River covered about 30 river-miles from A71B downriver to Bakers Bridge. This reach included the following sampling locations: A71B, A72, A73/A73B (grouped), A75D/A75B (grouped), and Bakers Bridge. Given the length of the Canyon Reach, each of the individual and grouped sampling locations were considered distinct EUs, which totaled five EUs in this reach **(Figure 3-2)**.

Environmental sampling results for these EUs were used to derive reasonable maximum exposure (RME) and central tendency exposure (CTE) EPCs to estimate exposure and associated risks to aquatic ecological receptors. RMEs represented either the maximum or 95th upper confidence limit (UCL) of measured COPEC concentrations. CTEs represented the average value of measured COPEC concentrations. EPCs were derived for surface water, sediment, pore water, and wildlife estimated daily doses (EDDs). The Upper Animas BERA evaluated BMI exposure to sediment and pore water, fish exposure to surface water, and wildlife exposure via ingestion of surface water, sediment, and dietary items.

The surface water data were represented by dozens of samples collected from EU sampling locations between May 2009 and September 2014. The sediment data set was substantially

smaller and consisted of analytical data collected from those same waterways during five sampling events in May 2012, October 2012, May 2013, April 2014, and September 2014. The pore water data set consisted of analytical data collected in April and September 2014.

The effects evaluation used chronic surface water benchmarks (hardness-adjusted, as appropriate), plus no- and low-effect sediment benchmarks, to quantify toxicity to aquatic community-level receptor groups exposed to surface water, sediment, and pore water. No- and low-effect toxicity reference values (TRVs) for birds and mammals were used to assess the toxicity of metals via ingestion by the four wildlife receptor species. In addition, surface water and sediment toxicity tests were performed in the laboratory using samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above Cement Creek and below Mineral Creek sampling locations. Tests measured lethality impacts to juvenile rainbow trout (*Oncorynchus mykiss*) following 96-hr exposures and survival and growth to benthic invertebrates (the freshwater amphipod *Hyalella azteca*) after 10-day exposures to field-collected surface waters and sediments, respectively. The Upper Animas BERA also considered fish community survey results obtained from CPW (2010; 2014) to assess the structure and function of the fish community. Similarly, the results from historic BMI surveys from Timberline Aquatics (2015) were used to assess the structure and function of the BMI community. Results from BMI tissue residue sampling and chemical analyses were also used to assess invertivorous wildlife dietary exposure.

Exposure to the four wildlife receptor species was quantified using a food chain model which calculated RME and CTE EDDs based on ingesting total recoverable metals (TRMs) in surface water (unfiltered), sediment, and dietary items. The food items consisted of benthic invertebrates (measured metal levels), fish (modeled metal levels based on sediment analytical data), and aquatic plants (modeled metal levels based on sediment analytical data), depending on the target wildlife species. The wildlife receptors consisted of the American dipper (surrogate for southwestern willow flycatcher), mallard, belted kingfisher, and muskrat. Note that wildlife risks were only characterized for the Animas River above mainstem Cement Creek and each of the five Canyon Reach sampling location EUs due to limited sediment data availability.

Risk was primarily quantified using HQs, which compared measured exposures (i.e., RME and CTE surface water, sediment and pore water EPCs) or estimated exposures (RME and CTE wildlife EDDs) to chronic surface water benchmarks, no- and low-effect sediment benchmarks, and wildlife no- and low-effect TRVs. Note that the current Upper Animas BERA (**Attachment 1**) used an updated set of wildlife TRVs than what was used in previous drafts. The wildlife TRVs were updated so the same set of TRVs could be used to assess wildlife risks among the Upper Animas BERA, this BERA, and the BPMD terrestrial BERA (EPA, 2017h). In addition to the change in TRV, computation errors identified during review were corrected in wildlife exposure calculations.

Toxicity testing data from fish and benthic invertebrates exposed to surface water and sediment in the laboratory were evaluated statistically to determine which of the observed responses were

significantly different from laboratory control samples. BMI and fish surveys provided an integrated measure of aquatic community health.

3.2.1 Upper Animas BERA results

The following summaries are separated into each of the three major receptor groups, namely BMI community, fish community, and aquatic wildlife, and when relevant, each EU.

BMI communities

Four independent risk measurement endpoints indicated that the BMI community was impacted in sections of the Animas River between A60 (above Cement Creek confluence) and Bakers Bridge (most downriver Canyon Reach site), and in mainstem Cement and Mineral Creeks. The BMI community in Cement and Mineral creeks were the most impaired of all other EUs; based on low multi-metric index (MMI) scores. The CO MMI incorporates numerous, separate benthic invertebrate metrics into one value that is used quantitate the health of the BMI community and to assess aquatic life impairment. MMI scores obtained from the Animas River starting in the early 1990s indicated that the BMI community at sampling location A68 (located in the Animas River just above mainstem Cement Creek) and at sampling locations A72 and A73 (located in the Animas River below mainstem Mineral Creek) had not consistently improved over time. The MMI scores derived from five to six surveys conducted between fall 1996 and fall 2014 at monitoring locations further downstream on the Animas River (i.e., A75CC, A75D and James River [located below Bakers Bridge]) were all above CO's aquatic life impairment threshold (MMI score of 42) and rarely below its attainment threshold (MMI score of 50). Together these results showed that BMI communities were likely at risk from metals exposure in all of the EUs that were evaluated, but risks diminished the further down the Animas River from BPMD sources.

Fish communities

Mainstem Cement Creek: The chemical conditions in surface water were determined to be highly toxic to fish, particularly due to low pH and high aluminum, and to a lesser extent by the presence of cadmium, copper, and zinc. The toxicity tests showed that surface water collected at CC48 in November 2012 (i.e., post-runoff period) was acutely toxic to juvenile rainbow trout after 96 hours of exposure in the laboratory. The preponderance of evidence suggested that a fish community (if present) in mainstem Cement Creek would experience lethal stress under current conditions.

Mainstem Mineral Creek: Low pH during the pre-runoff period coupled with high aluminum levels during the pre-runoff and post-runoff periods suggested that fish may experience high stress in the winter as well as summer and fall. The toxicity tests showed that surface water samples collected at M34 in November 2012 (i.e., post-runoff period) and April 2013 (pre-runoff period) were acutely toxic to juvenile rainbow trout. The preponderance of evidence suggested that the fish community (if present) in mainstem Mineral Creek would likely experience high stress under current conditions.

Animas River above mainstem Cement Creek: The chemical conditions indicated the presence of one or more sources of metal contamination located further upstream in the watershed. The chemical composition of the surface water suggested that long-term toxicity to the fish community was possible, particularly due to aluminum, cadmium, and zinc. Although juvenile rainbow trout acute toxicity testing for sampling location A68 did not result in significant mortality (no chronic tests performed), chemical analysis of surface water collected from A68, located just up river from Cement Creek suggested that the fish community in this reach could be stressed during much of the year.

Animas River between mainstem Cement Creek and mainstem Mineral Creek: With only two surface water samples collected and no acute toxicity testing, risk estimates for this EU were based on a relatively small dataset. However, available data suggested that the surface water in this reach would likely be lethal to fish, mostly due to low pH and high levels of aluminum, with secondary stress caused by cadmium and zinc.

Animas River below mainstem Mineral Creek: The chemical composition of the surface water in this reach reflected the major inputs from mainstem Mineral and Cement Creeks, and the reach of the Animas River above mainstem Cement Creek. Surface water samples collected from the first sampling location down river from Mineral Creek (A72) during the pre- and post-runoff periods were acutely toxic to juvenile rainbow trout. Surface water samples collected during the same two hydrologic periods from the EUs further downstream did not show acute toxicity, suggesting that the acute toxicity had been diluted. However, the preponderance of evidence showed that aluminum, cadmium, and zinc in surface water could exert chronic effects on the fish community to at least Bakers Bridge located about 30 miles downstream from Silverton. This conclusion was supported by two additional lines of evidence:

- Daily surface water samples collected between April and July 2014 using "MiniSipper" sampling devices positioned at Animas canyon locations near Elk Creek (A73) and Cascade Creek (A75D) and Bakers Bridge showed the presence of low-grade and multi-week chronic toxicity associated with dissolved aluminum, cadmium, and zinc during the pre-runoff and runoff periods.

- A fisheries survey performed by the CPW (2010) on the Animas River in the vicinity of sampling locations just down river from Mineral Creek (A72), near Elk Creek (A73), and near Cascade Creek (A75D/A75B) showed a severe decline of the trout populations at all three locations between 2005 and 2010. CPW ascribed this collapse to a drastic reduction in surface water quality apparently associated with the discontinuance of the water treatment project in the Gladstone area on Cement Creek upgradient from Silverton (Section 2.1). A 2014 follow-up fisheries survey by CPW (2014) in the vicinity of Elk Creek confluence (A75D/A75B) showed a sustained decline in the local brook trout population.

In summary, the Upper Animas BERA found substantial risk to fish that could or were inhabiting each reach that was evaluated from exposure to elevated metal concentrations and low pH in surface water. Estimated risks to fish were greatest in Cement and Mineral Creeks and continued at lower levels into the Animas River downriver of respective confluences. Risks lessened further downriver into the Canyon Reach to the most downriver Bakers Bridge sampling location.

Wildlife receptors

Animas River above mainstem Cement Creek: The greatest risks from lead exposure were identified in this reach. All lead RME and CTE HQs were above 1.0 for all four wildlife receptors. The greatest lead risks were identified for American dipper followed by belted kingfisher and mallard feeding on 100% invertebrate diet. Minimal potential risks associated with copper and zinc exposure were also observed in this reach but only for American dipper. American dipper had the greatest exposure and risks to COPECs compared to all other wildlife receptors.

Animas River below mainstem Mineral Creek: Copper was identified as the major risk driver to the two invertivorous wildlife species that were evaluated; American dipper and mallard. Copper exposure risks increased in a down to upriver direction throughout this reach (*i.e.* greater risk closest to Mineral Creek confluence); namely in A73B and A75B two sampling locations in which benthic tissues were estimated using conservative published sediment-to-benthic invertebrate regression models and uptake factors. Lead was also identified as a risk driver to wildlife species in this reach. The greatest risks were identified for American dipper followed by belted kingfisher. Although risks to these two species decreased in a downriver direction throughout the reach, RME and CTE HQs were still above 1.0. Selenium and zinc RME based HQs were slightly above 1.0 for dipper and muskrat but only in a few sampling locations lower in the reach.

3.2.2 Upper Animas BERA summary

In summary, the Upper Animas BERA identified metal exposure-related risks to BMI communities, fish communities, and specific wildlife receptors that could inhabit the Animas River and major tributaries near and downriver from the town of Silverton. When considering CTE EPCs and chronic water quality criteria (WQC), BMI community pore water HQs were most elevated followed by aquatic community surface water HQs. However, these pore and surface water aquatic community-level HQs were rarely above 5. Among EUs, Cement Creek routinely had the greatest pore water and surface water HQs despite having very high ambient water hardness which effectively lowered respective toxicity benchmarks for the hardness-adjusted COPECs (aluminum, beryllium, cadmium, copper, lead, manganese, silver, and zinc). This observation supported that HQs were primarily driven by very high metals concentrations and not from site-specific changes in surface water benchmarks. The greatest sediment-based HQs were observed in the Animas River above the Cement Creek reach. These results suggested

the presence of major sources of metals contamination in Mineral and Cement Creeks as well as above most of the Upper Animas BERA study area.

Wildlife risks were restricted to lead, copper, selenium and zinc. The greatest risks were associated with lead exposure in American dipper in the Animas River reach above mainstem Cement Creek. Dipper also had low to moderate risks for copper, selenium, and zinc exposure. Belted kingfisher risks were only observed for lead. Copper risk were elevated a A73B and A75B for most wildlife receptors but may be an artifact of conservative sediment-to-biota factors used to estimate exposure.

The three hydroperiod-based surface water risk characterization HQs were generally similar within each EU, despite occurrence of high pre-runoff and post-runoff surface water metals concentrations compared to runoff concentrations. This scenario is partially explained by changes in water hardness among the three hydroperiods, as hardness was a major driver in modifying the water-based benchmarks for the hardness-adjusted metals. Pre- and post-runoff conditions usually had greater hardness than runoff conditions which effectively increased hardness-dependent benchmarks. Therefore, the changes in hardness may have improved any effects on HQs derived with greater metals concentrations during pre- and post-runoff hydroperiods. These observations illustrated the complex seasonal exposure conditions and supported hydroperiod-based surface water risk analyses.

As stated in Section 1.1, Upper Animas BERA risk characterization results are included herein when presenting overall study area risk characterization summaries; specifically, in the Executive Summary **Table ES-1** and in Section 10 text and tables. This inclusion provides risk managers a comprehensive summary of BPMD contamination risks from the headwater Animas River and respective tributaries downriver to Durango. Although assessment methods were very similar between the two BERAs, there are some slight differences that limit direct comparison of results. Section 6.9 in this BERA provides a summary of these differences and actions taken to resolve them before results were incorporated into summary text and tables.

3.3 GKM release aquatic community impacts

EPA published two reports that presented their findings on effects of the GKM release to the Animas and San Juan rivers downgradient from Cement Creek. The first EPA (2017a) report analyzes impacts based on surface water and sediment data collected during and pre- and post-release; referred to as the transport and fate report. The second EPA (2018a) report provides an analysis of the biological data collected before, during, and after the release; referred to as the biological report. Text in this section summarizes findings from both reports. This summary focuses on the GKM release impacts in the Aquatic BERA study area; specifically, along the Animas River from Cement Creek to just downriver of Durango. This information is used to assess whether the Upper Animas BERA (EPA, 2019; **Attachment 1**) exposure analyses and subsequent risk characterizations are still valid or should be updated. All lines of evidence reported by EPA (2017a; 2018a) indicate that current exposure conditions (post spring 2016) are not different from what occurred before the release (i.e. including data used in the Upper Animas

BERA (EPA, 2019; **Attachment 1**). As such, respective risk characterization results are still valid and therefore, updating the Upper Animas BERA was determined to be unnecessary.

3.3.1 GKM transport and fate report

The EPA (2017a) transport and fate report analyzed chemistry results from thousands of surface water and sediment samples collected before, during, and after the GKM release. Sampling occurred from the GKM on Cement Creek in the BPMD down the Animas River into the San Juan River to Lake Powell, a total distance of about 350 river miles.

The transport and fate report objectives were to investigate 1) the GKM release effects on water quality after the release; 2) whether or not the water quality returned to pre-event conditions; 3) whether or not there was a second surge of contamination following storms and/or spring snow melt when high flows could remobilize deposits; and 4) whether or not any remaining GKM impacts could be detected given the legacy contamination from historic mining in the region. The following summary of the EPA (2017a) transport and fate report is organized with respect to each of these four objectives.

The first objective of the EPA (2017a) transport and fate report was to evaluate effects on water quality after the release. In addition to low pH water, primary contaminants released during the event were aluminum, iron, manganese, lead, copper, arsenic, zinc, cadmium, and a small amount of mercury. These contaminants were mostly associated with suspended sediments, colloids, and undissolved fractions or TRMs, but increased concentrations of dissolved metals (DMs) were also observed. As soon as the plume exited Cement Creek and flowed into the Animas River, the same geochemical reactions routinely observed near Silverton, CO, began to neutralize the plume's acidity and trigger the geochemical reactions that form insoluble iron and aluminum oxide precipitates. EPA (2017a) estimated that approximately 90 percent of the solid metal load initially settled in the Animas River and that DM concentrations decreased to pre-event conditions by the time the plume flowed into the San Juan River.

EPA (2017a) reported that the amount of contamination released during and days after the event was equivalent to an estimated 490,000 kg of metals. The bulk of this estimate was reported to be comprised of iron and aluminum. The total amount of metals entering the Animas River was comparable to the amount of metals carried by the river in one to two days of high spring runoff. Nevertheless, concentrations of potentially toxic metals were locally and temporally higher than historical acid mine drainage. During the release and in the plume (tail to tail), metal concentrations exceeded state and tribal WQC. The greatest acute WQC exceedances occurred for dissolved arsenic, cadmium, copper, lead, manganese, and zinc and total aluminum and within first 20 river miles downgradient from GKM. Chronic WQC exceedances occurred at times during the nine months after the release in some locations; especially for dissolved cadmium, copper, lead, and zinc and total aluminum and iron within the Animas River. Acute WQC exceedances were rare during this time frame. Metals associated with the GKM release also may have contributed to some WQC exceedances during the 2016 spring snow melt.

Long-term historic and post-release sampling data were used to assess when water quality returned to pre-event conditions. EPA (2017a) reported that there were a few episodic increases of GKM-related contamination that occurred after the initial plume passed. The first episode occurred downriver from the Aquatic BERA study area near the Animas and San Juan River confluence in Aztec, New Mexico. This event occurred three weeks after the mine release and was a large enough storm to flush some of the deposited GKM metals from the lower Animas River and the San Juan River. A second surge of GKM-related contamination occurred during the annual spring snow melt and storm season in 2016. Increased Animas River flows from melting snow and spring storms remobilized metals that had settled in the sediment in the river system. Metals concentrations were lower during this period than during the release but there were water quality exceedances for dissolved copper and lead and total aluminum and iron. Associated water chemistry data collected throughout the 2016 water year strongly implied that the mass of release event-related metals that had settled in the river beds was moved downstream to Lake Powell by the end of the snowmelt period. As such, Animas River aquatic receptor exposure conditions returned to pre-event conditions in less than a year after the GKM release.

Lastly, EPA (2017a) investigated whether there were any remaining, detectable impacts to the Animas River given the legacy contamination from historic mining in the region. Water and sediment sampling continued for the remainder of the 2016 water year and into 2017 to monitor conditions well beyond initial GKM release impacts. Monitoring through the summer and fall of 2016 showed that metal concentrations in water and sediment had returned to pre-event conditions throughout the Animas and San Juan Rivers. While not rigorously evaluated in the transport and fate report, Animas River monitoring data collected throughout spring 2017 was expected to confirm that exposure conditions were similar to those that have been historically dominated by BPMD-related contamination sources.

3.3.2 GKM biological data report

The EPA (2018a) GKM biological data report was drafted to gather and review all readily available biological data collected from the Animas and San Juan rivers to assess how the aquatic biota responded to the GKM release. As done in the previous section, this summary focuses on the Animas River from Cement Creek to Durango. The assessment also focuses on five types of biological data assessed by EPA (2018a). These five lines of evidence indicate that release impacts to aquatic life were limited to temporally increased concentrations of specific metals in BMI and fish tissues. The remainder of this section summarizes EPA (2018a) results for each of the five types of biological data. This includes information on changes in BMI community assemblages, increases of metals concentrations in BMI tissues, results from *in situ* fish toxicity testing, changes in fish communities, and increases of metals in fish tissues.

BMI community assemblage impacts were evaluated using survey data collected from June 2008 up to the August 2015 release (historic pre-release), within days after the plume (release), and after the event until fall 2016 (post-release). Surveys were conducted using slightly different methods, however methods did not deviate to an extent that would preclude the comparison of data from all survey datasets. BMI community survey datasets were analyzed with respect to

common assessment metrics and MMI scores known to be sensitive to and commonly used to evaluate impacts from metals exposure. EPA (2018a) BMI impacts analysis found no conclusive evidence of changes in the already degraded upper Animas River communities when comparing pre- and post-release GKM release survey results. There were no significant reductions between pre- and post-GKM release surveys for percent combined Ephemeroptera, Trichoptera and Plecoptera (%EPT) and total taxa community metrics and MMI scores. Lower MMI scores tended to cluster within 60 river miles downgradient from the GKM during the 5-day event but were within the pre-release range of variability.

EPA (2018a) evaluated trends in BMI tissue metals concentrations that were sampled before and after the GKM release. Data were obtained from four sampling events conducted at select Animas River locations. The two pre-release sampling events occurred in fall 2012 and 2014 and two post-release sampling events occurred in fall 2015 and 2016. Similar to BMI surveys, there were differences in how BMI tissue samples were prepared and analyzed. For example, wet- and dry-weight conversion assumptions were needed to normalize all results to a dry-weight basis and caddisfly casings were only included in 2016 samples. Nevertheless, data were statistically analyzed to detect differences in mean BMI tissue metals concentrations between pre- and post-release datasets. EPA (2018a) analyses showed that BMI tissue samples collected from the upper Animas after the GKM release in September 2015 had significantly greater copper and lower manganese concentrations when compared to pre-release concentrations. All other changes in metal concentrations from the pre-release dataset were not statistically significant and were within the range of potential sample variability. Authors reported that multiple lines of evidence suggested that the changes in copper and manganese concentrations were associated with the GKM event but may also reflect biases between pre- and post-release sample processing; specifically, inclusion of caddisfly casings that were in the 2016 samples. Note, that caddisfly casings often contain small pebbles and other exogenous materials that have potential to positively bias metal concentrations in respective samples.

Similar to BMIs, EPA (2018a) characterized GKM release event impacts to fish communities using presence/absence and adult fish density information from historic pre- and post-release surveys. Their analyses showed there were no significant impacts on adult fish population abundance in the Animas River after the GKM release. The EPA (2018a) fish community analysis did identify potential impacts to juvenile bluehead sucker (*Catostomus discobolus*) near Durango. Specifically, the lack of <200 mm juvenile bluehead sucker in a 2016 post-release survey near Durango. However, CPW saw evidence of reproduction in native species, including bluehead sucker in the months following the release. Combined, these two lines of evidence suggest that the GKM release was not acutely toxic to younger life stages. Adult and juvenile fish survey results agree with the fact that no widespread fish kills were observed or reported on the Animas River during or after the GKM release.

EPA (2018a) also summarized results from an *in situ*, sentinel fish toxicity study. The CPW-led sentinel fish study consisted of deploying juvenile trout in cages into the Animas River as the plume of contaminated water passed. Fish were deployed for 96-hours, after which, mortality was assessed. Of the 108 juvenile trout deployed in the study, only two mortalities were

observed in the most downriver location. These mortalities were reported to be associated with handling stress and not from exposure to GKM event-impacted waters. *In situ*, sentinel fish toxicity study results were consistent with WQC exceedance analyses that indicated the peak metal concentrations observed in the Durango area as the plume passed were not acutely toxic to fish.

Finally, EPA (2018a) compared concentrations of bioaccumulative metals in fish tissue samples collected within weeks after the release and again the following spring to address questions relating to long-term changes in biological communities. Their analyses showed that some fish accumulated metals in the weeks after the GKM event in the lower Animas River that received the majority of GKM metals deposits. Results showed that bluehead sucker (*C. discobolus*) liver tissue had statically greater aluminum, lead, manganese and selenium concentrations in August 2015 plume when compared to the mean concentrations the following March. Statically significant differences were also observed in the mean cadmium and lead concentrations measured in flannelmouth sucker (*Catostomus latipinnis*) liver tissue between these two sampling dates. Trout liver concentrations, on the other hand, did not differ between sampling dates. Fish metabolize, detoxify and excrete some metals through biological process that occur in the liver. Therefore, identification of elevated metals concentrations in liver tissues indicates that respective fish species were exposed to metals prior to sampling. It is noteworthy that the two *Catostomus* species of fish with elevated liver concentrations are benthic foragers that may be preferentially exposed to metals in sediment; opposed to trout that most often forage on prey drifting in the water column. Lastly, mean cadmium, lead and selenium concentrations in speckled dace (*Rhinichthys osculus*) beheaded and gutted bodies were significantly greater in August 2015 after the release, when compared to March 2016. Together, results indicate that metal concentrations in fish tissues declined to background conditions by the following spring (March 2016) after the GKM release.

After considering the above lines of evidence and transport and fate report analyses (Section 3.3.1), EPA determined that the GKM release did not significantly change the Animas River from conditions that occurred prior to the event. While elevated for a maximum of about nine months after the release, aquatic receptor exposures to metals in surface water and sediment were not different from those evaluated in the Upper Animas BERA. As such, updating the aquatic community-level EPCs presented in the 2015 Upper Animas BERA in response to the GKM release has been determined to be unwarranted. The final Upper Animas BERA is provided in **Attachment 1** of this Aquatic BERA.

SECTION 4 CONCEPTUAL SITE MODEL

This section provides the CSM for this Aquatic BERA (**Figure 4-1**). The BPMD Aquatic BERA CSM represents the culmination of the problem formulation process and is used to identify potentially complete exposure pathways for key ecological receptor groups and guide development of risk assessment and measurement endpoints presented in Section 5.

Readily available information was reviewed during CSM development to identify sources of contamination and determine which fate and transport mechanisms might result in complete exposure pathways to aquatic community-level receptors and wildlife receptors that live and feed in the BPMD and the Durango Reach EUs. The goal of this review is to identify the major elements of a complete exposure pathway, which consists of the following components:

- sources of contamination,
- release and transport mechanisms,
- contact points and exposure media,
- routes of entry, and
- key receptors.

Each of these components are discussed in the following subsections.

4.1 Sources of contamination

The major sources of anthropogenic contamination in the BPMD are associated with past mining activities in the watersheds of Mineral Creek, Cement Creek, and the Animas River above Silverton. While mining has not occurred in the BPMD since 1991, mine wastes associated with past mining activities are scattered throughout the environment. Below are summaries of the major sources of mining-related contamination in the BPMD:

1) Mine sites including adits, waste rock piles and tailings. Mining in the region often required advancing tunnels into mineral-rich deposits. Rock and low-value ore were dumped outside of the mine adits as tunnels advanced. The waste rock in these piles was often composed of highly-mineralized rock containing high concentrations of metals at levels great enough to be of value to claim owners. Early mine sites often used stamp mills, then floatation mills, to concentrate ore. Stamp mills were often constructed and operated at or near each mine. Most floatation mills were located in centralized areas and processed ore from surrounding mines. Milling processes produced fine-grained tailings that, up until the 1930s, were discharged untreated into local waterways. Waste tailings contained high concentrations of metals because the milling processes were not efficient at removing all metals from the ore. Tailings accumulated downgradient from mills and filled local floodplains with fine-grained, metal-enriched deposits.

2) Mill waste repositories. Starting in the mid-1930s, mills were required to impound tailings wastes on site so that fine-grained materials could settle out before water was reused or

discharged to local waterways. Fine-grained tailings accumulated in waste repositories which were poorly constructed and managed, and therefore often failed. Impoundments and repositories filled with mill wastes are still present in some areas of the BPMD.

3) Haul roads, railroads, and aerial tramways. Different types of transportation routes were constructed and used to bring ore from the mines to processing and shipping facilities. Waste rock and other mine wastes were readily available and were ideal base materials to build roads and rail lines. Spills and other unintentional releases of metal-rich ore or waste materials from trucks, trains, and trams had the potential to contaminate areas along transportation routes. Most of the major transportation routes were located along valley bottoms, in or near floodplain habitats (Jones, 2007).

4) Smelter sites and emissions-deposition areas. Around 10 smelters operated within the BPMD mostly before 1900, after which ore was transported by rail down the valley to several Durango smelters (Jones, 2007). The former smelters in the BPMD are potential sources of metals contamination. They produced slag-related waste byproducts enriched with high levels of metals that were disposed of on site. Smelting processes also had the potential to create large amounts of air pollution. Particulate and volatized metals found in smelter emissions may have contaminated areas downwind of these smelters. Smelters were mostly located next to creeks and rivers of the region near major transportation routes.

5) Naturally mineralized soils and rock. Soils and rock within the BPMD naturally contain high levels of metals. Over time, these geologic materials weather and erode into waterways. They likely contribute to a relatively metals-rich baseline background condition within natural areas of the BPMD. As noted in multiple sections of this BERA, identification and characterization of background conditions at this site represented a considerable challenge since much of the assessment area has been impacted by known and uncharacterized mine features. In addition, the BPMD covered a large area that contained a wide range of geological features and mineral types that may contribute to highly variable background conditions throughout the study area.

4.2 Release and transport mechanisms

The potential release and transport of BPMD-related contamination from the sources to points of contact with aquatic receptors depends on several physical and chemical processes which dictate the concentrations and spatial distribution of metals.

The following release and transport mechanisms may potentially be present throughout the BPMD:

- Erosion of metals-rich rock and soil by water, wind, and gravity from mine and mill waste sources to surrounding depositional, lower-elevation areas and floodplains;

- Transport of metals adsorbed to soil, waste rock and tailings particles via surface water runoff;

- Dissolution and leaching of metals from mine waste, host rock, or vein rock into soil solutions, pore water, and groundwater;

- Migration of metals in pore- and groundwater to floodplain soils, sediment and surface water in adjacent surface water features, and subsequent attenuation by dilution, dispersion, and sorption;

- Transport of dissolved and particulate metals in surface water to downgradient instream reaches and floodplains;

- Atmospheric deposition of metals-laden mine waste impacted soils as dust and emissions from smelters to surrounding floodplain soils and sediments, and;

- Uptake, accumulation, then trophic transfer of metals incorporated in tissues of aquatic and terrestrial plant, invertebrate, and wildlife food chains.

Metals-contaminated groundwater may sporadically or continuously emerge from the numerous adits, mine shafts and drainage tunnels located throughout the BPMD. Snow melt or rain water may interact with the tailings piles, waste rock piles, or slag piles, thereby becoming acidified. This acidified drainage water solubilizes high levels of metals which are then carried into the local waterways. Rapid snow melting or heavy rains may directly erode the various waste piles, thereby physically entraining metals-contaminated soil particles into the local waterways and depositing them into the substrate. Subsequent high-flow conditions during the annual snowmelt may entrain these particles and move them further downstream or deposit them along the banks of the waterways, depending on the local topography. Metals present in the waste material mixed in with the native river sediment can be released into the water column either as dissolved or particulate metals.

The Durango Reach is located outside of the direct influence of BPMD mining-related features. While not directly associated with BPMD, this reach is downgradient from BPMD contamination sources. As such, the Durango Reach received water and bed material carried downriver via BPMD gulches and creeks into the Animas River. Bed material may settle out along the Animas River between the BPMD and Durango reach and become incorporated into the river substrate as sediment. This transported material serves as a secondary source of contamination and could be mobilized and deposited in downriver reaches by high flows.

4.3 Suspected contaminants

Suspected contaminants at this site included potentially toxic heavy and essential metals, metalloids, and low pH. These contaminants are either directly or indirectly related to historic

mining and waste- management activities. Mined materials and wastes are naturally high in metal concentrations. These materials also contain sulfide minerals which, when exposed to water and air, produce sulfuric acid and highly-acidified drainage water known as acid mine drainage. This water dissolves and carries metals present in bedrock, veins, ore, tailings, and waste rock. These dissolved metals are then transported over land or via groundwater to small tributaries then into larger river reaches.

When released to the environment, acidic mine drainage may be buffered by native water and rock. The higher pH of the surface water in receiving waterways can cause some of the dissolved metals to precipitate out of solution and become integrated into the substrate. Metals may also be carried in particulate form (e.g., fine tailings) by the water current and deposited in lower-energy areas of the affected waterways. Previous investigations have shown that numerous metals in surface water samples collected from BPMD mine sites exceed applicable water quality standards (see Besser *et al.*, 2007; Chapter D in Church *et al.*, 2007). Additionally, the Upper Animas SLERA and BERA showed that BPMD waters and sediments have high concentrations of metals that could be toxic to BMIs, fish, and aquatic wildlife (EPA, 2013b; 2019).

The BPMD is located in the headwaters of the Animas River. As discussed in the previous section, BPMD contaminants have a high potential to be transported downriver into the Durango Reach. Therefore, the same BPMD contaminants are also suspected to impact the Durango Reach of the Animas River. However, the Durango Reach may also be impacted by contaminants from other sources that exist in the 33 miles between Silverton and James Ranch and within the watershed of the 22-mile reach itself. Most probable sources of contamination include urban runoff, agricultural runoff, waste water treatment plant (WWTP) effluents, and historic mining and smelting wastes from the BPMD and non-BPMD activities. These sources have the potential to release their own unique mix of contaminants into the Animas River. Toxic contaminants such as herbicides, pesticides, polycyclic aromatic hydrocarbons, surfactants, and pharmaceutical products are often associated with urban and agricultural runoff and WWTPs but not typically with mining activities. These sources can also release metals, the same contaminants potentially associated with BPMD sources, into the Durango Reach of the Animas River. The unknown magnitude of sources and related contaminants that may be present upgradient and within the Durango Reach makes identifying all suspected contaminants for this reach difficult and beyond the scope of this assessment. As such, this BERA focused on the same BPMD contaminants when assessing the Durango Reach risks.

4.4 Contact point and exposure media

The BPMD and Durango Reach EUs represent the points of contact with exposure media. EUs are specific exposure areas represented by concentrations of metals in exposure media that are used to calculate EPCs. Ecologically-relevant exposure media evaluated in this BERA consisted of surface water, sediments, pore water, and tissues of invertebrates, fish, and plants that have accumulated metals from the environment. Concentrations of contaminants in exposure media are summarized using two separate EPCs. Specifically, arithmetic mean or CTE and 95 UCL or RME values. The range of exposure scenarios provides less-conservative CTEs and more-

conservative RMEs in which the range of concentrations and magnitude of exposures experienced by receptors can be assessed. Section 8 of this BERA provides more information on the EPC-derivation methods.

4.5 Exposure routes

The major exposure routes for metals in surface waters, sediments, pore water, and dietary items within the BPMD and the Durango Reach to the receptors retained for evaluation in the Aquatic BERA are as follows:

- Direct contact of BMIs with sediment,
- Direct contact of BMIs with pore water,
- Direct contact of water-column invertebrates, fish, and amphibians with surface water,
- Ingestion of surface water by aquatic wildlife receptors,
- Incidental ingestion of sediment by wildlife receptors, and
- Ingestion of contaminated prey items by wildlife receptors.

Although the following exposure routes may occur, they are expected to be minor (most metals are not readily absorbed) and/or difficult to characterize (no established exposure models or toxicity evaluations) and are therefore not assessed in this BERA. This methodology was consistent with EPA (2007b) guidance on conducting metals-based risk assessments.

- Ingestion of contaminated dietary items by BMIs and fish,
- Direct contact of aquatic wildlife receptors with surface water and sediments, and
- Direct contact to or inhalation of dust (soil particles) by aquatic wildlife receptors.

4.6 Key ecological receptor groups

Key receptors should include aquatic community-level invertebrates, fish, amphibians and specific aquatic wildlife species ecological receptors that are relevant to the site, are culturally or ecologically important, and have high likelihood of exposure. Receptors should also be sensitive to metals exposure which, when elevated, result in physical dysfunctions, reduced growth, impaired reproduction, and/or mortality.

This BERA assumed that the BPMD and the Durango Reach supported the receptor groups listed below, or comparable receptors used as surrogate wildlife species.

- BMIs that live either on top of or within the substrate and sediments,
- Water-column invertebrates, fish, and amphibians that live either on top of the substrate or within the water column, and
- Aquatic birds and mammals that spend most of their life within riparian and floodplain habitats feeding on river-sourced food items (e.g. BMIs, fish, and aquatic plants).

4.7 Exposure pathways

Exposure pathways are the means by which contaminants can be transferred from a contaminated medium to the target receptors. This BERA evaluated the following complete exposure pathways:

- **BMIs**: direct contact with sediment and pore water.
- **Water-column invertebrates, fish, and amphibians**: direct contact with surface water.
- **Aquatic-dependent invertivorous birds**: ingestion of surface water, sediment and BMIs.
- **Aquatic-dependent herbivorous birds**: ingestion of surface water, sediment and plants.
- **Aquatic-dependent piscivorous birds**: ingestion of surface water, sediment and fish.
- **Aquatic-dependent herbivorous mammals**: ingestion of surface water, sediment and plants.
- **Aquatic-dependent piscivorous mammals**: ingestion of surface water, sediment and fish.

4.8 Conceptual Site Model

The BPMD Aquatic BERA CSM provides the foundation of a problem formulation and development of risk assessment and measurement endpoints. The current CSM was developed based on knowledge of natural and man-made sources of contamination, fate and transport of suspected contaminants, likely ecological receptors, and complete exposure pathways. All these elements are summarized in the previous sections. The CSM shows how metals move from the contaminant sources through the exposure media to the ecological receptors. **Figure 4-1** presents the CSM for this BERA.

SECTION 5 ASSESSMENT AND MEASUREMENT ENDPOINTS

Assessment endpoints represent explicit expressions of the key ecological resources to be protected from mining-related contaminants. These endpoints are generally associated with sensitive populations, communities, or trophic guilds (i.e., different feeding strategies). Listed below are general criteria used for selecting the assessment endpoints (EPA, 2016d):

- have ecological relevance (i.e. plausibly occur at the site),
- be susceptible to the stressors of concern,
- have biological, social, and/or economic value, and
- be relevant to the risk management goals for the site.

Measurement endpoints represent measurable ecological characteristics, quantified through predictive exposure/effects analyses and laboratory and field studies, which can be related back to the valued ecological resources chosen as the assessment endpoints. Measurement endpoints are required because it is often not possible to directly quantify risk to an assessment endpoint. Measurement endpoints should represent the same exposure pathway(s) and mechanisms of toxicity as the assessment endpoints to be relevant and useful in supporting risk-based decision making.

Risk questions establish a link between the assessment endpoints and their predicted responses. The risk questions provided in this section provide the basis for assessment and measurement endpoints for use in this BERA during risk characterization (EPA, 1997).

5.1 Representative receptor communities and species

It is neither practical nor possible to evaluate potential ecological risk to all the individual parts of the local aquatic ecosystem potentially affected by site-related contamination. Instead, key receptor groups and target species that are most likely to experience exposure and elicit toxic responses were identified to evaluate exposure and risk (EPA, 2016d). This BERA evaluates risk to two community-level receptor groups, namely aquatic BMIs, fish, and amphibians and five aquatic wildlife species.

5.1.1 Community-level receptors

This BERA evaluates potential ecological risks to aquatic invertebrates, fish, and amphibian communities in BPMD and Durango Reach waters under current conditions. It is understood that current conditions might not support healthy and diverse BMI communities. Similarly, contamination and/or habitat impacts may limit current distribution of fish and amphibians. Nevertheless, community-level risks and wildlife dietary exposures are assessed in aquatic habitats with impoverished BMIs and fishless aquatic communities. This assessment decision recognizes that aquatic community-level receptors may be healthier or present if not limited by

contamination. This BERA uses information from BPMD habitat assessments and aquatic community surveys to frame risks outcomes with respect to habitat suitability and current community compositions. The final outcome of this evaluation should be interpreted in a broader context, which considers naturally-altered surface water and substrate conditions.

Benthic macroinvertebrate communities

Aquatic BMIs form an integral link in all aquatic ecosystems. They play a key role in nutrient and energy transfers within those systems. They also process and assimilate organic material, feed on other invertebrates, and are themselves consumed by fish, birds, and mammals. BMIs reside and forage in and on instream substrates, including contaminated sediments. As such they are in direct contact and would have the greatest exposure to sediment- and pore water-based contamination. Key BMIs include amphipods and the aquatic life stages of numerous insect species (e.g., mayflies, stoneflies, and caddisflies).

Lentic and flowing BPMD habitats may also support water-column dependent invertebrates. These planktonic invertebrates, which spend a part of or their entire life-cycle in the water column, are in direct contact and have the greatest exposure to surface water-based contamination. Examples of water column-dependent invertebrates, include cladocerans, rotifers, and various BMI larvae (Williams, 1966; Martinez *et al.*, 2010).

Metals with the potential to bioaccumulate can be transferred from the sediment, surface water, or pore water into invertebrate tissues and up the aquatic food chain, thereby exposing higher-level receptors when they forage in impacted habitats. Significant alterations in invertebrate communities could also impact the energy cycling at the base of the aquatic food chain.

Fish communities

Similar to aquatic invertebrates, fish are also an integral link to healthy, functioning aquatic communities. They prey upon invertebrates and other fish or graze on algae and biofilm. When consumed by wildlife, they effectively transfer energy from instream habitats to floodplain habitats. Fish are also important biological resources to wildlife enthusiasts and anglers. Functioning fish communities can be visible symbols of healthy aquatic ecosystems and offer economic benefits to agencies and businesses that support sport fishing and general recreation opportunities.

Portions of the Animas River and its tributaries should be able to support a healthy fish community, consisting of cold-water stream species if not impacted with naturally high levels of metals and mine wastes. The aquatic environment should provide such a community with a diverse food base, suitable feeding and spawning areas, refuges for juvenile fish, and other essential environmental services. Results from BPMD fish surveys indicated that native fish are absent and/or existing fisheries are composed of metal-tolerant species (e.g. brook trout) in areas where suitable habitat was present, suggesting that some of the BPMD fish communities were likely limited by metals contamination (Besser and Brumbaugh, 2007; CPW, 2015; 2016a). It is

important to note that levels of naturally occurring metals in some locations suggests that portions of the site likely never supported significant aquatic communities (Church *et al.*, 1999) and brook and rainbow trout currently found in BPMD reaches are the result of historical and/or active fish stocking efforts.

Metals with the potential to bioaccumulate can be transferred from the sediment, surface water, or pore water into fish tissues and up the food chain. Significant alterations in or complete loss of fish communities could also impact the energy cycling in aquatic food chain, thereby harming higher-level wildlife receptors which feed on fish.

Amphibian communities

Where they occur, amphibians are an important part of the aquatic community where they help cycle energy from lower trophic levels and provide a prey base for predatory fish and wildlife. Amphibians are included herein to evaluate risks to the state-endangered boreal toad (*B. boreas*). Amphibians are often used in aquatic toxicity testing and included in the development of acute and chronic WQC for locally important and toxic meals (EPA, 1985; 1996; 2007a; 2016a; 2017e). Therefore, amphibians are evaluated as part of the aquatic community using WQC-based risk characterization methods.

5.1.2 Wildlife receptors

This BERA evaluates risks to select aquatic bird and mammal wildlife species. The Aquatic BERA work plan (EPA, 2016d) selected two bird and one mammal species for evaluation. However, two additional wildlife receptors are added and evaluated herein, namely the mallard (*A. platyrhynchos*) and muskrat (*O. zibethicus*). These two species were evaluated in the Upper Animas BERA and added here for completeness. This BERA evaluates exposure risks for the following target wildlife receptors:

- Invertivorous birds: represented by the American dipper (*C. mexicanus*)

The American dipper is a small passerine bird, which forages on the bottom of fast-moving rocky streams in mountainous regions of the western United States. It dives to the bottom of the stream where it seeks out and ingests aquatic insects and their larvae, but also small crustaceans (e.g., juvenile crayfish) or tiny fish and tadpoles. This species was selected for use in food chain modeling to represent invertivorous birds, which feed on aquatic insects and benthic invertebrates. It also served as a surrogate for the southwestern willow flycatcher, a federal- and state-endangered species of passerine invertivore listed for San Juan County, CO, which could be present in the riparian habitat of the Animas River.

- Omnivorous birds: represented by the mallard (*A. platyrhynchos*)

The mallard is a common dabbling duck species commonly found in ponds, lakes, rivers, and streams. Mallards feed by grazing on aquatic plants but will also consume invertebrates; especially during the breeding season. They are a prized species for waterfowl hunters. They can be important seed dispersers and prey for avian predators. This species was included to assess risks to birds associated with consumption of mixed diet that includes BMIs and aquatic plants.

- Piscivorous birds: represented by the belted kingfisher (*C. alcyon*)

The belted kingfisher is a piscivore that feeds mostly on fish that swim near the water surface or in shallow areas of ponds, lakes, rivers, and streams. Depending on food availability and season, they may also feed on other aquatic species such as crayfish, mussels, insects, and amphibians, among others. Kingfisher catch their prey by diving head-first into the water in flight or jumping from a perch along the shoreline. Kingfisher was selected to represent a bird species exposed to BPMD fish that have assimilated metals into their tissues from the local environment.

- Herbivorous mammals: represented by the muskrat (*O. zibethicus*)

The muskrat is a small aquatic rodent that inhabits a wide variety of freshwater habitats, including wetlands, rivers, lakes, and ponds. They mostly feed on cattail and other aquatic vegetation but will also consume invertebrates when vegetation is not available. They often build nests or burrows in the riverbank. Muskrat are important prey items for larger predatory wildlife. This species was selected to assess risks to mammals that consume aquatic plants.

- Piscivorous mammals: represented by the raccoon (*Procyon lotor*)

The raccoon is a nocturnal omnivore that lives in mixed forests, river floodplains, coastal marshes and urban areas. It is a habitat generalist that feeds on a wide variety of food items, including but not limited to invertebrates, plants, fish, amphibians, small birds and mammals. This species was selected for use in food chain modeling as an aquatic-dependent piscivorous mammal.

5.2 Adverse effects of metals exposure

This section summarizes adverse biological effects of acute and chronic (long-term) metal exposures to aquatic organisms. This information is helpful in understanding the possible adverse effects in aquatic receptors from exposures to suspected BPMD contaminants.

Aquatic communities

BMIs and fish can be very sensitive to metals exposures. When exposed to metals, BMIs can develop ionoregulation problems that can be lethal. Different BMI taxa have very different

sensitivities to metals. As such, metals contaminated waters may only support pollution tolerant species. These species also have potential to bioaccumulate metals into their tissues and thereby expose insectivorous species when consumed as forage. It is rare that BMIs are completely eliminated from aquatic communities; even in highly contaminated and/or poor habitats.

In fish and amphibians, toxicity to metals is primarily associated with oxidative stress which is the over production of free radicals in affected tissues and their effect on cellular functions (Sorensen, 1991). When antioxidant enzymes are overwhelmed, free radicals can damage cells in gills, liver, kidney, and other organs that are most exposed to or function in metabolizing metals (Sevcikova *et al.*, 2011). Acute exposures to high enough metals concentrations can be directly lethal to sensitive taxa. Chronic exposures can also be lethal or cause sublethal effects such as behavioral changes, osmoregulation dysfunction, reduced growth, deformities, lesions, and tumors. Fish and amphibian species can have much different sensitivities to metals exposure. As such, metals contaminated waters may be dominated by relatively metals-tolerant species and/or devoid of sensitive species. Finally, for a given species, metals sensitivity can be age-dependent. For example, juvenile fish are often more sensitive to metals exposure that larger juvenile and adult fish. As such, early life-stage and younger fish and amphibians may be missing, and adults may be present in metals contaminated waters.

Wildlife

In addition to being stressed from a reduced BMI and fish prey base, birds and mammals can be sensitive to direct metals exposures. Dietary exposures to metals can cause oxidative stress-related tissue and organ damage, reduced fecundity, immune system dysfunctions, reduced growth rates, decreased eggshell thickness, skeletal abnormalities, behavioral changes, dermatitis, anemia, tremors, and ataxia (Agency for Toxic Substances and Disease Registry [ATSDR], 2005, 2006; Eisler, 1985, 1988, 1998; EPA, 2005c, 2005d, 2007f; Irwin *et al.*, 1997; World Health Organization [WHO], 2005). All these deleterious effects can be detrimental to exposed individuals and, when severe and widespread, respective populations.

5.3 Endpoint selection and risk questions

The following assessment endpoints and risk questions are used to evaluate the potential for ecological risks to the targeted receptor groups and wildlife species in the BPMD and in the Durango Reach. It is assumed that evaluating and protecting these assessment endpoints would also protect all other similar aquatic receptors in the BPMD and Durango Reach EUs.

- **Maintain a stable and healthy BMI community**: *Are the contaminant levels in sediment and pore water high enough to affect survival, growth or reproduction in the BMIs?*

- **Maintain a stable and healthy water-column invertebrate, fish, and amphibian community:** *Are the contaminant levels in surface water high enough to affect survival, growth or reproduction in the water-column invertebrates, fish, and amphibians?*

- **Maintain stable and healthy aquatic-dependent invertivorous bird populations**: *Are the contaminant levels in surface water, sediment, and BMIs high enough to affect survival, growth, or reproduction in aquatic invertivorous birds?*

- **Maintain stable and healthy aquatic-dependent omnivorous bird populations**: *Are the contaminant levels in surface water, sediment, BMIs, and plants high enough to affect survival, growth, or reproduction in aquatic omnivorous birds?*

- **Maintain stable and healthy aquatic-dependent piscivorous bird populations**: *Are the contaminant levels in surface water, sediment, and fish high enough to affect survival, growth, or reproduction in aquatic piscivorous birds?*

- **Maintain stable and healthy aquatic-dependent herbivorous mammal populations**: *Are the contaminant levels in surface water, sediment, and plants high enough to affect survival, growth, or reproduction in aquatic herbivorous mammals?*

- **Maintain stable and healthy aquatic-dependent piscivorous mammal populations**: *Are the contaminant levels in surface water, sediment, and fish high enough to affect survival, growth, or reproduction in aquatic piscivorous mammals?*

5.4 Measurement endpoints

The following section identifies one or more measurement endpoints that are used to evaluate each assessment endpoint. for some assessment endpoints. In cases where multiple measurement endpoints are identified, this BERA does not attempt to prioritize endpoints with respect to one another since each endpoint provides an independent evaluation of risks and has uniquely inherent strengths and weaknesses.

Assessment endpoint #1:

Maintain a stable and healthy BMI community: *Are the contaminant levels in sediment and pore water high enough to affect survival, growth or reproduction in the BMIs?*

This Aquatic BERA uses up to four measurement endpoints to assess the potential impacts of metals to BMI communities:

1.A Compare the metal levels in bulk sediment samples to sediment no- and low-effect ecological screening values (ESVs).

1.B Compare the metals levels in pore water samples to surface water acute and chronic ESVs.

1.C Assess the toxicity of field-collected BPMD and Durango Reach sediments to the freshwater amphipod *H. azteca* after 10-day exposure in the laboratory.

1.D Assess the structure and function of the BMI community in the field.

Assessment endpoint #2:

Maintain a stable and healthy water-column invertebrate, fish, and amphibian community: *Are the contaminant levels in surface water high enough to affect survival, growth or reproduction in water-column invertebrates, fish, and amphibians?*

This Aquatic BERA uses up to three measurement endpoints to assess the potential impacts of metals to the water-column communities (2.A through 2.C). An additional habitat assessment endpoint was added and evaluated herein (2.D) to help discern COPEC exposure risks with respect to instream habitat quality and thermal regimes for trout.

2.A Compare metals concentrations in surface water to surface water acute and chronic ESVs.

2.B Assess the toxicity of field-collected BPMD surface water to juvenile rainbow trout (*O. mykiss*) after 96-hour exposure in the laboratory.

2.C Assess the presence or absence of fish in the field.

2.D Assess the quality of instream fish habitat and thermal suitability at locations within each EU.

Assessment endpoint #3:

Maintain stable and healthy aquatic invertivorous bird populations: *Are the contaminant levels in surface water, sediment and BMIs high enough to affect survival, growth, or reproduction in aquatic invertivorous birds?*

This Aquatic BERA used one measurement endpoint to assess the potential impact of metals ingested by this receptor group:

3.A Use metal levels measured in surface water, sediment and BMIs in a food chain model to calculate metal-specific EDDs for comparison against avian no- and low-effect TRVs.

Assessment endpoint #4:

Maintain stable and healthy aquatic omnivorous bird populations: *Are the contaminant levels in surface water, sediment, BMIs, and plants high enough to affect survival, growth, or reproduction in aquatic omnivorous birds?*

This Aquatic BERA used one measurement endpoint to assess the potential impact of metals ingested by this receptor group:

4.A Use metal levels measured in surface water, sediment, BMIs, and plants in a food chain model to calculate metal-specific EDDs for comparison against avian no- and low-effect TRVs.

Assessment endpoint #5:

Maintain stable and healthy aquatic piscivorous bird populations: *Are the contaminant levels in surface water, sediment, and fish high enough to affect survival, growth, or reproduction in aquatic piscivorous birds?*

This Aquatic BERA used one measurement endpoint to assess the potential impact of metals ingested by this receptor group:

5.A Use metal levels measured in surface water, sediment, and fish in a food chain model to calculate metal-specific EDDs for comparison against avian no- and low-effect TRVs. Note that the BERA work plan (EPA, 2016d) stated that kingfisher exposure would be evaluated using surface water and fish metals concentrations, but not sediment. Sediment was added herein because this species would likely incidentally ingest sediment when excavating nests in river banks and preying on fish.

Assessment endpoint #6:

Maintain stable and healthy aquatic herbivorous mammal populations: *Are the contaminant levels in surface water, sediment, and plants high enough to affect survival, growth, or reproduction in aquatic herbivorous mammals?*

This Aquatic BERA used one measurement endpoint to assess the potential impact of metals ingested by this receptor group:

6.A Use metal levels measured in surface water, sediment, and plants in a food chain model to calculate metal-specific EDDs for comparison against no- and low-effect mammalian TRVs.

Assessment endpoint #7:

Maintain stable and healthy aquatic piscivorous mammal populations: *Are the contaminant levels in surface water, sediment, and fish high enough to affect survival, growth, or reproduction in aquatic piscivorous mammals?*

This Aquatic BERA used one measurement endpoint to assess the potential impact of metals ingested by this receptor group:

7.A Use metal levels measured in surface water, sediment, and fish in a food chain model to calculate metal-specific EDDs for comparison against no- and low-effect mammalian TRVs.

5.5 Insights gained from the previous BPMD aquatic risk assessment activities

The Upper Animas BERA focused on Animas River reaches just above and below the town of Silverton (EPA, 2019; **Attachment 1**). The results of the risk characterization for the Animas River above the confluence with mainstem Cement Creek indicated that upgradient sources of metals were present in the watershed. This point was supported by the fact that a large portion of the BPMD is located above Silverton, CO. Also, many of the 48 NPL BPMD listed mining features are located upgradient of Silverton. Since these areas are likely most impacted by BPMD contamination, new assessments should characterize exposure and risk to receptors in the Animas River watershed above the confluence with mainstem Cement Creek. As such, this Aquatic BERA assesses risks to aquatic receptors in the mainstem of the Animas River and associated tributaries and gulches to respective headwater reaches upgradient from Silverton.

The Upper Animas BERA characterized risk to aquatic ecological receptors in Cement Creek, the Animas River Silverton reach, and the Animas River Canyon reach using samples collected prior to the GKM release. As discussed in Section 3.3, analysis of surface water and sediment samples and biological data collected and analyzed before, during, and after the GKM release event indicated that any release-related impacts were short in duration and were not expected to have resulted in significant changes in current instream conditions since the draft Upper Animas BERA was initially developed.

The Upper Animas BERA Mineral Creek EU was represented by a single sampling location (M34) near the Animas River confluence. This location may not reflect exposure and risks found throughout the watershed, as the Mineral Creek watershed is large and diverse. For example, the total area is about 1/3rd of the area of the entire BPMD study area (see **Figure 1-2**). Contamination may not be equally distributed throughout this large area. Mineral Creek also has

several tributaries that have received few to no mining impacts. As such, the current Aquatic BERA reevaluates risks in Mineral Creek using multiple EUs that correspond to the unique geographic and habitat attributes of this watershed.

The Upper Animas BERA relied on sediment-to-biota equations and factors to estimate metals concentrations in wildlife dietary item tissues. These equations and factors were obtained from readily-available literature sources and may not adequately represent what would occur in the BPMD. As such, this Aquatic BERA used analytical data from site-specific BMI and fish tissue samples to estimate realistic wildlife exposures. However, tissue modeling is still required to estimate concentrations of metals in plant tissue and other dietary items not collected within specific EUs evaluated herein.

The Upper Animas BERA assessed surface water risks according to three distinct hydroperiods; pre-runoff (January to April), runoff (May and June), and post-runoff (July to December). These hydroperiods are based on annual snowmelt and related hydrogeological cycling which affect metals transport and subsequent receptor exposure regimes. The Upper Animas BERA identified that water hardness and metals concentrations were unique to each hydroperiod within an EU. Therefore, this Aquatic BERA also uses a hydroperiod-based exposure and risk characterization analysis when assessing risks to invertebrates and fish exposed to surface water contamination.

SECTION 6 DATA PROCESSING & BASELINE ECOLOGICAL EFFECTS METHODS

This section summarizes environmental data processing steps and briefly describes methods used during laboratory toxicity testing and field aquatic community and tissue sampling field surveys. More detailed descriptions of these studies are provided in respective work plans and data reports; citations and full references are provided below. This section also summarizes the sources of toxicity benchmarks used to evaluate exposure data during COPEC selection and risk characterization.

6.1 Sources of environmental media data

This Aquatic BERA uses chemistry data from environmental samples collected, analyzed and compiled by EPA. Most of these data are stored and maintained by EPA in a BPMD-specific Scribe database (EPA, 2018b). The Scribe database is the same one that can be accessed through the EPA-sponsored online GeoPlatform BPMD project sample results viewer. Note that this database does not contain analytical chemistry data from samples collected during in the initial GKM release event response phase that lasted to about two months after the release.

As of January 2018, the full BPMD Scribe database contained about 200,000 entries for over 13,000 samples. Not all of these samples are relevant to assess aquatic risks in this Aquatic BERA. For example, in consultation with the BPMD BTAG, hundreds of established sampling locations in the Animas River and Mineral Creek watersheds were not selected to represent the 27 EUs evaluated in this BERA (EPA, 2017f). As defined in Section 1, the 27 EUs assessed herein are represented by one to five established sampling locations in each EU, for a total of 43 individual locations. All environmental media data from locations not representing one of the 27 EUs are not considered herein. The Scribe database also contains chemistry data for multiple environmental media such as road dust, upland soils, floodplain soils, and seeps/springs samples that were collected for human health risk assessments and other purposes. These data are also culled out of the working Aquatic BERA dataset.

The second source of environmental chemistry data is the EPA (2016f) conceptual monitoring plan (CMP) database. This database was obtained from EPA's GKM follow-up monitoring data webpage in early February 2018 (https://www.epa.gov/goldkingmine/follow-monitoring-data-gold-king-mine-incident). These data were collected during the second, monitoring phase of the GKM response that occurred between October 27, 2015 and June 14, 2017. The first GKM event response phase occurred immediately after the release and continued at various downstream locations for about two months. The second phase started after the first phase and followed guidance provided in the CMP (EPA, 2016f). The CMP focused on long term environmental monitoring at downriver sampling locations, which included sites in the Durango Reach. The BPMD Scribe database only contains a few samples from that reach. As such, environmental data collected under the CMP are primarily used to increase the Durango Reach exposure

dataset. The CMP also included data for the Mineral Creek M34 sampling location which was used as a local reference site not influenced by the GKM release. The CMP M34 dataset is incorporated into the current exposure analysis for EU-01.

6.2 Data summarization method

The following procedures were applied to compile and process chemistry data for metals in a given matrix to calculate the summary statistics used in this BERA:

- Results assigned laboratory or data validation qualifiers indicating that an analyte was positively detected or presumptively present (i.e., data without flags or data flagged as "D" [diluted] or "J" [estimated]) are retained as reported for use in the exposure calculations.

- Results assigned qualifiers indicating that an analyte was not positively detected (i.e., data flagged as "U" [non-detected] or "UJ" [estimated non-detected]) are retained at one-half their detection limit (DL)[b].

- Any results considered of inadequate quality (i.e., data qualified as "R") are not used in the risk calculations.

- Analytical results for samples collected from the same location but during different sampling events are considered unique samples and were not combined.

- Only non-quality control field assessment samples are considered. Therefore, analytical data from duplicate samples (i.e., samples collected at the same location, date, and time as the assessment samples) are not considered.

- All surface water results are grouped into three distinct hydroperiods to support hydroperiod-based exposure assessments. This approach ensured that the surface water exposures reflect the seasonal differences in exposure conditions. Hydroperiods are defined as follows:

    - Pre-runoff period: January, February, March, and April,
    - Runoff period: May and June, and
    - Post-runoff period: July, August, September, October, November, and December

[b] Although other data summation methods are available, use of ½ of the reported DLs when identifying COPECs and calculating exposure scenarios is a common and acceptable approach when working with censored datasets (EPA, 2017). This approach was also prescribed in the BERA work plan (EPA, 2016). Excluding a few specific metals (silver and mercury), most of exposure datasets were generated using adequately sensitive analytical methods and did not contain excessive proportions (<15%) of non-detect values.

6.3 Wildlife food chain modeling

Section 5.1 introduced the five wildlife receptors evaluated in this BERA using exposure modeling. These receptors include the American dipper (representing invertivorous birds), mallard (representing omnivorous birds), belted kingfisher (representing piscivorous birds), muskrat (representing herbivorous mammals), and raccoon (representing piscivorous mammals).

Wildlife species are assumed to be exposed to COPECs by direct ingestion of unfiltered surface water (TRM), incidental ingestion of sediment, and by feeding on dietary items that accumulated metals from the local aquatic environment. This BERA calculates total EDDs for each wildlife receptor to estimate their exposure using a standard additive exposure equation which incorporates species-specific exposure parameters.

The total EDD (EDD_{total}) experienced by the aquatic wildlife receptors foraging in the BPMD and Durango Reach EUs is the sum of the doses obtained from the three major routes of exposure, as follows:

$$EDD_{total} = EDD_{diet} + EDD_{water} + EDD_{sediment}$$

The dose associated with each exposure route is calculated as follows:

Dose from feeding on aquatic biota (BMIs, fish, and plants):

$$EDD_{diet} = FIR \times C_{biota} \times DF_i \times AUF$$

Where:

EDD_{diet}	= Dose of COPEC from feeding on aquatic biota (mg COPC/kg body weight [BW]-day)
FIR	= Food ingestion rate (kg food/kg BW-day, dry weight [DW])
C_{biota}	= RME or CTE COPEC level in each food item (mg/kg, DW for BMIs, fish and plants)
DF_i	= Dietary fraction of each food item (unitless; proportion of food type in the diet)
AUF	= Area use factor (unitless; assumed 1.0 for all wildlife receptors)

Dose from ingesting surface water:

$$EDD_{water} = WIR \times C_{water} \times AUF$$

Where:

EDD_{water} = Dose of COPEC obtained from drinking river water (mg COPEC/kg BW-day)
WIR = Water ingestion rate (L/kg BW-day)
C_{water} = RME or CTE COPEC level in drinking water (mg COPEC/L water)
AUF = Area use factor (unitless; assumed 1.0 for all wildlife receptors)

Dose from ingesting sediment:

$$EDD_{sediment} = SIR \times C_{sediment} \times AUF$$

Where:

$EDD_{sediment}$ = Dose of COPEC obtained from incidental ingestion of sediment (mg COPEC/kg BW-day)
SIR = Sediment ingestion rate (kg/kg BW-day, DW)
$C_{sediment}$ = RME or CTE COPEC level in sediment (mg COPEC/kg sediment, DW)
AUF = Area use factor (unitless; assumed 1.0 for all wildlife receptors)

Table 6.1 provides wildlife species-specific exposure parameters (e.g., BWs, ingestion rates, relative consumption of food items, etc.), as well as the reference sources and assumptions on which these values were based.

6.4 Toxicity testing

A series of laboratory toxicity tests were conducted to assess acute and sub-chronic toxicity in field-collected surface water and sediment samples, respectively. The methods and results from these tests have been published in stand-alone reports and are briefly summarized below.

6.4.1 Surface water toxicity testing

This Aquatic BERA uses results obtained from BPMD acute surface water toxicity tests to address assessment endpoint 2.B. Toxicity tests were conducted to characterize the effects of mine waste-impacted surface water on a site-relevant, sensitive fish species under acute exposure conditions. EPA Region 8 Environmental Services Assistance Team (ESAT) performed four sets of toxicity tests using surface water collected in October 2012, November 2012, April 2013, and October 2016 at their Golden, CO laboratory (EPA, 2013a; 2013c; 2017c). These tests consisted of exposing juvenile (15-30 days post yolk sac absorption) rainbow trout (*O. mykiss*) for 96 hours to undiluted field-collected water samples. In total, at least one toxicity test was conducted with surface water collected from representative monitoring sites at 19 BPMD and 6 reference EUs. No aquatic toxicity tests were conducted with surface water collected in the Durango

Reach. However, one aquatic toxicity test was conducted with surface water collected from Hermosa Creek, the Durango Reach reference site.

All the surface water toxicity tests were conducted according to EPA (2002b) guidance, met test acceptance criteria, and were ran under acceptable exposure conditions. Each test had four replicates, each containing ten individual fish. The average weight of rainbow trout at the start of each 96-hr test ranged from 0.17 to 0.84 grams among the four tests. Each test had at least one control test where trout were exposed to either moderately hard (2012 and 2013) or soft reconstituted laboratory water (2016). Control test performance was acceptable regardless of which type of reconstituted water was used. A reference toxicity test was also conducted for each test. Reference toxicity tests exposed trout to reconstituted laboratory water spiked with serial dilutions of zinc sulfate as the toxicant. **Table 6.2** summarizes the mortality estimates obtained from reference toxicity tests. As seen in this table, reference test LC50s (modeled zinc concentration in which 50% of the test organisms would die) were comparable among all four sets of tests.

The juvenile trout were not fed during the 2012 tests but were fed during the 2013 and 2016 tests (**Table 6.2**). Fish are not routinely fed during 96-hour tests, due to potential for waste accumulation, subsequent fouling of test chambers, and associated metabolic changes that might affect contaminant exposure and uptake. Fish were fed in later tests to help improve survival. Water quality was not degraded between renewals as test exposure water was renewed daily with respective field-collected surface water. This and comparable LC50 between the 2012 and 2013/2016 tests suggested that feeding did not have a negative impact on test performance.

Percent survival was measured at the end of the 96-hour exposure duration. Comprehensive Environmental Toxicity Information System (CETIS) statistical software was used to identify statistically significant differences in trout survival between field collected surface water and laboratory control tests. Samples of exposure water were collected at the start and the end of each test and analyzed for TRM and DM. Dissolved oxygen (DO), pH, conductivity, and temperature were measured directly from each replicate each day.

6.4.2 Sediment toxicity testing

This BERA uses results obtained from BPMD sediment toxicity tests to address assessment measurement endpoint 1.C. Toxicity tests were conducted to characterize the effects of mine waste-impacted sediments on a sensitive benthic invertebrate species (*H. azteca*) under sub-chronic exposure conditions. The EPA Region 8 ESAT performed four sediment toxicity tests at the Golden, CO laboratory on December 2012, November 2014, November 2016, and November 2017 (EPA, 2012a; 2015a; 2017d; 2018c). The samples used in each test were collected in October and November 2012, September 2014, October 2016, and September 2017, respectively. These tests consisted of exposing 7- to 14-day old juvenile amphipods (*H. azteca*) for 10 days to the field-collected sediment samples. At least one test was conducted using sediment samples collected from one sampling location at each of the 27 EUs. Multiple tests were conducted for a

handful of sampling locations over the course of several years. These sampling locations were M34, A56, 32nd Street Bridge, above Lightner Creek, Purple Cliffs, and lower Hermosa Creek.

All of the sediment toxicity tests were conducted according to EPA (2000b) Method 100.1 guidance, met test acceptance criteria, and were ran under acceptable exposure conditions. Each test had eight replicates, each containing ten amphipods. Each 300 milliliter (mL) test chamber was filled with 100 mL of sediment and 175 mL of moderately-hard reconstituted laboratory water. The overlying water was renewed daily. The test organisms were fed during the 10-day exposure period. Survival and growth were estimated at the end of the test. Samples of the overlying water were collected at the start and end of each test and analyzed for TRMs and DMs. Sediment and filtered pore water samples were collected at the start of each test and analyzed for TRMs (September 2017 only) and DMs (all tests), respectively. DO and temperature were measured directly from each replicate each day. Overlying water conductivity, pH, alkalinity, anions, and ammonia were measured in overlying water samples collected at the start and end of each test.

Amphipod biomass was also measured at the end of each test, in addition to survival. Biomass was defined as the total dry-weight of the surviving organisms across replicates in a single test (sediment sample) at the end of the test divided by the number of organisms introduced in that sample at the start of the test. CETIS statistical software was used to identify statistically significant differences in survival and biomass between field site sediment and laboratory control tests.

6.5 Benthic invertebrate surveys and habitat assessment

This BERA uses MSI (2016; 2017a,b) BMI community surveys and instream habitat data to address assessment endpoint 1.D (Section 5.3). The MSI surveys were conducted during the fall of 2015 and 2016. At least one survey site was located in each of the 19 BPMD, two Durango Reach, and six reference EUs. MSI (2016; 2017a) surveys were conducted throughout the Durango Reach (Oxbow Park, 32nd Street Bridge, above the Lightner Creek confluence, and Purple Cliffs) about a month after the GKM release in September 2015. These surveys were conducted to evaluate if the GKM release negatively affected BMI community health and species known to be sensitive to metals contamination. Although MSI (2016; 2017a) summarized results from historic, pre-release BMI surveys, only results from the September 2015 post-release surveys are used herein. These surveys represent the most current conditions available for the Durango Reach and were conducted using the same methodology as MSI (2017b) BPMD surveys. The MSI (2017b) surveys are most recent to the BPMD, spatially comprehensive, and specifically designed to support this BERA and are the primary source of BMI community composition data for assessment EU-01 through -19 and reference EU-R1 through -R6.

6.5.1 BMI community survey methods

The MSI (2016; 2017a,b) BMI sampling method, i.e., the targeted riffle method, followed, to the greatest extent possible, those developed by Anderson (2007) which was historically used within the Animas River watershed. This method used a rectangular dip net coupled with a dolphin cup to collect BMIs. At each sampling location, ten dip net subsamples were collected at even intervals along a 150-meter (m) reach. At each subsample location, about 0.115 m^2 of bottom substrate was disturbed for 30 seconds, by hand in front of the dip net. This action allowed dislodged BMIs to drift into the dolphin cup. All BMIs and debris collected from each subsample location were composited into a single sample that represented all the organisms and taxa collected from 1.15 m^2 of habitat at each site.

BMI community samples were brought back to the laboratory for taxa identification and enumeration. All samples were processed by MSI staff and Dr. Michael Bogan of the University of Arizona. Processing consisted of subsampling a random 500 organisms from each field sample. These 500 organisms were identified to the lowest-practical taxonomic level based on Merrit and Cummins (1996) keys. As a quality control step, around 10% of all taxa were independently verified by Dr. Bogan. All organisms collected were identified and enumerated if a sample contained less than 500 organisms.

MSI (2016; 2017a,b) reported several common metrics to assess the composition and health of BMI communities, namely number of organisms, number of taxa per sample, Shannon-Weaver Diversity Index (H'), Hilsenhoff Biotic Index (HBI), and numbers and percent abundance and occurrence of sensitive taxa. The CO Department of Public Health and Environment ([CDPHE], 2010) MMI scoring and aquatic life attainment analyses were also conducted. The MMI scoring tool is composed of numerous, separate benthic invertebrate indices calibrated to respond to stressors affecting aquatic communities in one of three biotypes. A biotype is defined as an aggregation of macrobenthos sites that have similar general environmental attributes, such as elevation, stream slope, and ecoregion. The BPMD and Durango Reach sampling locations were assumed to be in the CO Mountain, Biotype 2 attainment threshold category.

The MMI scores are compared to aquatic life attainment threshold category thresholds. The attainment and impairment thresholds for Mountain Biotype 2 are 50 and 42 (unitless), respectively. MMI scores that fell between the two thresholds are identified as being in a gray zone. Locations with MMI scores in the gray zone are further evaluated using diversity and stressor tolerance metrics. These metrics are BMI community H’ and HBI, respectively. CDPHE (2017c) Class 1 waters H’ and HBI thresholds were used in this analysis. A grey zone site is considered impaired if H’ was less than 3.0 or HBI was greater than 5.1. These thresholds are specific to the CO Mountain, Biotype 2 attainment category. Note that this analysis does not consider whether or not a site had an official State of CO aquatic life designation. Many sampling locations in the BPMD do not have aquatic life designations. Nevertheless, all sites are assumed to be in the CO Mountain, Biotype 2 attainment threshold category.

CDPHE (2017a) developed a new version of the MMI model to improve indicators, refine stream classifications, and add new benthic samples collected from reference and test sites throughout Colorado. This model was used to update and normalize all of the MMI scores from BMI surveys that this BERA relies on; including historic surveys summarized in the Upper Animas BERA. As such, MMI scores presented in this BERA may not match those reported in respective, cited supporting studies.

6.5.2 BMI habitat assessment methods

BPMD BMI instream habitat was assessed by MSI (2016; 2017b) using the CDPHE's (2015) "105-Count Procedure." This procedure involved establishing transects within each 150-meter reach along which substrate composition and condition were measured. Habitat condition was also evaluated using the habitat assessment protocol developed for high-gradient streams by Barbour *et al.* (1999). This protocol involved numerically scoring epifaunal substrate/available cover, embeddedness, velocity/depth regime, sediment deposition, channel flow status, channel alteration, frequency of riffles, bank stability, vegetation, and riparian vegetative zone on site- and protocol-specific worksheets. Note that MSI (2016) did not assess instream habitat when conducting the Durango Reach surveys; therefore, this information is not available for Durango Reach EUs. However, EPA is thoroughly familiar with the general habitat features in this reach and present this information herein when appropriate.

6.6 Site-specific dietary item sampling

Site-specific BMI, fish, and aquatic plant tissue sampling and modeling was conducted to estimate wildlife dietary exposures to COPECs. This section describes how tissue chemistry data were obtained and processed into working wildlife exposure datasets.

6.6.1 BMI tissue

This BERA uses BMI tissue chemistry data obtained from four sources (EPA, 2012c, 2014, and 2015d, and MSI 2017b). These sources provide BMI tissue chemistry data for 15 of the 19 BPMD EUs, the six reference EUs, and the two Durango reach EUs.

Each BMI tissue data source followed the same general sampling and analysis methods. Briefly, BMIs were collected throughout each of the sampling locations using a rectangular dip net until enough sample mass was obtained. The dip-netted BMI were separated from sediment, rocks, organic matter, and other debris by picking using decontaminated forceps. BMIs were then placed into a clean, decontaminated sample bottle and sent to the EPA Region 8 ESAT laboratory for chemical analysis. All samples were analyzed for TRM using EPA methods 200.7 and 200.8, and mercury using EPA method 2473A. Results were all reported on a DW basis.

Site-specific BMI tissue chemistry data are not available for EU-06, EU-15, EU-17, and EU-18. Therefore, this BERA uses co-located sediment and tissue results from the sediment and BMI

tissue datasets to build regression models to estimate BMI tissue concentrations for these four EUs from the sediment analytical data. This analysis was done by pairing metals concentrations in sediments with tissue samples collected at the same location, date, and time, plotting results, and semi quantitatively selecting the best fitting or most conservative models. Microsoft Excel was used to build scatter plots for each metal with sediment concentrations as the independent variable and BMI tissue concentrations as the dependent variable. Linear, logarithmic, and power regression models were applied to each scatter plot using Microsoft Excel. The direction of each regression model's slope and R^2 value were inspected for each plot to assess the applicability of modeling BMI tissue from sediment. No attempt was made to test for assumptions or significance of slope terms. Of the three regression models, the one with the greatest R^2 was selected as the best fit regression model. No minimum R^2 value threshold was considered. A site-specific model was not derived if all three regression slopes were negative. Next, sediment-to-invertebrate tissue models (equations) and uptake factors (single multiplication values) used in the Upper Animas BERA (EPA, 2019; **Attachment 1**) were applied to the site-specific BMI and sediment metals scatter plots. This approach allowed for a direct comparison between site-specific models, Upper Animas BERA models, and actual BMI and sediment metals concentrations. These plots and models are provided in **Appendix 6** of this BERA.

The next step in this process was to select the model or factor with the best fit to the data or when similar, the most conservative sediment-to-invertebrate model or factor. **Table 6.3** provides the sediment-to-invertebrate models and factors used in this BERA to estimate BMI tissue metals concentrations for the four EUs for which BMI tissue data are unavailable. In total, only two of the ten bioaccumulative metals (i.e., mercury and zinc) are modeled using site-specific data because site-specific models are more conservative than Upper Animas BERA models or site-specific data are too variable to be modeled. All other metals are modeled based on the same equations and factors used in the Upper Animas BERA, which often results in tissue levels well above those observed in site-specific samples (**Appendix 6**).

6.6.2 Fish tissue

Whole body (WB) fish tissue chemistry data are needed to estimate piscivorous wildlife dietary exposure in EUs in which fish tissue samples are unavailable. Field collected fish tissue samples data were obtained from EPA (2014) and USGS (2018). These sources provide fish tissue chemistry data for three of the 19 BPMD EUs, one of the six reference EUs, and none of the Durango Reach EUs.

EPA (2014) obtained WB fish tissue samples from a September 2014 fish survey that was conducted at monitoring location A45 in EU-09 (CPW, 2014). Twenty brook trout (total length [TL] range, 6.4 to 17.7 centimeters [cm]) were collected, euthanized, and placed in clean, new sample containers. These fish were transported to the EPA Region 8 ESAT laboratory for chemical analysis. All samples were analyzed for TRM using EPA Methods 200.7 and 200.8, and mercury using EPA Method 2473A. The WB fish tissue results were all reported on a DW basis. Since this BERA investigates fish-based exposure risks to belted kingfisher and raccoon,

only fish small enough to be prey to these two species are used to estimate exposure; namely, fish with TLs under 18 cm as prescribed in the EPA (2016d) BERA work plan. All 20 trout collected from EU-09 in September 2014 measured less than 18 cm and retained for wildlife exposure analyses.

Forage and adult fish were collected and retained for chemical analysis as part of the USGS (2018) fish community survey (Section 6.7). Both fish fillets and the associated carcasses were analyzed for TRM. Wet weights (WWs) were also taken of each whole fish, fillet, and carcass. These measurements were used to reconstruct a WB fish tissue concentration for each sample using a mass balance-based approach. In total, ten forage fish (<18 cm TL) WB tissue results were obtained from USGS (2018). Together, these fish were collected from EU-03, EU-05, EU-09, and the Mill Creek reference EU. Fish were also collected from Maggie Gulch, but they are too large to be considered forage for wildlife receptors (TLs >18 cm).

Since site-specific fish tissue data are only available for three BPMD and one reference EU, sediment-to-fish tissue modeling was conducted to estimate WB fish tissue metals concentrations for remaining EUs. As noted in Section 5.1.1, many of these EU do not currently support fish. Nevertheless, the Aquatic BERA assumes that they do occur for the purpose of estimating hypothetical wildlife exposures.

Fish tissue modeling uses the same approach as BMI modeling, described in Section 6.6.1. **Appendix 7** provides fish tissue vs. sediment scatterplots with site-specific and the uptake equations and factors used in the 2015 Upper Animas BERA. **Table 6.4** provides all of the regression model equations and uptake factors used to estimate fish tissue metals concentrations from sediment metals concentrations. In total, four of the ten bioaccumulative metals (i.e., cadmium, copper, selenium, and zinc) are modeled using site-specific data. The remaining six metals are modeled based on the factors used in the Upper Animas BERA.

6.6.3 Plant tissue

Tissue chemistry data on aquatic plants are needed to estimate dietary exposures in herbivorous and omnivorous wildlife. However, field collected plant tissue chemistry data are not available for use in this BERA. As such, the plant tissue residue levels are estimated using the sediment-to-plant tissue equations and factors used in the 2015 Upper Animas BERA (EPA, 2019; **Attachment 1**). These equations and factors are summarized in **Table 6.5**.

6.7 Fish habitat assessments and community surveys

This BERA uses information obtained from a site-specific habitat assessments and co-located fish community surveys to evaluate risk measurement endpoint 2.C (Section 5.3). This effort was conducted by USGS (2018) following protocols presented in detail within approved EPA SAPP/QAPs (2016e), Appendix A, *Animas River Fish Habitat Protocol*. The habitat assessments were conducted to characterize the current and potential fish habitat in the BPMD Animas River

watershed. Habitat assessments and fish surveys were conducted concurrently in the fall of 2016. USGS (2018) did not survey Durango Reach fish communities or habitat; however, historic fish survey data are available for and EPA is thoroughly familiar with the general fish habitat characteristics in this reach and reports on them when appropriate.

USGS (2018) fisheries surveys targeted specific reaches within each EU with optimal fish habitat. Survey reaches were selected by considering past survey locations, presence of potential fish habitat, and input from EPA and BTAG members. A total of 19 fisheries survey reaches among the 24 BPMD EUs were identified and surveyed using qualitative electrofishing techniques (i.e., spot shocking). This left five BPMD EUs that were not surveyed by USGS (2018); namely, EU-02, EU-04, EU-06, EU-07, and Picayne Gulch. Physical habitat assessments were conducted in most BPMD Animas River and tributary EUs (12 of 18 EUs) but not in any Mineral Creek EUs.

The fish community surveys occurred before the habitat assessment activities to reduce the risk of scaring fish out of the study reach. The surveys used a backpack electrofishing unit and dip nets to sample fish. Electrofishing focused on the highest-quality fish habitat in each reach and progressed in an upstream direction until fish presence was documented or the upper end of the reach was attained. All captured fish were identified, photographed, and released, except for those individuals that were retained for chemical analysis (Section 6.6.1). These surveys provide a one-time snapshot of fish presence/absence information for each of the 19 survey reaches.

Physical habitat assessment included measuring stream gradients, length, width, and depth, identifying and enumerating micro habitats, and characterizing substrate and riparian compositions. USGS (2018) authors developed fish habitat ratings that considered the above physical habitat parameters measured in each survey reach. Stream temperature, intermittency, relative conductivity (STIC) loggers were deployed in survey reaches to monitor year-round thermal regimes and presence of liquid water at 26 locations throughout the BPMD Mineral Creek and Animas River and associated tributaries. STICs deployed in fall 2015 were located, data downloaded, and redeployed until fall 2016. STICs deployed in fall 2016 were retrieved in fall 2017. In total, STIC temperature and water intermittency data were available for most of the fish survey reaches and EUs; some STICs and their data were lost and data not recovered. Annual thermal regimes were determined for each STIC sampling point and compared to literature-based regimes for cutthroat trout (Harig and Fausch, 2002) as well as a reference cutthroat trout thermal regime data set from cutthroat trout streams in Rocky Mountain National Park and in the mountains surrounding the San Luis Valley of CO.

6.8 Toxicity benchmarks

Toxicity benchmarks are used to select COPECs and generate HQs for community-level and wildlife receptors that have complete exposure pathways. The benchmarks consist of readily-available, literature-based ESVs and TRVs that correspond to acute and chronic effects in surface and pore water for fish and water-column invertebrates, and no- and low-effect sediment

concentrations and dietary thresholds for BMIs and wildlife, respectively. Specifically, ESV are direct-contact toxicity benchmarks based on concentrations of contaminants in surface water, pore water and sediments. They have units of micrograms per liter (µg/L) or milligrams per kilogram (mg/kg). On the other hand, TRVs are based on doses or the amount of contaminant that is ingested by a wildlife receptor on a daily basis. They have units of mg of COPEC per kg of BW per day (mg/kg BW-day). TRVs are solely used to generate HQs for wildlife receptors. Even though TRVs are applicable to all birds and all mammals, they are not specific to individual species. Sources for all ESVs and TRVs are summarized in the next three BERA sections.

6.8.1 Surface and pore water benchmarks

Metals concentrations measured in surface and pore water samples are compared to surface water ESVs to select COPECs and generate EPC-based HQs for the aquatic community-level receptors. HQ derivation methods are described in detail in Section 7 of this BERA. Surface water ESVs corresponded to acute and chronic WQC. The CO Water Quality Control Commission's *Regulation No. 31, Basic Standards and Methodologies for Surface Water* (CDPHE, 2017c) table value WQC are the primary water-based ESVs used in this BERA. Michigan Department of Environmental Quality ([MDEQ], 2015) water quality standards (WQS) are used when CDPHE (2017c) WQC were unavailable.

This BERA assumes that pore water exposures are equivalent to surface water exposures and use the same set of surface water ESVs to select COPECs and generate HQs for both sediment dwelling invertebrates and water column fish communities. This application is supported by the fact that surface water ESVs were designed to be protective of all aquatic community-level receptor groups, including the BMIs and early life-stage trout that may be directly exposed to pore water in substrate.

The BERA work plan did not specify a source for the pH ESV. However, CDPHE (2017c) provides a Class 1 cold-water biota physical and biological standard range of pH between 6.5 and 9.0 standard units. The lower 6.5 pH standard threshold was selected for use in this BERA. In addition to this CDPHE (2017c) lower pH threshold, this BERA uses pH ESVs from Robertson-Bryan, Inc (2004). These ESVs are 5.5, which corresponds to the lower pH limit for general fish protection and 4.4, which corresponds to the lower toxic limit for trout.

Acute and chronic WQC and WQS ESVs are based on either TRM or DM concentrations depending on which metal is evaluated. Combined WQC/WQS sources specify that aluminum, antimony, barium, beryllium, cobalt, iron, mercury (chronic only), molybdenum, thallium (acute only), and vanadium ESVs correspond to TRM concentrations. Arsenic, cadmium, chromium, copper, lead, manganese, mercury (acute only), nickel, selenium, silver, thallium (chronic), and zinc are evaluated using DM concentrations. Most all surface and pore water samples were co-analyzed for both TRM and DM. Therefore, the full set of suspected contaminants can be screened for each surface and pore water sampling event at each sampling location. Note that co-

analyzed TRM and DM sample received different unique samples IDs which is reflected in **Appendices 1** and **2** surface and pore water sample ID tables.

Most of the acute and chronic WQC/WQS ESVs are calculated according to ambient water hardness. CDPHE (2017c) has determined that the aquatic toxicity of aluminum, cadmium, chromium, copper, lead, manganese, nickel, silver, and zinc depend on hardness. In addition, MDEQ (2015) has determined that the aquatic toxicity of barium and beryllium are also influenced by ambient water hardness. All else being equal, the toxicity of these metals drops in hard water but increases in soft water at a rate which is metal-specific. When evaluating these metals, sample-specific hardness values are used to modify ESVs and derive sample-specific ESVs. Hardness is calculated using dissolved calcium and magnesium concentrations in each DM sample using the Standard Method 2340B equation:

Hardness, mg equivalent $CaCO_3$/L = 2.497 [Calcium, mg/L] + 4.118 [Magnesium, mg/L]

The chronic aluminum WQC is not only hardness-dependent, but also has a minimum pH threshold (CDPHE, 2017c). The chronic hardness equation is applied when the ambient pH equals or exceeds 7.0. Either the default chronic ESV of 87 µg/L or, when more stringent, the hardness-dependent criterion, is applied when the ambient pH was less than 7.0. The pH results used to make this determination were field-based measurements taken when water samples were collected. When assessing if aluminum is a COPEC, the minimum pH value measured in each EU is used to determine which aluminum criterion to apply. This approach is highly conservative but ensures that aluminum is not overlooked when selecting COPECs. Lastly, the acute and chronic aluminum criteria are based on a relatively narrow hardness range. The highest hardness value for which aluminum criteria should be calculated is 220 mg of $CaCO_2$/L ([milligrams per liter] CDPHE, 2017c). As such, this BERA caps all aluminum criteria calculations at this hardness, even if a measured hardness exceeds 220 mg of $CaCO_2$/L. This maximum hardness threshold equates to a TRM acute and chronic criterion of 10,071 and 1,438 µg/L, respectively. Note that in some cases, this BERA presents HQs based on chronic default and hardness criteria, regardless of pH. This occurs when summarizing chronic pore and surface water HQs based on modeled hardness values (Section 8.2) and is useful in showing how different or similar aluminum exposure risks are when default and hardness-dependent WQC are used.

Table 6.6 summarizes the acute and chronic surface water ESVs for all the metals evaluated in this BERA when assessing risk to aquatic community-level receptors. All hardness-dependent ESVs in this table are normalized to a hardness of 25 mg of $CaCO_2$/L to provide standardized numbers. This table also provides the sources for each of the ESVs. Except for pH, these ESVs are the same as those identified in the EPA (2016d) Aquatic BERA work plan.

6.8.2 Sediment benchmarks

The metal concentrations measured in bulk sediment samples are compared to no-effect sediment-based ESVs to select sediment COPECs and generate EPC-based HQs for the BMI

receptors. Low-effect ESVs are also used to generate EPC-based HQs. The sediment ESVs consist of Probable Effect Concentrations, Threshold Effect Concentrations, Probable Effect Levels, Effect Range-Medium concentrations, and/or Severe Effect Levels obtained from readily available literature sources. The sources of all ESVs are summarized in this section. **Table 6.7** summarizes the sediment no- and low-effect ESVs used in this BERA.

MacDonald *et al.* (2000) is the primary source of sediment-based ESVs used in this BERA. MacDonald *et al.* (2000) is commonly used for evaluating sediment-based toxicity to sensitive benthic invertebrates and is the most statistically sound and generally accepted source of sediment ESVs for benthic invertebrates that is currently available. However, not all suspected contaminants are reported in MacDonald *et al.* (2000). Therefore, this BERA uses additional sources of sediment-based ESVs so that all 20 suspected contaminants can be evaluated. When more than one ESV was available among remaining suspected contaminants and ESV sources, this BERA uses the ESV from the most cited and generally accepted source. The published sources of sediment ESVs are described below by order of preference (from highest preference to lowest preference):

- MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. *Arch. Environ. Contam. Toxicol*. 39(1):20-31.

- Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Ontario Ministry of Environment and Energy.

- Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.

- US EPA Region 5 RCRA Ecological Screening Levels, August 22, 2003, Available at: http://epa.gov/region5/waste/cars/pdfs/ecological-screening-levels-200308.pdf

- Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and Evaluation of Sediment Effect Concentrations for the Amphipod *Hyalella azteca* and the Midge *Chironomus riparius*. *J. Great Lakes Res*. 22(3):602-623.

- Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and Use of Sediment Quality Guidelines for Ecological Risk Assessment of Metals and Radionuclides Released to the Environment from Uranium Mining and Milling Activities. *Canada. Environ. Monitor. Assess*. 110(1-3):71-85.

- Long, E.R., D.D. Macdonald, S.L. Smith and F.D. Calder. 1995. Incidence of Adverse Biological Effects with Ranges of Chemical Concentrations in Marine and Estuarine Sediments. *Environ. Manag*. 19(1):81-97.

- Los Alamos National Laboratory (LANL). 2016. ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

The silver ESV developed by Long *et al.*, (1995) is included herein, even though this benchmark pertains specifically to estuarine and marine environments. The reason for inclusion is that this reference is the only readily available and defensible source that provides a sediment benchmark for silver.

6.8.3 TRVs for wildlife receptors

The wildlife toxicity evaluations consider both no- and low-effect TRVs in mg/kg BW-day, which is a common dose metric for bird and mammal exposure assessments. Bird and mammal TRVs are not species-specific, but represent concentrations of contaminants, via the ingestion pathway, that are considered to be protective of most bird and mammal species. **Table 6.8** and **Table 6.9**, summarize the bird and mammal TRVs, respectively.

This BERA uses the no- and low-effect TRVs for birds and mammals primarily obtained from the ecological soil screening level (EcoSSL) documents (EPA, 2005d) and the LANL (2016) ECORISK Database, except for mercury in birds. These sources derive TRVs using similar, statistically robust and agency-accepted methods and data from a systematically screened literature base. They are the most defensible and rigorous sources of acceptable TRVs currently available. The no-effect TRVs were derived from the same toxicity studies used by EPA (2005d) to develop soil-based EcoSSLs. The low-effect TRVs were derived by LANL (2016) by either applying an uncertainty factor or 10 to the EcoSSL no-effect TRV or using the lowest observable adverse effect level (LOAEL) associated with the same study used to derive no-effect TRVs. The no-effect and low-effect mercury TRVs for birds were obtained from Sample *et al.* (1996). These TRVs were derived by selecting the most-applicable toxicity study for each COPEC obtained from an independent review of primary toxicity literature. Additional details on how the LANL TRVs were developed can be found in LANL (2014; 2016).

The wildlife low-effect TRVs applied in this BERA are not the same as those prescribed in the EPA (2016d) Aquatic BERA work plan, which were sourced from Lower Darby Creek Area Superfund Site. Although different, both sets of low-effect TRVs were derived from the EcoSSL databases. Differences between the low-effect TRVs from each source resulted from using different methods in picking or summarizing EcoSSL-selected LOAELs. For example, the TRVs presented in the BERA work plan EPA (2016d) are based on the geometric means of all growth and reproductive endpoint LOAELs from all studies selected in metal-specific EcoSSL reports. This methodology may generate low-effect TRVs that are not protective of all bird and mammal

species for important bioaccumulative metals such as lead. Therefore, the more protective and conservative LANL (2016) TRVs are used in this BERA. In addition, the LANL (2016) low-effect TRVs are the same as those selected for use in the future BPMD terrestrial BERA (EPA, 2017f) and used herein for consistency between the two risk assessments. Also note that the 2015 draft Upper Animas BERA used the Lower Darby Creek Area Superfund Site low-effect TRVs. This draft was recently amended and the final Upper Animas BERA now uses the same wildlife TRVs used in this BERA (**Attachment 1**).

6.9 Assimilating of the Upper Animas BERA into the Aquatic BERA risk summaries

As described in Sections 1.1 and 3.2, Upper Animas BERA risk characterization results are incorporated into the Aquatic BERA risk characterization summaries; specifically, in the Executive Summary and Section 10 text and tables. This inclusion provides risk managers a comprehensive summary of BPMD contamination risks from the BPMD headwaters of the Animas River and respective tributaries, downriver to Durango. Although assessment methods are very similar between the two BERAs, there are slight differences that limit direct comparison of results. This section identifies these differences and actions taken herein to integrate results between the two BERAs. It is important to note, that results from respective actions are not included in the final, **Attachment 1** Upper Animas BERA (EPA, 2019). Also, not all discrepancies were addressed. This was mostly due to not having required underlying data. This section is organized with respect to risk measurement endpoints evaluated herein (Section 5.4). **Attachment 3** provides supporting tables associated with assimilation actions described in this section.

6.9.1 Sediment contamination-based risks to the BMI communities

ISSUE: The Upper Animas BERA sediment low-effect ESV (250,000 mg/kg) for iron is greater than that used in this Aquatic BERA (40,000 mg/kg). This Aquatic BERA also uses a more conservative no-effect ESV for iron; 20,000 mg/kg versus 190,000 mg/kg.

> RESOLUTION: Given the large discrepancies between iron sediment ESVs between the two BERAs, the complete Upper Animas BERA risk assessment process, from COPEC selection to risk characterization, was revised using the Aquatic BERA ESVs. This revision started with the sediment dataset in *Appendix 2* in the Upper Animas BERA (**Attachment 1**). The risk characterization text and tables presented herein reflect the revised Upper Animas BERA iron risk analysis.

ISSUE: The Upper Animas BERA sediment low-effect ESV for manganese (1,200 mg/kg) is slightly greater than that used in this Aquatic BERA (1,100 mg/kg). This Aquatic BERA also uses a more conservative no-effect ESV for manganese; 460 mg/kg versus 630 mg/kg.

> RESOLUTION: Given the discrepancies between manganese sediment ESVs between the two BERAs, the complete Upper Animas BERA risk assessment process, from

COPEC selection to risk characterization, was revised using the Aquatic BERA ESVs. This revision started with the sediment dataset in *Appendix 2* of the Upper Animas BERA (**Attachment 1**). The risk characterization text and tables presented herein reflect the revised Upper Animas BERA manganese analysis.

ISSUE: This Aquatic BERA assesses sediment contamination-based BMI risks for molybdenum and vanadium exposure, but these two metals are not assessed in the Upper Animas BERA.

RESOLUTION: Molybdenum and vanadium are minor contaminants in BPMD impacted sediments. As discussed in subsequent sections of this BERA, these contaminants are rarely identified as COPECs and EPCs are all below low-effect ESVs. HQ-based risk characterization summaries presented in this BERA are all based low-effect ESVs. Therefore, no actions were taken to assimilate assessment methods between the two BERAs for this discrepancy.

ISSUE: This Aquatic BERA reports BMI habitat quality results obtained from the MSI (2016; 2017a,b) BMI survey reports, whereas the Upper Animas BERA did not assess BMI habitat.

RESOLUTION: BMI habitat assessments provide supplemental information that is used to evaluate impacts to respective BMI communities. Since no BMI habitat assessments were conducted for the Upper Animas BERA EUs, there are no available data to evaluate BMI habitats. Therefore, this endpoint was not included for the Upper Animas BERA nor in the current Aquatic BERA summary text and tables. It should be noted that MSI (2016) only assessed habitat quality in a subset of Aquatic BERA EUs. Therefore, BMI habitat quality information is not equally available among all Aquatic BERA EUs. As such, the exclusion of Upper Animas BERA EUs habitat quality information in Aquatic BERA summary tables does not substantially impact a comparative analysis of EU risks.

ISSUE: Although included in an attachment and discussed, the Upper Animas BERA did not specifically assess BMI impairment using MMI scores.

RESOLUTION: The Upper Animas BERA MMI scores are presented in *Appendix 20* of that report. As noted in Section 6.5.1 of this BERA, the MMI scoring program has recently been updated and accepted for use by CDPHE. To make the Upper Animas BERA MMI scores comparable to the Aquatic BERA EU MMI scores, they were updated using the current CDPHE (2017a) MMI scoring protocol. These updates focused on only the most recent surveys. Specifically, BMI surveys conducted in the fall of 2014 and 2015 at monitoring sites A60, A68, CC49, A72, A73, 75D, and Bakers Bridge are recalculated with the updated MMI program. Since most of the MMI scores presented in this BERA were generated using data from BPMD BMI surveys conducted in fall 2016, additional fall 2016 BMI survey MMI scores for A73, A75D, and Bakers Bridge from MSI (2017a) were used to summarize BMI community impairment status herein.

6.9.2 Pore water contamination-based risks to BMI communities

ISSUE: This Aquatic BERA assessed pore water contamination-based risks to BMIs for antimony, barium, cobalt, molybdenum, thallium, and vanadium that were not assessed in the Upper Animas BERA.

> RESOLUTION: All six of these metals are minor contaminants within BPMD impacted pore waters. As discussed in subsequent sections of this BERA, these metals were not routinely analyzed in pore water samples and not identified as pore water COPECs when analyzed. As such, no actions were taken to assimilate assessment methods between the two BERAs for this discrepancy.

6.9.3 Sediment toxicity tests

There are no differences in amphipod 10-day sediment toxicity tests assessment methods between the two BERAs. As such, results for this assessment endpoint are directly comparable.

6.9.4 Surface water community

ISSUE: This Aquatic BERA assesses BMI community risks using three separate pH risk categories (<6.5 but >5.5 [low risk]; <5.5 but >4.4 [moderate risk]; and <4.4 [high risk]). These thresholds were compared to the lowest CTE pH EPCs among each hydroperiod and EU. The Upper Animas BERA uses a single pH threshold (6.5) to evaluate surface water community risks. The Upper Animas BERA only identifies pH as a COPEC for respective EUs and plots EU pH values but does not quantitatively evaluate pH risks.

> RESOLUTION: Aquatic BERA summary text and tables incorporated the above pH risk categories and lowest CTE of all pH values collected from each EU and hydroperiod for Upper Animas BERA EU summaries so that risk characterization results are compatible between both BERAs. Specifically, the pH values reported in *Appendix 1* pH data table in the Upper Animas BERA (**Attachment 1**) were used to derive hydroperiod- and EU-based CTE EPCs for pH. CTEs derivations followed methods provided in Section 8.1 of this BERA.

ISSUE: This Aquatic BERA assessed surface water community risks for antimony, barium, cobalt, molybdenum, thallium, and vanadium that were not assessed in the Upper Animas BERA.

> RESOLUTION: None of the listed suspected contaminants were identified as COPECs in the Aquatic BERA. Therefore, their exclusion in the Upper Animas BERA does not impact respective risk characterization summaries presented herein. As such, no actions were taken to assimilate assessment methods between the two BERAs for this discrepancy.

ISSUE: The Upper Animas BERA generated chronic aluminum HQs using a single water quality criterion of 87 µg/L during the final risk characterization, whereas the Aquatic BERA used the pH and hardness-dependent CDPHE (2017c) criteria. Note that *Appendix 7* of the Upper Animas BERA did generate HQs for both the default and hardness-dependent aluminum criteria, but it was done on a sample-by-sample basis and not by hydroperiod-based concentration and hardness values.

> RESOLUTION: This Aquatic BERA presents results for both the static 87 µg/L criterion and pH/hardness-dependent criteria. Summary tables refer to the pH/hardness-dependent CDPHE (2017c) criteria. To assimilate Upper Animas BERA aluminum risks into current summary tables and text, surface water chronic criteria aluminum HQs reported in the Upper Animas BERA were updated using the pH/hardness-dependent criteria; see Section 6.8.1 for details on how CDPHE (2017c) aluminum criteria are derived. This reanalysis is based on surface water TRM aluminum concentration, water hardness, and pH data in *Appendix 1* in the Upper Animas BERA (**Attachment 1**). Note that this analysis resulted in all Upper Animas EU chronic aluminum HQs being derived using the 87 µg/L criterion, except the Bakers Bridge EU that is hardness-dependent. This was primarily due to the sub-neutral pH default to the 87 µg/L criterion associated with the CDPHE (2017c) criteria.

6.9.5 Acute surface water toxicity tests

There are no differences in trout 96-hr surface water toxicity tests assessment methods between the two BERAs. As such, results for this assessment endpoint are directly compatible.

6.9.6 Fish community surveys and habitat assessments

ISSUE: This Aquatic BERA primarily relies on USGS (2018) fisheries assessments for most of the EUs evaluated herein. Other than measuring temperature and qualitatively electrofishing the lower Mineral Creek (EU-01) reach, this USGS study did not survey any of the Upper Animas BERA EU reaches.

> RESOLUTION: Although the recent USGS (2018) fisheries survey data are unavailable for Upper Animas BERA EUs, historical fish community survey data are available for the majority of respective EUs. However, no historical surveys were conducted in the Animas River reach between Cement and Mineral Creek confluences and just downriver from the Mineral Creek confluence. When available, this BERA uses historic fish survey data to normalize this endpoint between the two BERAs. Trout presence/absence information was obtained from ARSG (2000) *Appendix 6A Fisheries Report* that summaries historic fish survey results from many sources that date back to 1984 and up to 2000. This trout presence/absence information is included in risk characterization summary text and tables presented herein.

ISSUE: Similar to BMI habitat assessments, USGS (2018) fisheries habitat assessments were not conducted in Upper Animas BERA EU reaches. Therefore, current fisheries habitat data are unavailable for Upper Animas BERA EUs.

RESOLUTION: Fish habitat surveys provide supplemental information that is used to evaluate impacts to respective fish communities. It should be noted that USGS (2018) only assessed habitat quality in a subset of Aquatic BERA EUs. Therefore, fish habitat quality information is not equally available among all Aquatic BERA EUs. As such, the exclusion of Upper Animas BERA EUs habitat quality information in Aquatic BERA summary tables does not substantially impact a comparative analysis of EU risks. USGS (2018) also identified Aquatic BERA EU reaches that were intermittent or too cold to support viable trout communities. Since the Upper Animas BERA EUs are in lower elevation Animas River reaches and downgradient from reaches that do support trout, excluding this information does not substantially impact a comparative analysis of EU risks. As such, no actions were taken to assimilate assessment methods between the two BERAs to address this discrepancy.

6.9.7 Wildlife risk assessments – dipper, mallard, kingfisher, muskrat, and raccoon

ISSUE: Cement Creek EU wildlife risks analyses are not included in the Upper Animas BERA.

RESOLUTION: The Upper Animas BERA provides sediment and surface water (TRM) data for the Cement Creek EU. These data were used to derive EDDs and HQs for each of the wildlife receptors so that risk characterization summary text and tables presented in this BERA provide a complete assessment of wildlife risks. Note that sediment data from only one sampling event is provided in the Upper Animas BERA; so, sediment exposure estimates are not based on a robust dataset. However, 25 surface water TRM data points were available and used to estimate wildlife exposures to surface water.

ISSUE: Raccoon is not included in the Upper Animas BERA wildlife risk assessment. The Aquatic BERA analyzed raccoon risks as a mammalian piscivore.

RESOLUTION: The Upper Animas BERA provides sediment and surface water (TRM) data that can be used to estimate raccoon COPEC exposure and risks. To provide a complete summary of risks for all wildlife receptors analyzed in this BERA, Upper Animas BERA exposure data were used to estimate COPEC risks to raccoon. This analysis uses the same food chain and dietary intake rates used in this Aquatic BERA.

SECTION 7 COPEC SELECTION

This section summarizes the COPEC selection process and results. This process identifies the contaminants of interest that needed further evaluation in the risk characterization phase of this BERA. COPEC selection is specific to each environmental matrix of interest (i.e., surface water, pore water, and sediment) and receptor type (i.e., BMIs, water column invertebrates and fish, amphibians, and wildlife species). All bioaccumulative metals are automatically retained as wildlife receptor COPECs.

Aquatic community COPECs are identified by calculating HQs based on dividing a conservative EPC, represented by the maximum-detected concentrations (or ½ the maximum detection limit [MDL] for non-detects) for each of the 20 metals (contaminants of interest) measured in the surface water, pore water and sediment, by the conservative ESVs discussed further below. Due to the logarithmic nature of pH measurement units, HQs are not used to determine whether this contaminant of interest is a COPEC. Low pH is selected as a COPEC when the lowest measurement made at an EU is less than 6.5 (see Decision Criteria below). Metal COPECs are derived for each of the 27 EUs, as follows:

$$HQ = \text{exposure} \div \text{toxicity}$$

Where:

HQ	= Hazard quotient (unitless)
Exposure	= The EPC (i.e., the maximum concentration or ½ the MDL for non-detect metals) for a contaminant measured in surface water (µg/L), pore water (µg/L) and sediment (mg/kg)
Toxicity	= The surface water chronic ESV (µg/L) or no-effect sediment ESV (mg/kg) for that contaminant of interest

The following decision criteria are used to select surface water, pore water, and sediment COPECs; including pH.

Decision Criterion 1: A contaminant of interest is retained as a COPEC when one of the following conditions is met:

- The maximum-detected concentration, or ½ the MDL for a non-detected metal, equals or exceeds its ESV (i.e., HQ $\geq$ 1.0).
- A metal is present above its MDL at least once but lacked an ESV.
- The lowest pH value is below 6.5.

Decision Criterion 2: A contaminant of interest is excluded as a COPEC when one of the following conditions is met:

- The maximum concentration, or ½ the MDL for a non-detected metal, falls below the ESV (HQ <1.0).

- The lowest pH value is above 6.5

As described in Section 6.2, surface water samples are categorized into the three hydrologic periods (i.e., pre-runoff, runoff, and post-runoff). When selecting surface water COPECs, all data are combined into one dataset for each of the 27 EUs. In other words, COPECs are selected for individual EUs across the three flow periods. This approach is conservative because the highest concentrations measured during the pre-runoff, runoff, and post-runoff periods are used to select the COPECs that would apply to all three flow periods.

Calcium, magnesium, potassium, and sodium are automatically eliminated as COPECs because they represent essential physiological electrolytes that are not expected to cause toxicity at prevailing concentrations. These elements are not included in the 20 contaminants of interest that are evaluated herein.

7.1 Hardness-dependent toxicity

As discussed in Section 6.8.1, the toxicity of many of the suspected contaminants depends on water hardness. It would therefore be inaccurate to automatically select the highest concentration of each of these metals to select surface/pore water COPECs because a lesser concentration could be more toxic if the hardness of the water is much lower.

Under these circumstances, the only reliable way to identify the most-toxic surface or pore water concentration is to calculate hardness-adjusted HQs for each target metal in each surface and pore water sample (note: a hardness-adjusted HQ is obtained by dividing a metal concentration [or half of the non-detection value] by its toxicity benchmark adjusted for the hardness of the water sample associated with that metal). If a hardness-adjusted HQ is greater than one, then the corresponding metal is retained as a COPEC. Note that COPEC selection tables provide the screening values used to select COPECs for each EU and this value might not be the maximum concentration measured within an EU. This occurs when a greater hardness-adjusted HQ was calculated using a lower concentration.

7.2 Surface water COPECs for aquatic community-level receptors

This subsection summarizes the results of the surface water COPEC selection process for aquatic community-level receptors, which is based on comparing maximum surface water concentrations measured in each EU against the chronic ESVs identified in **Table 6.6**. **Appendix 8** provides COPEC derivation tables for each of the 27 EUs. These tables summarize the frequency of

detection, minimum and maximum concentrations, ESVs, and screening-level HQs for each of the 20 contaminants of interest for each EU. As described in the previous section, for hardness-dependent metals, the highest concentration of a suspected contaminant may not necessarily be associated with the greatest HQ.

Ten of the 20 metals, plus pH, are identified as surface water COPECs among all 27 EUs (**Table 7.1**). Aluminum is selected as a COPEC for all Mineral Creek and Animas River watershed EUs (EU-01 through -19), the Durango Reach, and most reference EUs. Silver is also a common COPEC and selected for all but one of the 27 EUs (specifically, Hermosa Creek reference). Cadmium, copper, pH, and zinc are also common COPECs. Lead and pH are identified as COPECs for most Mineral Creek watershed EUs and the EUs in the upper Animas River watershed and respective tributaries. Iron is primarily a Mineral Creek watershed and Durango Reach COPEC, except for a few EUs in the mainstem Animas River and South Fork Animas River. Manganese is identified as a COPEC almost entirely in the mainstem Animas River and associated tributaries above the South Fork Animas River confluence.

Generally, EUs located in mainstem Mineral Creek and the upper Animas River have the greatest number of COPECs. The fewest numbers of COPECs are identified in the Durango Reach and reference EUs. No COPECs, besides silver (see next paragraph), are identified for the Hermosa Creek reference EU. This is largely due to high water hardness and low concentrations of metals in this EU. All other reference EUs have a few COPECs, mostly consisting of aluminum and silver and to a lesser extent, beryllium and lead. The Upper North Fork Animas River reference EU-R5 has the most COPECs (six out of 10 contaminants) among reference EUs. This reach is in the heavily mineralized Eureka Graben area and is downgradient from a few smaller mines (Jones, 2007). Nevertheless, this EU was selected as a reference area and is upgradient from all the NPL sources.

Silver is retained as a COPEC, even though it is not present above its analytical MDL in all but one surface water sample in EU-01. This metal is commonly flagged as a COPEC because half of the highest MDL consistently exceeds its chronic surface water ESV. At ambient hardness levels observed in the BPMD and Durango Reach EUs, the chronic silver criterion ranges from 0.005 to 0.381 µg/L while the MDLs ranges from 0.5 to 2.5 µg/L. Risks associated with this analyte are discussed as an uncertainty in the risk characterization section of this BERA because it cannot be further evaluated quantitatively. The same issue exists for beryllium at a few low-hardness locations. These two COPECs are nonetheless included in **Table 7.1** for completeness.

Note also that barium, cobalt, molybdenum, and vanadium are not consistently analyzed in all of the surface water samples since these are not considered contaminants of interest at this site. As such, they cannot be evaluated as COPECs in certain EUs. However, when measured, all concentrations fall well below their chronic ESVs which results in HQs less than 1.0. Given that these analytes are rarely detected, and when detected have low concentrations, they are not considered COPECs for any of the EUs evaluated in this BERA.

7.3 Pore water COPECs for aquatic community-level receptors

The pore water COPEC selection process for aquatic community-level receptors is based on comparing maximum concentrations measured in pore water samples collected from each EU against the chronic surface water ESVs identified in **Table 6.6**. **Appendix 9** provides the COPEC-derivation tables for each of the 27 EUs. The methods for deriving the pore water COPECs are identical to those used for surface water and are therefore not described again.

Nine of the 19 metals measured in pore water (mercury not analyzed), plus pH, are selected as pore water COPECs among all 27 EUs (**Table 7.2**). These ten COPECs are the same COPECs (less mercury) that are selected for surface water (Section 7.2). Aluminum, beryllium, copper, lead, and zinc are identified as pore water COPECs in fewer EUs than for surface water. Most pore water COPECs are identified in the Animas River upriver from South Fork confluence and Mineral Creek watershed EUs. Iron and pH are more pervasive as COPECs in pore water than in surface water, with pH showing up as a COPEC in more reference EUs. Copper, manganese, and silver are identified as Durango Reach pore water COPECs.

Similar to surface water, silver is routinely retained as a COPEC even though it is not present above its analytical MDL. It is flagged as a COPEC in all but three EUs with high hardness because half of the highest MDLs exceeds the chronic surface water ESV. Silver risks are discussed as an uncertainty in the risk characterization section of this BERA because they cannot be further evaluated quantitatively.

The selection of pore water COPECs in the Durango Reach is hindered because none of the pore water samples were analyzed for TRM. This data gap limits the COPEC selection process to the 11 metals and metalloids that have chronic surface water ESVs based on DM concentrations. Therefore, the evaluation cannot assess aluminum, antimony, barium, beryllium, cobalt, iron, molybdenum, and vanadium for any Durango Reach pore water samples. In addition to these metals, no pH measurements are available from Durango reach pore water sampling events. Risks associated with these suspected contaminants are discussed as an uncertainty in the risk characterization section of this BERA because they cannot be further evaluated quantitatively.

7.4 Sediment COPECs for benthic invertebrates

The sediment COPEC selection process for benthic community-level receptors is based on comparing maximum concentrations measured in bulk sediment samples collected from each EU against the no-effect sediment ESVs identified in **Table 6.7**. **Appendix 10** provides COPEC derivation tables for each of the 27 EUs.

Sixteen of the 18 metals measured in sediment samples (beryllium and thallium not analyzed) are sediment COPECs among all 27 EUs (**Table 7.3**). Arsenic, barium, cadmium, copper, iron, lead, manganese, selenium, and zinc are selected as COPECs for almost every EU, including the Durango Reach and the reference EUs. Aluminum is a COPEC for most of the BPMD Animas

River EUs, but only for two Mineral Creek EUs (EU-01 and -06). Molybdenum is a COPEC in mainstem Animas River and respective tributaries upriver from the South Fork Animas River confluence. Antimony, cobalt, mercury, and vanadium are identified as COPECs for a few EUs with no apparent EU- or watershed-specific trends.

7.5 COPECs for wildlife receptors

The approaches outlined above do not apply to the five wildlife receptors evaluated using food chain modeling. The reason is that the exposures are not based on direct contact with surface water or sediment, but from ingesting surface water, sediment, and dietary items. As such, food chain modeling is required to estimate exposure for each contaminant of interest, regardless of COPEC selection. Therefore, a metal is automatically retained as a wildlife COPEC for evaluation in the food chain models if it is identified as an "important bioaccumulative compound" in Table 4-2 in EPA (2000a) *Bioaccumulation testing and interpretation for the purpose of sediment quality assessment, status and needs*. Bioaccumulative metals consist of; arsenic, cadmium, hexavalent chromium, copper, lead, methylmercury, nickel, selenium, silver, and zinc. Note that hexavalent chromium and methylmercury chemistry data are not available in the current BPMD database. As a conservative measure, oxidized chromium and inorganic mercury are retained as surrogates for evaluation in the wildlife food chain models. This is a conservative approach, since these two contaminants are less toxic at similar concentrations than hexavalent chromium and methylmercury.

SECTION 8 BASELINE EXPOSURE ESTIMATES

The exposure analysis for this BERA consists of the following two components: (a) quantify surface water, pore water, and sediment exposures to aquatic community-level receptors and (b) perform wildlife exposure modeling to calculate RME and CTE EDDs (mg/kg BW-day). Exposure analyses are performed for each COPECs identified in each of the 27 EUs and each hydroperiod (surface water only). In Section 9.0. exposure estimates are compared to ESVs and TRVs to characterize risk to community-level and wildlife receptors, respectively. This section describes the RME and CTE derivation process and presents respective EPC results for each EU.

8.1 Exposure point concentrations

The EPCs used in the exposure calculations consist of RMEs and CTEs for COPECs in surface water, pore water, sediment, and wildlife dietary items. Only metals and pH identified as COPECs in Section 7.0 are used to calculate EPCs for each EU. Depending on the structure of a dataset, the RMEs represent either 95% UCLs of the mean derived using the ProUCL software (using the program recommended method), or the maximum-detected values when UCLs cannot be calculated due to limited datasets. ProUCL 95% UCLs recommendations are based upon data size, data distribution, and skewness and simulation studies summarized in Singh *et al.* (2006). The RME represents the maximum concentration of a COPEC when a 95% UCL exceeds the maximum concentration.

The RMEs for pH are always the lowest pH measurement for each hydroperiod (surface water only) and EU. All CTEs, except for pH, are arithmetic means that include half of the MDL for non-detected compounds. CTE pH values are calculated by first taking the average concentration of hydronium ions (Ci) in each EU (pore water) or hydroperiod (surface water) sample (n) before converting back to standard pH units using the following equation:

$$\text{Average pH} = -\log_{10}[(\Sigma Ci)/(n)]$$

The ProUCL outputs are not included as an Appendix to this BERA but are available via CD-ROM upon request. ProUCL outputs are specific to each environmental medium and EU.

8.2 Hardness-dependent metals

The surface and pore water risk characterizations consist of calculating RME and CTE HQs for all the COPECs identified across the various EUs, including those with ESVs that are hardness-dependent. Therefore, the HQ calculations require for respective metals be compared to benchmarks adjusted for hardness. This BERA uses two hardness values to derive hardness-adjusted benchmarks for each EU; “reasonable minimum” and “average” hardness values using the same methods used in the Upper Animas BERA (EPA, 2019; **Attachment 1**). The toxicity of

metals increases with decreasing hardness; hence, a reasonable minimum hardness is used as a conservative value for HQ calculations.

A reasonable minimum hardness value is obtained for each EU as follows:

- The water hardness data are organized by EU and hydrologic period (surface water only)
- For datasets too small to be evaluated using the ProUCL software, a minimum water hardness is obtained from the available data. The minimum hardness value is used as the reasonable minimum hardness for smaller datasets.
- For the larger datasets, a 95% UCL and an average water hardness is calculated, after which the difference between the 95% UCL and the average is subtracted from the average to obtain the average difference hardness value. If the average difference is greater than the minimum hardness, the average difference is used as the reasonable minimum hardness value. If the average difference is less than the minimum hardness, the minimum hardness value is used as the reasonable minimum hardness value

Tables 8.1 and 8.2 summarize the steps for deriving the reasonable minimum and average surface water and pore water hardness values, respectively. The shaded reasonable minimum and average hardness values in these tables are used to calculate acute and chronic ESVs and derive the HQs for the hardness-adjusted metals.

8.3 Aquatic community-level receptors

Aquatic community-level receptors are assumed to be directly exposed to surface water, pore water, and/or sediment. Therefore, RMEs and CTEs are calculated using COPEC analytical chemistry results for samples collected in each EU (pore water and sediment) and hydroperiod (surface water) in each of these media.

- The EPCs for metal COPECs in surface water for each EU are provided in **Appendix 11**, **Tables A11.1** to **A11.25**.
- The EPCs for metal COPECs in pore water for each EU are provided in **Appendix 12**, **Tables A12.1** to **A12.24**.
- The EPCs for metal COPECs in sediment for each EU are provided in **Appendix 13**, **Tables A13.1** to **A13.27**.

The surface water exposures for the aquatic community-level receptors are also evaluated using scatter plots on a sample-by-sample basis for core COPECs (aluminum, cadmium, lead, and zinc) and BPMD EUs in Mineral Creek watershed and mainstem Animas River and North Fork Animas River upriver of Silverton. Scatter plot COPECs are metals with elevated and spatially-variable concentrations. The concentrations of these key surface water COPECs are assessed on a sample-by-sample basis and plotted as HQs that are based on dividing the measured concentrations by sample-specific hardness-dependent surface water benchmarks. Scatter plots

are used to visualize the temporal (hydroperiod) and spatial (EU) variability in surface water risk.

Figure 8-1 presents scatter plots for aluminum HQs throughout the BPMD Mineral Creek and Animas watersheds. The HQs in these figures are based on sample-specific chronic hardness-dependent surface water ESVs or the default ESV (87 µg/L) when sample pH is less than 7.0 (CDPHE, 2017c). Each sample is represented by a single dot. No pre-runoff samples are available for EU-03 through -06, -11, -12, and -15 through -19. Among Mineral Creek EUs, aluminum HQs are generally greater during pre- and post-runoff conditions than runoff. This is primarily due to low pH (<7.0) conditions that occur during pre- and post-runoff hydroperiods and subsequent default chronic surface water ESV application. Among all Mineral Creek EUs, lower (EU-01) and middle (EU-02) mainstem Mineral Creek reaches have higher HQs than upper mainstem reaches. The high HQs may be reflective of sources located in these reaches or Middle Fork Mineral Creek (EU-06) that enters mainstem Mineral Creek at the upstream boundary of EU-02. In the Animas River EUs, aluminum HQs are highest in the upper watershed EUs above the South Fork Animas River confluence (EU-14 through -19). Animas River aluminum HQs generated for Eureka Gulch (EU-13) and EUs below Eureka (EU-10 through -07) follow the same general hydroperiod-specific pattern as Mineral Creek HQs (**Figure 8-1**).

Figure 8-2 presents scatter plots for cadmium HQs throughout the BPMD Mineral Creek and Animas watersheds. The HQs in these figures are based on sample-specific chronic hardness-dependent surface water ESVs. Cadmium does not have a pH-dependent default criterion. Cadmium HQ scatter plots provides an opportunity to inspect how changes in hardness between the three hydroperiods can affect surface water risks. Seasonal hardness effects are best seen in Animas River EUs with pre-runoff data below South Fork Animas River (EU-10, -09, and -07) that have higher HQs during runoff conditions. Upper Animas River EUs has some of the highest chronic cadmium HQs, regardless of hydroperiod, among all EUs evaluated in the BERA.

Figure 8-3 presents scatter plots for lead HQs throughout the BPMD Mineral Creek and Animas watersheds. The HQs in these figures are based on sample-specific chronic hardness-dependent surface water ESVs. Lead does not have a pH-dependent default criterion. Similar to cadmium, lead HQ risks are generally greater during the runoff hydroperiod, except at higher elevation EUs in each watershed. In the Mineral Creek watershed, lead HQs are greatest in the higher elevation mainstem EUs and decrease in a downstream fashion. All Middle and South Fork Mineral Creek lead HQs are less than 1.0. The same downstream trends occur among the Animas River watershed EUs between Burrows Gulch (EU-19) and the South Fork Animas River confluence (EU-14).

Figure 8-4 presents scatter plots for zinc HQs throughout the BPMD Mineral Creek and Animas watersheds. The HQs plotted in these figures are based on sample-specific chronic hardness-dependent surface water ESVs that do not have a pH-dependent default criterion. Zinc HQs are almost always greater during runoff conditions; especially throughout the Animas River watershed. Regardless of hydroperiod, Mineral Creek zinc HQs are generally lower than those

seen in the Animas River watershed EUs. The lowest zinc HQs are observed in the two Mineral Creek tributaries and upper South Fork Animas River.

Additional COPEC scatter plots are provided in Section 9.2.1 to illustrate differences in trout sensitivity and spatial and temporal trends in additional COPECs.

8.4 Wildlife receptors

The five wildlife receptors evaluated in this BERA are assumed to forage within each EU, regardless as to whether or not an EU supports BMIs, fish, or aquatic vegetation required for forage. Wildlife are expected to consume raw, unfiltered surface water. Therefore, only surface water TRM analytical data are used to derive the RMEs and CTEs for metals in drinking water consumed by the wildlife receptors. The sediment datasets used to assess risk to BMIs are retained to model wildlife exposures associated with the incidental ingestion of sediment during foraging. Finally, BMI and fish tissue RMEs and CTEs are calculated for EUs for which these data are available. When unavailable, BMIs, fish, and aquatic vegetation tissue RMEs and CTEs are modeled from respective sediment RMEs and CTEs (Section 6.6).

The EPCs for metals in surface water (TRM results only), sediment and field-collected dietary items and are provided for each EU in **Appendix 14 Tables A14.1** to **A14.27**. **Appendix 15 Tables A15.1 to A15.27** provide EU-specific EDDs for American dipper, **Tables A15.28 to A15.54** provide EU-specific EDDs for mallard, **Tables A15.55 to A15.81** provide EU-specific EDDs for belted kingfisher, **Tables A15.82 to A15.108** provide EU-specific EDDs for muskrat, and **Tables A15.109 to A15.135** to provide EU-specific EDDs for raccoon. The EDD tables provide all supporting information and individual EDD dietary item calculations used to derive the EDDs for each EU and wildlife receptor, including ingestion rates (**Table 6.1)**.

SECTION 9 RISK CHARACTERIZATION

The potential for ecological risk from exposure to the COPECs is determined during the risk characterization phase of this BERA and results are presented in this section. The exposure analysis and effects analysis described in earlier sections are integrated to determine the likelihood of adverse effects to the assessment endpoints, given the assumptions inherent in the analysis phase. For most endpoints, risk findings are summarized, interpreted, and discussed in the risk description section using various lines of evidence which address risk estimates.

Risk is quantified using the HQ method, which compares measured exposures (i.e., surface water, sediment, and pore water EPCs) or estimated exposures (wildlife EDDs) to corresponding toxicity values (i.e., acute and chronic surface water benchmarks or no- and low-effect sediment benchmarks, plus wildlife no- and low-effect TRVs). Remaining, toxicity testing and field survey endpoints are evaluated on an individual basis.

COPEC-specific HQs are calculated using the following general equation:

$$HQ = EPC \text{ or } EDD/ESV \text{ or } TRV$$

Where:

HQ	=	Hazard quotient (unitless)
EPC	=	Exposure point concentration (µg/L or mg/kg)
EDD	=	Estimated daily dose (mg/kg BW-day)
ESV	=	surface water or sediment benchmark (µg/L or mg/kg)
TRV	=	wildlife toxicity reference value (mg/kg BW-day)

HQs at or above 1.0 are interpreted as having potential for ecological risk under the exposure and toxicity assumptions used in this evaluation. Although both RME and CTE risks are evaluated herein, most of the risk characterization summaries in this BERA focus on chronic and low-effect CTE HQs. Even though it is understood that risk does not increase in a linear fashion with increasing HQs, HQs are often described in context of relative risk as follows;

- CTE effect HQs ≥1.0 but <5.0 – which corresponds to low risk;
- CTE effect HQs ≥5.0 but <10.0 – which corresponds to moderate risk; or
- CTE effect HQs ≥10.0 – which corresponds to high risk.

These HQ thresholds are developed in the Aquatic BERA work plan (EPA, 2016d) and provide a consistent categorization method to assess relative risks between COPECs and EUs. As such, this terminology is only used to qualitatively highlight differences in risk and should not be interpreted beyond this intended use.

Note that HQs are not calculated for pH EPCs. The series of pH ESVs presented in Section 6.8.1 are used to evaluate risks from low pH water exposure. The pH CTE effect relative risk categories are;

- pH ≤6.5 but >5.5 (low risk), which corresponds to the lower pH limit for general fish protection;
- pH ≤5.5 but >4.4 (moderate risk), which corresponds to mortality of some life stages of certain fish species and reduced primary productivity of freshwater aquatic ecosystems, and;
- pH ≤4.4 (high risk), which corresponds to the lower toxic limit for trout.

In addition to HQ-based risk characterization, this BERA also uses information obtained from laboratory toxicity tests and field studies to assess several risk measurement endpoints. Toxicity testing assesses risks associated with complex mixtures of metals found in BPMD surface water and sediments to sensitive organisms under controlled conditions. Analysis of field studies provides an integrated health measure of the aquatic communities in each EU under current exposure conditions. These studies also provide context in which to place the HQ-based risk characterization results. For example, this BERA investigates distribution and concentrations of COPECs at locations that support fish versus locations with similar habitat that do not support fish. These site-specific insights are useful to risk managers when selecting remedial action goals and objectives.

Besides assessing the potential impacts associated with RME and CTE surface water exposures, the risk characterization for aquatic community-level receptor groups also evaluates individual surface water samples. Each surface water sample represents an individual event in which organisms are exposed to COPECs. For this analysis, HQs are calculated for surface water samples and select COPECs using chronic surface water ESVs and plotted by sampling location and hydroperiod (Section 8, **Figures 8-1 through 8-4**). Risk may be acceptable if the community, as a whole remains healthy and stable over time even when individual exposure events results in elevated HQs. For example, it can be assumed that community-level risks are unlikely to occur if all the surface water HQs measured within a particular EU fall below 1.0. On the other hand, community-level risks may be more likely to occur if most or all of the individual surface water HQs exceed 1.0. Finally, some impact may occur, but without resulting in community-level effects, if only a small portion of the HQs exceed 1.0. **Figures 8-1 through 8-4** are useful in understanding risks with respect to variability in sample results over time and space.

This BERA characterizes risk for six separate reference EUs. The HQs in these reference EUs can be compared to the HQs in the EUs impacted by NPL mine features without having to specifically define background conditions. They provide such an analysis on the same or similar geographic scale as non-reference EUs. As such, co-analysis of reference EUs is useful when comparing relative risk between EUs potentially impacted by NPL mine features versus EUs that are not downgradient from NPL sources.

Uncertainty is an inherent feature of any BERA because many assumptions must be made to proceed with the evaluation. These assumptions can affect all or some aspects of an assessment, including the CSM development, effects analyses, exposure analyses, and risk characterization. The uncertainty analysis provided at the end of this section identifies and discusses the major assumptions made in this BERA, as well as potential biases associated with them. The end result is a balanced overview of uncertainty to help risk managers understand the full extent of potential ecological risk to receptors living or feeding in aquatic habitats throughout the BPMD and Durango Reach EUs.

The remainder of this section summarizes the results of the risk characterization phase for each of the risk assessment endpoints.

9.1 Aquatic community-level receptors - Benthic Invertebrates

Assessment endpoint 1: Maintain a stable and healthy BMI community. *Are the contaminant levels in sediment and pore water high enough to affect survival, growth or reproduction in the BMIs?*

The potential for ecological risk to the BMI community is assessed using four separate measurement endpoints.

9.1.1 Measurement endpoint 1A

Compare the metal levels measured in sediment to no- and low-effect ESVs.

Appendix 13 Tables A13.1 to A13.27 present the no- and low-effect HQs for BMIs exposed to COPECs in sediment from each EU. **Table 9.1** summarizes the CTE low-effect ESV HQs for each EU. Note that only COPECs with at least one CTE low-effect HQ at or above 1.0 are shown in this table. These HQs represent the highest levels of risk among BMIs exposed to contaminants in sediment. The more conservative no-effect HQs are typically 2 to 10 times higher than those summarized below.

Eight of the 16 sediment COPECs have CTE low-effect HQs above 1.0 (**Table 9.1**). The greatest HQs are derived for lead, manganese, and zinc. Silver, iron and arsenic CTE low-effect HQs are comparably lower, but still above 1.0 in a few EUs. Cadmium and copper HQs are also relatively low, except in Placer Gulch (EU-16).

The CTE low-effect HQs for cadmium (7.4), copper (7.2), lead (51), manganese (29), silver (3.4), and zinc (19) are highest in Placer Gulch (EU-16). This EU is evaluated using sediment chemistry data collected at one sampling location (A20) with four sediment samples collected between August 2015 and September 2017. As would be expected, the lead and manganese HQs are also high in the West Fork Animas River reach (EU-15) this is just downstream from the Placer Gulch confluence, as well as in mainstem Animas River below the West Fork confluence

(EU-14). Mainstem Animas River reaches EU-9 and -10 also have high lead, manganese, and zinc HQs. These two EUs are located in a lower elevation depositional zone in the mainstem Animas River downriver from the South Fork Animas River confluence. Mine waste-impacted sediments from upriver sources may have accumulated in this depositional area. Two large tailings deposits (Kittimack and Howardsville Goldfield tailings NPL sites) are also located in or near the floodplain in these two EUs.

The Mineral Creek CTE low-effect HQs for lead, manganese, and zinc are generally lower than those observed in the mainstem Animas River and associated tributaries and gulches (**Table 9.1**). Of the Mineral Creek watershed EUs, upper Mineral Creek (EU-04) and Middle Mineral Creek (EU-03) have the highest CTE low-effect HQs. The highest HQs within these reaches are associated with lead and zinc (HQs >10), but not manganese as seen in Placer Gulch and other upper Animas River watershed EUs. Also, the highest arsenic HQ (3.8) among all 27 EUs occur in upper Mineral Creek (EU-04). This may reflect a unique source(s) of arsenic in the headwaters of Mineral Creek.

The Durango Reach CTE low-effect HQs are generally below 1.0 for all COPECs, except for lead (1.6), manganese (1.8), and zinc (1.5). These low-level HQs are all derived from sediment samples collected in the upper Durango Reach (EU-DR01). Sediment HQs are very similar between the two Durango Reaches despite the fact that the EU-DR02 sediments were collected in an urban river corridor. All the sediment CTE low-effect HQs from Hermosa Creek (Durango Reach reference EU-R6) are below 1.0.

The CTE low-effect HQs at the six reference EUs are variable but generally lower than corresponding watershed assessment EUs. The greatest reference EU HQs are for manganese, especially in upper North Fork Animas River EU-R5 (HQ = 4.5). Low-level arsenic, cadmium, and zinc risks are only identified in Animas River tributary reference EUs (EU-R4 and -R5). These results suggest that some of the reference EU sediments might be impacted by metals from unaccounted mining activities or elevated background conditions. They also exemplify the potential variability of background conditions that exist in the BPMD watershed.

9.1.2 Measurement endpoint 1B

Compare the metal levels measured in pore water samples to surface water acute and chronic ESVs.

Appendix 16 Tables A16.1 to A16.48 presents the acute and chronic HQs for benthic invertebrates exposed to COPECs in pore water for each EU. **Tables 9.2 and 9.3** summarize the low-hardness, CTE-based acute and chronic ESV HQs and pH values for each EU, respectively. Acute HQs represent the highest levels of risk among BMIs exposure to contaminants in pore water.

The highest acute and chronic CTE HQs for pore water are derived for aluminum, cadmium, zinc, iron, and lead. As described in Section 6.8.1, the chronic aluminum criterion has a pH threshold (i.e. pH < 7.0) which, when met, defaults to 87 µg/L. As result, **Table 9.3** provides two chronic aluminum CTE HQs that correspond to the default and low hardness-dependent criteria. The two chronic aluminum HQs (default and hardness-dependent) are provided because CTEs represent averages that were calculated from a set of individual samples; by definition, CTEs could not be paired with individual pH measurements. HQs derived using the default criterion are substantially higher than the HQs derived from the hardness-dependent criteria. Irrespective of which criteria is used to derive the HQs, aluminum still poses some of the greatest risks to BMIs from chronic pore water exposure. As for acute exposures, zinc has some of the highest HQs. This pattern is partly caused by the fact that the acute and chronic zinc criteria are very similar.

Similar to sediment risks, the highest acute and chronic low-hardness CTE HQs are observed in EUs located in upper BPMD Animas River watershed tributaries and gulches. The highest HQs are derived from pore water collected in Burrows Gulch (EU-19). Placer Gulch (EU-16), which has the highest sediment-based HQs, also has elevated pore water HQs but not nearly as high as sediment HQs. This difference might be an artifact of the low number of pore water samples collected among the EUs.

Pore water pH is low for many of the BPMD EUs. The lowest CTE pH values occur in EUs that also have the highest HQs for metals. As such, the lowest pH values are associated with upper Animas River watershed and most of the Mineral Creek EUs. The lowest CTE pH value (3.94) is from Middle Fork Mineral Creek (EU-06). This EU also has elevated chronic low-hardness CTE HQs for iron (36), aluminum (8.1), and cadmium (1.2); see **Table 9.3**.

Both the default and hardness-adjusted aluminum HQs in Mineral Creek pore water samples are high when compared to the lower mainstem Animas River and associated tributaries and gulches. Aluminum concentrations in upper mainstem Mineral Creek (EU-04) pore water are low (max detection 47.6 µg/L) and this metal is not identified as a COPEC for this EU. Therefore, most of the aluminum inputs into Mineral Creek most likely occur below the Mill Creek confluence in EU-03 or in Middle Fork Mineral Creek (EU-06). Manganese is not as pervasive of a COPEC in pore water compared to sediments. However, manganese CTE HQs are elevated in a few upper Animas River watershed EUs. A similar pattern is evident for copper (**Table 9.3**).

Similar to sediment risks, the Durango Reach pore water acute and chronic CTE HQs are low when compared to those from the BPMD EUs. Copper and manganese are the only two pore water COPECs identified within the Durango Reach, with manganese having the highest HQs (2.5 and 1.4; **Table 9.3**). Note that manganese HQs are also relatively high in Durango Reach sediments (Section 9.1.1). Also note that neither TRM pore water chemistry nor pH data are available for this reach; therefore, potential risks from pore water aluminum, antimony, barium, beryllium, cobalt, iron, molybdenum, vanadium, and low pH exposures are unknown.

The pore water CTE HQs in the reference EUs are low when compared to EU HQs measured in the Mineral Creek and Animas River watershed. In the Bear Creek reference EU-R1, located lower in the Mineral Creek watershed, aluminum CTE chronic HQ are 7.4 and 2.0 (default and hardness-adjusted, respectively) and pH is 6.3. Mill Creek (EU-R2), the second Mineral Creek reference tributary, also has slightly elevated aluminum HQs and low pH (**Table 9.3**). This pattern might indicate the pervasiveness or presence of natural sources of elevated aluminum and low pH waters in this watershed. Elevated cadmium, iron, and pH exposure risks are observed in the upper North Fork Animas River reference EU-R6. Risks from low pH and iron are comparable to those observed in respective, upper Animas River watershed assessment EUs. However, low-level cadmium risks for EU-R5 are minute when compared to moderate and high-level cadmium risks within the upper watershed assessment EUs.

9.1.3 Measurement endpoint 1C

Assess the toxicity of field-collected BPMD and Durango Reach sediments to the freshwater amphipod H. azteca after 10 days of exposure in the laboratory.

While the above sediment and pore water risk analyses are predictive of BMI risks, sediment toxicity tests provide a direct measurement of risks. Laboratory toxicity tests also help identify which risk drivers might be important for each EU when coupled with chemical analyses of field-collected and tested sediment samples.

Table 9.4 summarizes the sediment toxicity test performance and sediment-based CTE low-effect HQs. Minimum overlying water pH measurements are also provided for each of the tests/EUs. Most sediment toxicity tests have significantly lower amphipod survival and biomass than the corresponding clean laboratory control sediment tests. Significantly reduced biomass generally tracks reduced survival but is a more sensitive performance endpoint than survival for a few tests. Exposure to almost every BPMD and Durango Reach sediment adversely affect amphipod survival or biomass after 10 days of exposure.

Several EU sediments greatly reduced amphipod survival down to less than 20%. These sediments were collected from EUs located in the Mineral Creek and upper Animas River watersheds. For example, mainstem Mineral Creek EU-01, -02 and -06 test sediments resulted in very low (0% to 10% amphipod survival). EU-01 and -02 are directly downgradient from Middle Fork Mineral Creek (EU-06) indicating that this tributary might be a source of sediment toxicity to amphipods.

Unexpectedly low amphipod survival (3%) is observed during the October 2016 sediment toxicity test using the reference sample collected from the Hermosa Creek EU-R6. The sediment metals concentrations are low in this sample and it appears that the amphipods might have been affected by the very fine-grained, silty nature of the reference sample (EPA, 2017d). The November 2017 sediment toxicity test used larger-grained sediment collected from the same general area in Hermosa Creek (HC02) and resulted in better survival (65%). However, this

improved survival is still significantly lower than that observed in the clean laboratory control sample (EPA, 2018c). These results suggest that amphipods may be sensitive to exposure from unknown stressors that occur in lower Hermosa Creek sediments.

Similar to the HQ-based results observed in field-collected sediment samples (Section 9.1.1), some of the bulk sediment samples used in the toxicity tests have high CTE low-effect HQs for lead, manganese, and zinc (**Table 9.4**). The distribution of HQs among the EUs for these metals is also similar to those described in Section 9.1.1. Therefore, the sediment samples used in the toxicity tests appear to represent current conditions within respective EUs. Despite these consistencies, toxicity test performance rarely matched up with what is expected based on the calculated sediment-based HQs. For example, the upper Animas River watershed EUs with the highest sediment HQs (EU-16) have similar toxicity when compared to BPMD reference EUs and EUs with much lower sediment HQs. Additionally, several Mineral Creek sediment samples recorded some of the highest toxicities which are unexpected based on the sediment HQs alone.

It is expected that analysis of metals in bulk sediments might be a poor predictor of amphipod toxicity since total metals concentrations do not reflect what would be bioavailable to amphipods. Sediment pore water may be a better predictor of metals bioavailability. As such sediment pore water was collected during toxicity tests. **Table 9.5** summarizes maximum pore water chronic HQs. Iron HQs are elevated in the pore water samples collected from the Durango Reach samples used in the September 2017 sediment toxicity test. These tests are the only ones in which pore water TRM analyses were available, so it is not possible to compare aluminum or iron HQs between all the tests. Low overlying water pH seems to also track low survival, but not in all cases (**Table 9.4**). In general, the HQs in the pore water samples look to be more predictive of amphipod toxicity than the sediment low-effect HQs (compare **Table 9.4** against **Tables 9.5**). Therefore, pore water chemistry should be considered when evaluating sediment toxicity test organism performance and continue to be monitored in future tests.

For all but one September 2014 Purple Cliffs test with 31% survival, exposure to Durango Reach sediments did not cause substantial and widespread toxicity in amphipods. The Durango Reach sediment samples used in the toxicity tests generally result in low-risk CTE low-effect sediment HQs for lead, manganese, and zinc. Again, high sediment HQs did not correspond to decreased survival. For example, the low-effect sediment HQs from the September 2014 Purple Cliffs test with 31% survival are all below 1.0. However, high pore water chronic HQs are noted in that test and for a few other Durango Reach sites; namely iron but these results still do not correspond well to test performance (**Table 9.5**). Amphipod survival for most of the Durango Reach sediment toxicity tests are higher than in most of the BPMD sediment tests, including reference sites. Metals concentrations measured in pore water samples are lower than those observed in BPMD sediment samples/tests. Together, these results suggest that the Durango Reach sediments are generally least toxic to amphipods.

9.1.4 Measurement endpoint 1D

Assess the structure and function of the BMI community in the field.

Table 9.6 summarizes BMI community composition metrics from surveys conducted by MSI (2016, 2017b) in September 2015 and MSI (2017a) in September 2016 at BPMD and Durango Reach EUs. As noted in Section 6.5, this information is the primary source for assessing the structure and function of current BPMD BMI communities. MSI surveys provide an integrated endpoint that reflects actual BMI community impacts and associated risks. Consistent sampling and sample processing methodology allow for a quantifiable analysis to compare BMI metrics among EUs.

The BMI community risk characterization focuses on select metrics derived using species (taxa) and frequencies of field-collected invertebrates. The CO MMI metric is particularly useful for this analysis since it integrates many different community composition metrics and is also used to assess whether or not sites are attaining aquatic life designations. As seen in **Table 9.6**, MMI scores indicate that most of the BPMD EUs have impaired BMI communities. Impairments and low MMI scores generally occur in EUs located in the upper Animas River watershed and mainstem Mineral Creek. The lowest MMI scores in the Animas River watershed occur in Burrows Gulch (EU-19), West Fork Animas River (EU-15 and -17), Placer Gulch (EU-16), and North Fork Animas River (EU-18). The MMI scores are also low in the Middle Fork Mineral Creek (EU-06) and lower mainstem Mineral Creek (EU-01 and 02). The most diverse and robust BMI communities occur in the reference EUs and in Cunningham Creek (EU-08).

The Durango Reach CO MMI metric results indicate that many survey locations are impaired in September 2015 (**Table 9.6**). The lowest MMI scores occur in Oxbow Park, 32nd Street Bridge, and Rotary Park survey locations. Oxbow Park and 32nd Street Bridge are just upriver from the City of Durango in a depositional zone dominated by fine-grained silty and sandy sediment. MSI surveys follow targeted riffle sampling methods developed by Anderson (2007). The Oxbow Park survey reach did not contain riffle habitat preferred by EPT (combined Ephemeroptera [mayfly], Plecoptera [stonefly], and Tricoptera [caddisfly]) taxa; therefore, depositional habitat was sampled. This difference might explain the relatively low numbers of EPT taxa and individuals and MMI scores at this location. The highest MMI scores of all six Durango Reach locations occur at James Ranch, Purple Cliffs, and Lightner Creek. These locations have better riffle habitats than the Oxbow Park survey reach.

Durango Reach BMI metrics are highly variable among survey locations. This variability might be the result from the diverse habitat that is found throughout this reach. For example, the greatest numbers of EPT taxa and individuals occur at James Ranch which has large, well-developed riffle habitat preferred by these taxa. Similar conditions exist at the Lightner Creek and Purple Cliffs survey locations which also have relatively high EPT taxa and individuals. BMI communities in more depositional survey locations are dominated by Chironomids; especially *Eukiefferiella* and *Cricotopus* which are moderately tolerant of fine-grained sediments

(CDPHE, 2017b). It is important to note that deposition habitats have high potential to accumulate contaminants; although sediment HQs (**Table 9.1**) and amphipod toxicity tests (**Table 9.4**) indicate that these locations are not heavily impacted by metals.

In addition to impaired aquatic life use classifications and low MMI scores, the upper Animas River watershed EUs generally have low BMI densities, low numbers of taxa, and few metals-sensitive Ephemeroptera taxon or individuals. These locations also have relatively high substrate embeddedness and no aquatic macrophytes, which are common attributes of low value BMI habitats and substrates impacted by metal precipitates (data not shown; see MSI, 2017b). Burrows Gulch has a high BMI density, but taxa are comprised of pollution-tolerant taxa, mainly Chironomids. This pattern might be an artifact of slightly better habitat conditions, specifically smaller-grained and non-embedded sediments found in the Burrows Gulch sampling reach (data not shown; see MSI, 2017b). Mineral Creek community metrics are similar to those observed in upper Animas River EUs, except that BMI densities and total number of taxa are slightly greater.

Table 9.6 summarizes BMI survey metrics for a few locations that were not selected to represent one of the 27 EUs evaluated in this BERA. These locations are included herein for completeness and are located in the upper portions of select tributaries, such as M26B in South Fork Mineral Creek (EU-05) and A36A in South Fork Animas River (EU-11). Survey results from these additional locations exemplify the high variability of impacts that can occur within a single EU. For example, the Upper South Fork Animas River (EU-11) representative assessment location (A36), which is located near the Eureka Gulch confluence, is impaired whereas the non-representative location A36A, situated about one mile further upstream from A36, is not impaired.

Despite low MMI scores, densities, numbers of taxa, and diversity, many impacted BPMD EUs have substantial proportions of EPT taxa and individuals. EPT taxa are generally considered to be intolerant to environmental contamination (Barbour *et al.*, 1999). BPMD EPT metric results are mostly represented by Plecoptera and Tricoptera at most EUs and not by Ephemeroptera (**Table 9.6**). Among these two BMI orders, the most abundant genera are *Zapada*, *Taenionema*, and *Rhyacophila* (data not shown; see MSI, 2017b). *Zapada* and *Rhyacophila* are moderately tolerant to environmental stress while *Taenionema* is fairly tolerant which generally reflects their distributions among sampled locations (CDPHE, 2017b). These taxa are also common to high-elevation, cold-water streams and are important prey for invertivorous fish and aquatic wildlife species where they occur. Durango Reach BMI communities in locations, not dominated by fine grained sediments, also contain good numbers of EPT taxa. Unlike the BPMD reaches, the Durango Reach EPT taxa often contain a fair number of Ephemeroptera which are almost exclusively dominated by *Baetis*. This mildly intolerant taxon is often observed in BPMD survey reaches, but not anywhere near the high densities observed in the Durango Reach. Like most EPT taxa, *Baetis* can be important forage for trout and often found at high abundances in cold, unpolluted rivers.

9.1.5 Risk conclusion for assessment endpoint 1 (benthic invertebrate community)

Taken together, the four independent measurement endpoints (i.e., comparison of bulk sediment chemistry to sediment no- and low-effect benchmarks, comparison of field-collected pore water chemistry to acute and chronic surface water benchmarks, sediment toxicity tests, and BMI community survey results) show a strong potential for risk to the benthic invertebrate community in various sections of the upper Animas River watershed, as well as select reaches in Mineral Creek. Durango Reach sediments and pore water also contain metals at concentrations that might be stressful to BMIs. However, the metals concentrations and risk potential in the Durango Reach are much lower than those observed in the BPMD.

Sediment toxicity test results do not provide a consistent risk characterization picture. For some EUs, HQs derived for sediments used in tests identify high BMI risks but test performance is on par with tests using less-contaminated sediments. Substantial variability is also observed in test performance for locations where multiple tests were conducted. Regardless, low pH and metals impacted sites have relatively low amphipod survival and growth. HQs derived from pore water samples more accurately identify potential risk drivers than sediment HQs alone. This observation might reflect greater bioavailability of metals in interstitial water than in bulk sediments.

MSI (2016; 2017a,b) BMI community survey results show a consistent pattern of aquatic life use impairments, with low densities, low numbers of taxa, and low diversity occurring in the most metals-contaminated EUs and collection sites. These sites also have low value BMI habitats with sediments cemented or covered with metal precipitates and biofilm mats. MSI (2016; 2017a) showed that the Durango Reach BMI communities are highly variable with respect to the diverse habitats that were sampled. Despite BMI impairment results, extant BMI communities often contain and are sometimes dominated by relatively pollution intolerant EPT taxa.

A summary of additional BMI risk characterization results is provided below:

- The evaluation focuses on metals that yielded the highest BMI community-level HQs. Those metals include lead, manganese, and zinc in sediments and aluminum, cadmium, iron, and zinc in toxicity test pore water samples.
- Toxicity tests show that sediments collected from most of the BPMD EUs are toxic to amphipods after 10-day exposures.
- The pH of the water collected from the sediment toxicity test chambers is low for tests with low survival. The lowest pH waters were measured in Mineral Creek tests that have relatively low HQs in tested sediments, suggesting that pH might be a risk driver for this watershed. However, low pH is co-located with high pore water metals concentrations.
- BPMD BMI community surveys show that a high proportion of upper Animas River watershed and Mineral Creek EUs are impaired, as shown by the low MMI scores. Impairment is not observed in any of the reference EUs.

- The MSI community surveys in the Durango Reach show that five of the six sampled locations are impaired with most MMI scores in the impairment grey zone. The lowest scores are observed in depositional locations dominated by fine grained sediments, such as Oxbow Park.
- While found in low densities, some BPMD EUs support relatively sensitive Plecoptera and Tricoptera taxa that are valued forage for invertivorous fish and wildlife. Ephemeroptera are more common in Durango Reach BMI communities; especially in locations with well-developed riffle habitats with cobble-sized substrates.

9.2 Aquatic community-level receptors – water column invertebrates, fish, and amphibians

Maintain a stable and healthy water-column invertebrate, fish, and amphibian community: *Are the contaminant levels in surface water high enough to affect survival, growth or reproduction in the water-column invertebrates and fish?*

The potential for ecological risk to BPMD and Durango Reach water-column invertebrate and fish communities is assessed using four separate measurement endpoints.

9.2.1 Measurement endpoint 2A

Compare metal concentrations in surface water to surface water acute and chronic ESVs.

Appendix 17 Tables A17.1 to A17.51 provide acute and chronic HQs for aquatic community receptors exposed to COPECs in surface water for each EU. **Tables 9.7 and 9.8** summarize the minimum-hardness, CTE-based acute and chronic ESV HQs for each EU. The acute HQs represent the highest levels of risk from exposure to contaminants in BPMD and Durango Reach surface water.

In decreasing order of risk, the highest acute CTE HQs are derived for zinc, cadmium, aluminum, copper, and manganese, whereas the highest chronic CTE HQs are derived for aluminum, cadmium, zinc, iron, copper, lead, and manganese. Risks from low pH exposure are also high in the Animas River watershed above the South Fork Animas River confluence, mainstem Mineral Creek, and Middle Fork Mineral Creek. As described in Section 6.8.1, the chronic aluminum criteria have a pH threshold which, when met, defaults to 87 µg/L. Similar to pore water analysis, surface water CTEs are calculated values from a set of individual samples and could not be explicitly paired with pH measurements to determine whether or not the default aluminum criterion should be applied. For completeness, **Table 9.8** provides two aluminum HQs that correspond to the default and the hardness-dependent criterion. As expected, the HQs derived using the default criterion are substantially higher than the hardness-dependent criteria. Irrespective of which criteria are used to derive the HQs, aluminum still pose some of the greatest risks to aquatic community-level receptors from chronic surface water exposure. Note that **Figure 8-1** summarizes all sample-specific aluminum HQs that incorporate the pH threshold

criterion. Low surface water pH may also pose a substantial risk to aquatic community-level receptors in select EUs but low pH often co-occurs in EUs with high metals.
The greatest risks to aquatic community-level receptors exposed to surface water occur in the upper Animas River watershed (EU-14 through -19), the lower and middle reaches of mainstem Mineral Creek (EU-01 through -03), and Middle Fork Mineral Creek (EU-06). The upper North Fork Animas River reference EU also has high chronic CTE HQs for cadmium, zinc, and aluminum, but not at levels observed in Burrows Gulch (EU-19) and downstream mainstem Animas River reaches. On the mainstem Animas River, metals concentrations and low pH in surface water and risks to aquatic communities decrease in a downriver direction from the Burrows Gulch (EU-19) to the South Fork Animas River confluence near Eureka. Although less contaminated than upper reaches, surface water in the South Fork Animas River (EU-13) and the mainstem Animas River reach below its confluence (EU-10) contains enough zinc and cadmium to generate acute and chronic CTE HQs above 4.9. In the Mineral Creek watershed, the highest acute and chronic CTE HQs occur in Middle Fork Mineral Creek (EU-06) and mainstem Mineral Creek below the Mill Creek confluence (EU-01 through -03). The chronic HQs suggest that aluminum may pose risks to aquatic community-level receptors in South Fork Mineral Creek, but not at levels observed in Middle Fork Mineral Creek and downstream mainstem reaches.

Five surface water COPECs and pH are identified for the Durango Reach locations (**Table 7.1**). As stated in Section 8, silver is retained as a COPEC even though it is not detected in any surface water samples; because half of the MDL exceed the COPEC screening ESV. Therefore, silver is not evaluated further. While pH is identified as a COPEC in the lower Durango Reach (EU-DR02), the CTE pH value (6.8) for this reach is above the 6.5 threshold. The acute surface water HQs for the remaining surface water COPECs in the Durango Reach COPEC all fall below 1.0 (**Table 9.7**). The highest chronic CTE HQs in the Durango Reach EUs are for aluminum (HQ = 31 and 11; based on the default criterion and hardness-dependent criterion, respectively) in the upper reach (EU-DR01) and iron (HQ = 6.9) in the lower reach ([EU-DR02]; **Table 9.8**). The chronic CTE aluminum HQs are also elevated in the lower reach (HQ = 17 and 5.4). These HQs are from a combination of high TRM concentrations and low surface water hardness (lower WQC) in samples collected during the runoff hydroperiod (**Appendix 17**). Therefore, these results might reflect mobilization of particulate metals during high-flow conditions.

Chronic, low-level risk CTE mercury HQs (4.0) are also derived for Durango Reach surface waters. However, these HQs are derived from samples in which mercury was not detected and therefore, based on half of MDL values. Among the 30 available Durango Reach TRM mercury data points, mercury is measured above the MDLs 16 times. Detected mercury concentrations range from 0.015 to 0.0003 µg/L with an average of 0.003 µg/L. The CDPHE (2017c) chronic WQS for mercury is 0.01 µg/L. Therefore, among the detected mercury values, the chronic WQS is only exceeded once (HQ = 1.5) and occur during the runoff hydroperiod near Purple Cliffs. Given these observations, the chronic mercury HQs presented in **Table 9.8** may not reflect actual risks associated with surface water mercury exposure in the Durango Reach. No surface water COPECs or subsequent risks are identified for the Hermosa Creek reference EU.

A few COPECs with high acute and chronic CTE HQs are observed at some of the BPMD reference sites. As stated above, analysis of the surface water data collected from the upper North Fork Animas River EU identify low- to high-level risk from acute and chronic HQs for cadmium (HQ = 3.3 and 11, respectively) and zinc (HQ = 5.5 and 7.2, respectively). Chronic aluminum HQs are also high (HQ = 4.8 and 6.4; based on the default criterion and hardness-dependent criterion, respectively) in this EU. Low-level chronic aluminum HQs are also observed in Maggie and Picayne gulches, indicating the presence of an uncharacterized source(s) of aluminum to surface water at these high-elevation reference reaches. Mill Creek, reference EU for Mineral Creek, also has a few low-level chronic HQs for aluminum (HQ = 3.1 and 1.6), beryllium (HQ = 1.6), and lead (HQ = 1.6). No COPECs are identified in the Bear Creek reference EU. These results indicate that the aquatic communities at some of the reference sites may experience low levels of stress from surface water metals exposure but nowhere near the levels observed in the non-reference EUs. The elevated HQs measured in these reference EUs suggest the presence of anthropogenic and/or natural sources of metals to surface water.

As stated above, the cadmium, copper, and zinc acute CTE HQs are exceedingly high in the upper Animas River watershed EUs, specifically EU-14 through EU-19. These HQs are derived using CDPHE (2017c) WQC designed to be protective to the most sensitive aquatic organisms for which toxicity information was available. In an effort to develop site-specific WQC for trout species of interest, the Upper Animas BERA (**Attachment 1**) used similar WQC derivation methods as CDPHE (2017c) to develop acute toxicity threshold equations for brook, rainbow, brown, and cutthroat trout (*Appendix 5 Steps and Background for Developing Trout Specific Hardness-Dependent Toxicity Thresholds* in EPA, 2019; **Attachment 1**). In order to display all trout thresholds on a single figure for each metal, metal concentrations and respective thresholds are normalized to a standard water hardness of 50 mg/L using the same methods described in in EPA (2019) and trout species-specific acute toxicity threshold equations provided in **Attachment 1** of this BERA.

Figures 9-1 through 9-3 show hardness normalized (@ 50 mg of $CaCO_2$/L) dissolved cadmium, copper, and zinc concentrations, respectively, for each water sample collected in Mineral Creek and Animas River EU sampling locations by hydroperiod. Each of the three, trout-specific acute toxicity thresholds and the acute CDPHE (2017c) table values standards (each normalized to a hardness of 50 mg of $CaCO_2$/L) are superimposed over the hardness normalized metal concentrations. As seen in **Figures 9-1 through 9-3**, acute toxicity thresholds are often much higher than CDPHE (2017c) table value standards. These figures also illustrate the differences in trout species sensitivity to cadmium, copper, and zinc. They also show how differences in acute thresholds for each trout species could predict distributions of trout in the Animas River. For example, normalized zinc concentrations in most Animas River watershed EUs are almost always above the rainbow and cutthroat trout acute thresholds but not for brook trout (**Figure 9-3 b**). Zinc concentrations are only above the brook trout acute threshold in the upper Animas River EUs above Eureka (EU-14 through -19) and in Eureka Gulch (EU-12). This scenario suggests that mainstem and tributary reaches in EU-07 through EU-11 may support brook but not rainbow, brown, or cutthroat trout due to high concentrations of zinc in surface water.

The Upper Animas BERA (EPA, 2019; **Attachment 1**) did not derive trout-specific toxicity threshold equations for aluminum because not enough toxicity testing data were available to do so. **Figure 8-1** shows hardness- and pH-dependent chronic ESV HQs for aluminum for each sample to observe the spatial and temporal variability of aluminum risks in the Mineral Creek and Animas River BPMD EUs. The highest aluminum HQs occur in the lower reaches of mainstem Mineral Creek (EU-01 and -02) and Middle Fork Mineral Creek (EU-06). Among each EU, surface water samples collected during the runoff hydroperiod generate lower aluminum HQs than pre- and post-runoff samples. This pattern is partially explained by low pH and subsequent application of the default 87µg/L aluminum criterion in pre- and post-runoff but not in runoff samples. Default criterion application effectively ignores any effects of higher water hardness observed during the pre- and post-runoff on increasing hardness criteria and lowering HQs as seen in zinc (**Figure 8-4**). These observations highlight the complex temporal variability between metals concentrations, pH, and water hardness and interrelatedness of risks between the them.

Appendix 18 Table A.18-1 through **A.18-6** are scatter plots showing all pH measurements, all hardness measurements, and remaining COPEC (beryllium, copper, iron, and manganese) HQs for each surface water sample, respectively. Results are summarized with respect to each of the three hydroperiods and each BPMD EUs in Mineral Creek (EU-01 through -06) and Animas River (EU-01 through -19).

9.2.2 Measurement endpoint 2B

Assess the toxicity of field-collected BPMD surface water to juvenile rainbow trout (O. mykiss) after 96-hours exposure in the laboratory.

Table 9.9 summarizes the acute toxicity test performance and acute ESV HQs derived using chemistry results from overlying water samples collected during the 96-hour tests. The greatest acute ESV HQs and lowest pH values measured in the exposure waters are provided for each of the tests/EUs. Only COPECs with acute ESV HQs ≥1.0 are summarized.

Rainbow trout generally have high survival rates when exposed to field-collected surface water; only eight of the 28 tests have significantly reduced survival when compared to the clean laboratory control water. These eight tests typically have 0% survival, indicating that the surface water samples collected from the respective EUs are acutely toxic to juvenile rainbow trout. Acute toxicity is generally, but not always, associated with high acute HQs in overlying water. For example, lower Mineral Creek (EU-02) has 0% survival despite having acute HQs well below 1.0. Additionally, rainbow trout exposed to Placer Gulch (EU-16) surface water has 70% survival after 96-hours even though maximum HQs for cadmium (1.67) and zinc (8.12) are well above 1.0. However, 0% survival is typically observed in toxicity tests using exposure water collected from most of the upper Animas River watershed EUs which have high HQs associated with zinc, cadmium, aluminum, and manganese.

Unlike metals, low pH in overlying water is always associated with significantly reduced survival. **Table 9.9** summarizes the lowest pH measured in exposure water during each acute toxicity test. Significantly reduced survival always occurred when pH is below the 6.5 threshold value, regardless of the metals concentrations. The importance of pH in affecting acute toxicity is exemplified by the three tests conducted using M34 (EU-01) surface water. The metal HQs in the test exposure water are similar between these tests, but pH is not. The only test without significant mortality occurs in exposure water with a near neutral pH of 6.82. The two tests with significant mortalities have exposure water with pH measurements equal to 4.98 and 5.45.

Rainbow trout exposed to reference EUs surface waters show good survival ranging from 98% to 100%. All acute ESV HQs generated from the overlying water samples collected during these tests fall below 1.0, and pH is always above the 6.5 threshold. No acute toxicity tests were conducted using water collected from the Durango Reach. Therefore, it is unknown if the surface water flowing through the Durango Reach would be acutely toxic to juvenile rainbow trout. This issue is further discussed in the uncertainties section.

9.2.3 Measurement endpoint 2.C

Assess the presence or absence of fish in the field.

Table 9.10 summarizes trout species presence/absence results from the most current USGS (2018) fall 2016 fish survey and historic surveys conducted since 1975. Between USGS (2018) and historic surveys, at least one fish survey was conducted in each of the 27 EUs. USGS (2018) surveyed 19 BPMD EUs in the Animas River and Mineral Creek. USGS (2018) did not conduct any fish surveys in the Durango Reach EUs or in the Hermosa Creek reference EU. However, these reaches are routinely sampled by CPW (2010; 2014; 2015; 2016). CPW and historic survey results (pre-1998) generally agreed with the fall 2016 survey trout presence/absence results. While the fall 2016 surveys found trout in a few reaches that historic surveys determined are devoid of trout, fish are found in all reaches that historically supported fish. This scenario might reflect improvements in water and habitat quality that have occurred in the BPMD and Durango Reach over the 40 years of historic surveys. It is noteworthy that most of the trout species observed in BPMD EU reaches (rainbow and brook trout) are non-native species, most likely a product of active or historic fish stocking efforts.

The fall 2016 survey did not report trout in any of the Animas River mainstem, tributary, or gulch EUs above the South Fork Animas River confluence, up to the Burrows Gulch confluence (**Table 9.10**). This is the same conclusion made by ARSG (2000) after compiling all available historic fish survey results. Brook trout are present in the North Fork Animas River reference EU above the Burrows Gulch confluence in historic and fall 2016 surveys. This reference EU represents some of the highest-elevation habitat assessed in this BERA. Finding trout in this EU indicates that all EUs with similar habitat, without consideration of potential naturally occurring metals, have the physical habitat to support brook trout. Mainstem Animas River reaches below

the South Fork Animas River confluence and respective reference tributaries support viable trout communities; mostly brook trout in mainstem EUs and mixed brook and cutthroat trout in tributaries.

Mainstem Mineral Creek and select connected tributaries also support trout. The fall 2016 surveys report rainbow and brook trout in lower Mineral Creek (EU-01) and brook trout in Mineral Creek between Mill and Middle Fork Mineral Creek confluences (EU-03). Fish have not been observed in these EUs in past surveys. Of note, the documented presence of trout in the fall 2016 does not fully support that these reaches are now capable of supporting viable trout populations, as it is possible that these fish are transient from less contaminated reaches in the watershed (e.g. Mill Creek in the case of EU-03, South Fork Mineral in the case of EU-01).

Lower Mineral Creek (EU-02) downstream from Middle Fork Mineral Creek, upper mainstem Mineral Creek (EU-04), and Middle Fork Mineral Creek (EU-06) did not historically support trout (**Table 9.10**). In contrast, South Fork Mineral Creek has supported both brook and rainbow trout since at least the early 1990s (Colorado Department of Health, 1992; Brantlinger, 1998). Of the Mineral Creek reference EUs, only Mill Creek support trout in recent fish surveys; historic surveys did not observe fish in this tributary (Colorado Department of Health, 1992). No trout were observed in historic and recent surveys conducted in the Bear Creek reference EU. As reported in the Use Attainability Analysis (UAA), Horn (1988) suggests that relativity high stream gradients, a lack of holding pools, physical isolation, and substrate transport during high flow events may all be impeding trout colonization in this stream (ARSG, 2000).

The Animas River through the Durango Reach EUs becomes a large, broad, lower-gradient river as it emerges from the confined Canyon Reach near Bakers Bridge (ARSG, 2000). The upper Durango Reach changes from a somewhat braided channel with ample cobble and gravel to a meandering oxbow-type channel with substrate dominated by silt and sand. The size of this reach and diverse habitat assemblage supports a more diverse and larger fish community. In addition to rainbow trout, brook trout, and brown trout, this reach supports native mottled sculpin (*Cottus bairdii*), dace (*Rhinichthys osculus*), fathead minnow (*Pimephales promelas*), and several sucker species (*Catostomus* spp.). Trout communities in the Durango Reach EUs are highly managed, with any natural reproduction greatly supplemented by intensive annual fish stocking (CPW, 2016). For example, the lower Durango Reach (EU-DR02) is regularly stocked with 10,000 brown and rainbow trout each year. This reach usually contains enough large trout to be classified as a "Gold Medal" trout fishery in most years, which is defined as a fishery represented by trout biomass over 60 pounds per acre and with 12 or more 14-inch trout per acre.

Despite heavy stocking and fishing pressure, past CPW surveys have observed early life-stage trout throughout the upper and lower Durango Reach EUs (*Figure 14* in CPW, 2016). These juvenile trout are likely the result of natural reproduction and not directly from stocking. Length-frequency analyses of Durango Reach trout also support the premise that natural reproduction occurs, as multiple age-class trout are encountered during most surveys. Unlike trout, the native sculpin, dace, and sucker species are not stocked in the Durango Reach (CPW, 2014; 2015;

2016). The sculpin is a small demersal fish species which is considered highly sensitive to metals, especially zinc (Besser *et al.*, 2007; Brinkman and Woodling, 2005). As reported in the UAA, although sculpin abundance changes from year-to-year, they have been observed in the Durango Reach since 1975 (Smith, 1976; ARSG, 2000). These observations indicate that the Durango Reach can support sensitive early life-stage trout and native species.

9.2.4 Measurement endpoint 2.D

Assess the quality of instream macrohabitat and thermal suitability at fish survey locations.

Analysis of this measurement endpoint requires an understanding of the habitat requirements of trout species common to the ecoregion and their relation to the types of habitats that currently exist throughout the BPMD study area. Below is a summary of general trout habitat requirements as summarized in the UAA (ARSG, 2000):

- Mature spawning adult trout need clean, non-embedded gravel to excavate nests or redds in which eggs are fertilized and lightly covered. Upwelling areas are particularly important as they provide ideal water quality for developing embryos.
- Newly-hatched alevins and fry require slow-moving water and sheltered habitats along the edges of streams close to the spawning areas. Alevin in particular develop within interstitial coarse gravel and large rock substrates with good water circulation; i.e. non-embedded substrate.
- After juvenile trout have absorbed their yolk sac, they emerge from the stream substrate, and start feeding on exogenous food sources. However, they are poor swimmers and easily fall prey to fish and wildlife species. As such, juvenile trout require slower water habitats with adequate cover near feeding zones. They also require deep pools and cobble-size substrates for over-wintering habitat.
- Adult trout do best in deeper riffle, run and pool habitats that support diverse BMI communities. Ideal instream conditions include a diverse combination of these three habitat types. Boulders, undercut banks, and debris are important holding areas and used for cover to avoid predators. Similar to juvenile trout, adults also require deep water areas for over-wintering.
- Trout have species-specific temperature requirements and can only survive and reproduce in waters within a relatively narrow thermal regime. Harig and Fausch (2002) showed that the thermal regime for some high mountain streams can be too cold for the recruitment of cutthroat trout. Because many of the EUs evaluated in this BERA are high elevation reaches, thermal regimes may be an important factor when considering potential for trout colonization, recruitment, and survival (USGS, 2018).

All life-stages require liquid water throughout the entire year to survive. This requirement is often a limiting factor for trout colonization in high-elevation, Rocky Mountain streams which may freeze solid during the winter months. Note that although rivers and creeks may look to be frozen during winter, water often flows under the ice and up through the substrate (upwelling).

In addition to the habitat requirements summarized above, different life stages of trout also have different sensitivity to metals exposure. For example, developing embryos inside the egg and adults are considerably more tolerant that juvenile trout. Juveniles (within the size range used in acute toxicity tests described in Section 9.2.2) are often the most sensitive life-stage. Trout species also have different sensitivities to environmentally-hostile habitats prevalent at high elevations. For example, brook trout tend to outcompete other species at the highest elevations, while brown trout thrive in larger-river habitats found in lower-elevation reaches. Finally, trout distribution and community health can be affected by barriers that limit movement throughout a watershed. For example, a large rock waterfall or road culvert could limit the amount of upstream spawning habitat when adults cannot migrate upstream. Partial barriers can also adversely affect trout communities if they limit the numbers of trout or specific species that can pass. Chemical and physical barriers can also limit the long-term genetic integrity of fish populations above barriers if reaches above barriers are too short to be able to maintain genetic diversity over an extended period of time.

As discussed in USGS (2018), all of the surveyed EUs contain liquid water throughout the year (**Table 9.11**). Many of the survey sites in the upper Animas River and Mineral Creek watersheds contain large proportions of larger-sized substrates, mainly cobbles and boulders. These reaches also have relatively steep gradients. Combined, these habitat attributes may impede the upstream migration of trout. Many of the survey sites most impacted by mining wastes also have cemented or highly-embedded substrates that could limit the amount of spawning habitat and diversity of BMI prey. Aquatic vegetation (less often) or other instream holding and retreat habitats occur in most survey sites.

USGS (2018) STIC loggers show no evidence of stream intermittency or stream freezing at any location measured as a part of that study. However, thermal suitability analysis results suggest that water temperature regimes in certain reaches may be limiting to cutthroat trout (**Table 9.11**). These reaches occur within the high-elevation regions in the Mineral Creek and Animas River watersheds. Despite having temperature regimes on the lower end of the realized thermal niche for brook trout, the majority of the BPMD reaches likely have water temperatures that are suitable for brook trout in the absence of other limiting factors. This, and the fact that brook trout are observed in the highest elevation reaches (North Fork Animas River reference EU and South Fork Mineral Creek above Clear Creek), suggest that water temperatures are not precluding brook trout from inhabiting the majority of stream reaches evaluated in the USGS (2018) study.

In summary, those EUs evaluated for both thermal suitability and physical habitat potential have reaches of sufficient habitat to support trout. The quality of such habitats greatly differed within EUs but not at levels that would completely preclude trout populations (**Table 9.11**). For many BPMD Animas River EUs habitat potential is rated fair to good and within the thermal regime for trout; however, these reaches do not contain any fish. Hardy trout species, such as brook trout should be able to colonize all of the surveyed areas. However, specific habitat requirements that support spawning and reproduction, as well as larval and juvenile survival, may be limited, especially in reaches with habitats impacted by mine wastes. It is also important to note that all

USGS (2018) fish survey and habitat assessments focused on optimal fish habitats in each EU. As such, results may not represent all instream habitats in surveyed EUs and survey reaches may be geographically isolated by complete or partial fish barriers.

9.2.5 Risk Conclusions for assessment endpoint 2 (water-column invertebrates and fish community)

Four separate measurement endpoints are assessed to characterize risk to the water-column invertebrates and fish communities in the BPMD reaches and the two Durango Reach EUs. First, metal COPECs concentrations measured in surface water samples are compared to acute and chronic WQC/WQS protective of sensitive aquatic organisms. HQs generated using these criteria are useful in predicting COPEC-specific toxicity and risk to water column invertebrates and fish. Next, acute toxicity tests are performed to measure the effects of short-term exposures to field-collected surface water samples in the laboratory on juvenile rainbow trout. The toxicity test results and water chemistry analyses help identify the potential risk drivers (i.e., low pH, zinc, cadmium, aluminum, and manganese) and the EUs most at risk. Finally, the presence or absence of trout observed during fish habitat and community field surveys are evaluated. Analysis of current and historic surveys results allow for an integrated assessment of fish community risks and respective habitat impacts. Together, risks associated with these four endpoints generally agree with each other and provide a comprehensive assessment of water column receptor risks. These risk characterization conclusions are outlined below:

- The highest acute surface water HQs are associated with zinc, cadmium, aluminum, copper, and manganese. The highest chronic surface water HQs are associated with aluminum, cadmium, zinc, iron, copper, lead, and manganese. Low pH is also a likely risk driver which generally co-occurs with high metals concentrations.

- Surface water HQs predict that both acute and chronic toxicity to aquatic community-level receptor groups may be present in select EUs throughout the BPMD. However, the risks are not equally distributed between EUs nor COPECs. For example, zinc and cadmium risks are greatest in the mainstem reaches, tributaries, and gulches located upgradient from the South Fork Animas River confluence. Zinc and cadmium risks in Mineral Creek are generally an order of magnitude lower than those observed in the upper Animas River EUs. Risks from aluminum exposure are greatest in Animas River watershed reaches above South Fork Animas River confluence, as well as Middle Fork Mineral Creek (EU-06) and in mainstem Mineral Creek (EU-02 and -01), downstream from Middle Fork Mineral Creek confluence. Exposure to metals in surface water from the BPMD reference reaches generally result in low-level risk estimates. However, localized moderate- and high-level risks associated with cadmium, zinc, and aluminum are observed in the upper North Fork Animas River reference EU.

- An analysis of the surface water HQs for the Durango Reach did not identify any acute surface water exposure risks. However, chronic HQs suggest that aquatic communities in this

reach may experience some low- to moderate-level risks from TRMs (particularly aluminum and iron) during runoff conditions. The combination of high metals concentrations and low hardness during runoff in the Durango Reach indicates that seasonal risk to aquatic communities might occur.

- Hydroperiod-based HQ analyses indicate that that surface water risks to the aquatic community in the BPMD EUs are driven as much by water hardness and pH water quality conditions as actual metals concentrations. The level of risks fluctuates between hydroperiods for each metal. For example, aluminum risks are generally higher during the pre- and post-runoff periods than during runoff period due to low pH and subsequent application of the default chronic aluminum criterion. The opposite is observed for zinc risks (highest during runoff) when water hardness and resulting criteria are lower compared to the pre- and post-runoff conditions.

- An analysis of the acute zinc threshold HQs for brook trout show that these HQs are almost always below 1.0 in Animas River EU-07 through EU-13, indicating low risk to this species from acute surface water exposure (**Figure 9-3**). The same analysis for rainbow trout shows that this species is at high risk from acute exposure in most all Animas River EUs. Note that fish surveys consistently observed brook trout in EU-07, -08 and -09.

- Toxicity testing results show that surface water collected from the most-contaminated EUs are acutely toxic to juvenile rainbow trout. The EUs with the highest surface water acute HQs and the lowest pH have the lowest trout survival. These EUs are located in the upper Animas River tributary and gulch reaches above Animas Forks, lower mainstem Mineral Creek, and Middle Fork Mineral Creek. Although surface water samples collected from these reaches differ considerably from each other, they all have high concentrations of metals, low pH, and are acutely toxic to a sensitive trout species.

- The BPMD and Durango Reach EUs has a variety of instream aquatic habitats which range from small, boulder-dominated, high-gradient streams and gulches at high elevations, to large-river, silt- and sand-dominated, low-gradient meandering reaches below the Canyon Reach, to an urban river corridor through the City of Durango.

- Fish habitat assessments indicate that not all BPMD aquatic habitats would be able to support all trout life history stages (from eggs to adults) or native cutthroat trout due to physical habitat limitations and/or low water temperatures. These habitats occur in the upper Animas River and Mineral Creek watershed EUs. However, instream habitat within these EUs is of sufficient quality to support larger juvenile and adult life-stage brook trout. Lower elevation EUs should be able to support all trout species if not impacted by past mining activities, mineralized background conditions, or other uncharacterized impacts such as fish barriers.

- The fall 2018 and historic fish surveys show that large areas of the BPMD do not support trout. Animas River mainstem, tributary, and gulch reaches above the South Fork Animas River confluence are devoid of fish, with the exception of the North Fork above Burrows Gulch. These reaches are the same ones that had the highest acute and chronic WQC HQs for cadmium, zinc, and aluminum, coupled with the lowest survival of juvenile rainbow trout exposed to field-collected surface water samples.

- The results of fish community composition surveys indicate that brook trout are more common than either rainbow or cutthroat trout in moderately contaminated reaches. This pattern is particularly evident in Animas River EU-08 and -09 and the middle section of Mineral Creek (EU-03). These trends might be partially explained by species-specific sensitivity to metals exposure as shown in **Figures 9-1 through 9-3**. It is important to realize that trout have been stocked in some of the surveyed reaches, fish can move throughout the system, and surveys only provide a snapshot of fish presence/absence. Therefore, without additional evidence, observations of fish in a given survey reach should not automatically imply that the reach is capable of supporting a viable fish community.

- The Durango Reach fish community is comprised of at least three trout species (i.e., rainbow trout, brook trout, and brown trout), plus native sculpin, sucker, and dace species. Portions of the Durango Reach are managed to produce a high-quality trout fishery. This reach has been stocked annually with several trout species for many years. Stocking is required to bolster natural trout production to levels that support a Gold Metal standard fishery in the region. The current management practices make it a challenge to analyze the fish community risks because older, metals-intolerant fish are regularly stocked to maintain the desired trout fishery. Despite this complicating factor, age-length frequency analyses show that trout and sensitive native fish species are naturally reproducing in both of the Durango Reach EUs. These observations suggest that risks to the aquatic community in the Durango Reach are relatively low when compared to those associated with most of the BPMD EU reaches that do not support relatively tolerant adult fish.

9.3 Aquatic invertivorous birds

Assessment endpoint 3: Maintain stable and healthy aquatic-dependent invertivorous bird populations: *Are the contaminant levels in surface water, sediment and BMIs high enough to affect survival, growth, or reproduction in aquatic-dependent invertivorous birds?*

The potential for ecological risk to this receptor group is assessed using one measurement endpoint, as follows:

Use metal levels measured in surface water, sediment and BMIs in a food chain model to calculate metal-specific EDDs for comparison against avian no- and low-effect TRVs.

Appendix 18 Tables A18.1 to A18.27 presents RME and CTE EDD HQs for the American dipper for each EU. **Table 9.12** summarizes the CTE low-effect HQs for this species exposed to surface water, sediment, and BMI tissues collected or modeled from sediment for each of the 27 EUs. Three of the ten wildlife COPECs (namely copper, lead, and selenium) have at least one CTE low-effect HQ ≥1.0 in at least one EU.

Lead has the highest CTE low-effect HQ (36) in Placer Gulch (EU-16). Lead HQs are also high (>10) just downstream from Placer Gulch in Lower West Fork Animas River (10; EU-15), the lowest mainstem Animas River reach (12; EU-07), and in upper Mineral Creek (16; EU-04). All mainstem Animas River reaches between the West Fork Animas River confluence and EU-07 also have HQs >5.0 indicating that the American dipper are at moderate to high risk from lead exposure in Animas River EUs downgradient from Placer Gulch to Silverton. CTE low-effect HQs fall between 1.0 and 5.0 (low-level risk) in all remaining Animas River watershed EUs, except for Maggie Gulch (0.2) and Picyane Gulch (0.5) reference EUs.

Low to high lead risks are also identified in all mainstem Mineral Creek reaches, with CTE HQs ranging from 2.2 to 13. Lead CTEs low-effect HQs above 1.0 are also observed in Mill Creek (2.0), but not in South or Middle Fork Mineral Creek tributaries (<0.8). These results suggest that the major sources of lead in Mineral Creek may be located in the higher-elevation reaches.

The lead HQs in Placer Gulch (EU-16) are primarily driven by high levels measured in sediments; RME and CTE for lead in sediments equaled 9,009 and 6,488 mg/kg, respectively. Stratus Consulting (2014) investigated lead toxicity in field-based exposure and effects studies to determine injury thresholds in songbirds. They found that sensitive songbirds inhabiting areas with soil lead concentrations above 5,000 mg/kg would have a reasonable likelihood of experiencing systematic and potentially life-threatening toxic effects from lead exposure. Above 6,700 mg/kg of lead in soil, direct life-threatening toxic effects have high likelihood of occurring. While these results do not directly reflect site conditions and bioavailability of lead in BPMD sediments they do indicate that avian invertivores might be at high risk from lead exposure in Placer Gulch.

CTE low-effect HQs above 1.0 are also observed for copper in a few upper Animas River watershed EUs, primarily in the West Fork Animas River EU-15 (4.1) and EU-17 (2.6). At these EUs, low-level risks are driven by high concentrations of copper in sediment; specifically, ingestion of sediment and BMI tissue concentrations modeled from sediment.

Slightly elevated CTE low-effect HQs are also observed for lead (2.0) and selenium (1.1) in the upper Durango Reach (EU-DR01). The selenium HQ is primarily driven by one high BMI tissue selenium value. Selenium is not detected in this one sample, but the MDL equaled 3,960 µg/kg wet-weight. This MDL is an order of magnitude above all other selenium MDLs from the same sampling campaign (EPA, 2016e). Other than lead and selenium, exposure to all other metals in both Durango Reach EUs result in CTE low-effect HQs below 1.0 for the American dipper.

The southwestern willow flycatcher, which is listed as an endangered bird species both at the federal and state level, might forage for aquatic insects and breed in the riparian habitats in the BPMD and the Durango Reach. It is not known if this bird species is actually present on the Animas River, but this BERA assumes it to be the case as a precautionary measure. Under the CTE low-effect scenario, potential risk to this T&E species is identified, primarily from lead and copper in most Animas River and Mineral Creek watershed reaches; including reference tributaries.

9.4 Aquatic omnivorous birds

Assessment endpoint 4: Maintain stable and healthy aquatic-dependent omnivorous bird populations: *Are the contaminant levels in surface water, sediment, BMIs, and plants high enough to affect survival, growth, or reproduction in aquatic-dependent omnivorous birds?*

The potential for ecological risk to this receptor group is assessed using one measurement endpoint, as follows:

Use metal levels measured in surface water, sediment, BMIs, and plants in a food chain model to calculate metal-specific EDDs for comparison against avian no- and low-effect TRVs.

Appendix 19 Tables A19.1 to A19.27 presents RME and CTE HQs for mallard for each EU. **Table 9.13** summarizes the CTE low-effect HQs for mallard exposed to surface water, sediment, and plant and invertebrate tissues. Only three of these HQs exceed 1.0 and all are for lead. These low-level HQs occur in Placer Gulch EU-16 (HQ = 2.5), Upper Mineral Creek EU-04 (HQ = 1.9), and mainstem Animas River EU-07 (HQ = 1.2). These HQs occur in the same EUs with the greatest lead risk for the American dipper and are primarily driven by high concentrations of lead in sediments. These results indicate that mallard are at low risk from lead exposure in the most-contaminated EUs via consumption of surface water, sediment, BMIs, and plants.

9.5 Aquatic piscivorous birds

Assessment endpoint 5: Maintain stable and healthy piscivorous bird populations. *Are the contaminant levels in surface water, sediment, and fish high enough to affect survival, growth, or reproduction in aquatic-dependent piscivorous birds?*

The potential for ecological risk to this receptor group is assessed using one measurement endpoint, as follows:

Use metal levels measured in surface water, sediment, and fish in a food chain model to calculate metal-specific EDDs for comparison against avian no- and low-effect TRVs.

Appendix 20 Tables A20.1 to A20.27 presents RME and CTE EDD HQs for belted kingfisher for each EU. **Table 9.14** summarizes the CTE low-effect HQs for kingfisher exposed to surface

water, sediment, and fish tissues collected or modeled from sediment for each of the 27 EUs. The lead and selenium CTE low-effect HQs exceed 1.0 in most of the 19 Animas River and Mineral Creek watershed BPMD EUs. The highest kingfisher CTE low-effect HQ is for lead in Placer Gulch (HQ = 25) followed by the next downstream reach, namely lower West Fork Animas River (HQ = 5.9). These risks are almost entirely driven by high lead levels in fish that are estimated using a literature-based sediment-to-fish tissue bioaccumulation factor of 0.07 (EPA, 2019; Krantzberg and Boyd, 1992). This factor is likely overly conservative since predicted tissue concentrations are an order of magnitude over what is observed in site-specific fish tissues at similar sediment concentrations (**Figure A7-5**). It is also important to recognize that fish are not present in many of the EUs that have the highest exposure risks. Therefore, risks from consuming fish in EUs that do not support fish are purely theoretical and not likely realized in the field.

Low-level risks from selenium exposure are also observed in many Animas River and Mineral Creek watershed EUs. These risks are primarily associated with high levels of selenium in fish, which are either directly measured in fish tissue or modeled from sediment. The highest selenium HQ is observed in lower Mineral Creek EU-01 (HQ = 2.1). This HQ is primarily driven by three sediment samples with measured selenium concentrations ranging from 9.36 to 15 mg/kg DW. Selenium is measured above its detection limit in five out of ten additional EU-01 sediment samples, ranging from 0.67 to 1.74 mg/kg DW. These results show that selenium concentrations in EU-01 sediments are quite variable.

9.6 Aquatic herbivorous mammals

Assessment endpoint 6: Maintain stable and healthy herbivorous mammal populations. *Are the contaminant levels in surface water, sediment, and plants high enough to affect survival, growth, and reproduction in aquatic-dependent herbivorous mammals?*

The potential for ecological risk to this receptor group is assessed using one measurement endpoint, as follows:

Use metal levels measured in surface water, sediment, and plants in a food chain model to calculate metal-specific EDDs for comparison against no- and low-effect mammalian TRVs.

Appendix 21 Tables A21.1 to A21.27 presents RME and CTE EDD HQs for muskrat for each EU. **Table 9.15** summarizes the CTE low-effect HQs for muskrat exposed to surface water, sediment, and plant tissues modeled from sediment for each of the 27 EUs. The three wildlife COPECs (copper, lead and selenium) are a risk concern to the muskrat, but only in a few of the most-contaminated EUs. For example, the highest risks to the muskrat occur in Placer Gulch (EU-16); for lead (6.4) and copper (1.2). Similar to what is seen in lead risks to other community-level and wildlife receptors, elevated lead HQs occur in all the Animas River EUs downgradient from Placer Gulch. For muskrat, low-level HQs are primarily driven by ingestion of sediment with elevated lead concentrations. Plant ingestion is a relatively minor dietary

exposure route for muskrat when compared to sediment ingestion, despite the fact that plant metals concentrations are modeled from sediment. The selenium HQs are below 1.0 for all BPMD EUs, except for a single low-level HQ (1.03) in the lower Mineral Creek (EU-01). This is the same location for the highest selenium CTE low-effect HQs among all 27 EUs for the American dipper, mallard, and kingfisher.

All Mineral Creek, Durango Reach, and reference EU CTE low-effect HQs were less than 1.0 (**Table 9.15**).

Despite the low to moderate risks from lead and copper in Placer Gulch, these findings suggest that muskrats are unlikely to be affected by the current exposure conditions in Mineral Creek, most of the Animas River, and all Durango Reach EUs evaluated in this BERA.

9.7 Aquatic piscivorous mammals

Assessment endpoint #7: Maintain stable and healthy aquatic-dependent piscivorous mammal populations: *Are the contaminant levels in surface water, sediment, and fish high enough to affect survival, growth, and reproduction in aquatic-dependent piscivorous mammals?*

This BERA uses one measurement endpoint to assess the potential impact of metals ingested by this receptor group:

Use metal levels measured in surface water, sediment, and fish in a food chain model to calculate metal-specific EDDs for comparison against no- and low-effect mammalian TRVs.

Appendix 22 Tables A22.1 to A22.27 presents RME and CTE EDD HQs for raccoon for each EU. **Table 9.16** summarizes the CTE low-effect HQs for the raccoon exposed to surface water, sediment, and fish tissues collected or modeled from sediment for each of the 27 EUs. Of all the COPECs and EUs, only three CTE low-effect HQs exceed 1.0. These exceedances are for lead (HQ = 4.3) in Placer Gulch (EU-16), lead (HQ = 1.02) in the next downstream reach (i.e., EU-15, lower West Fork Animas River), and selenium (HQ = 1.4) in lower Mineral Creek EU-01. Again, these HQs are primarily driven by lead and selenium via ingestion of sediment and fish tissue modeled from sediment. No CTE low-effect HQs are above 1.0 in the Durango Reach.

These findings suggest that the raccoon, representing all piscivorous mammals, are unlikely to be affected by the current exposure conditions in upper BPMD Animas River, Mineral Creek, and Durango Reach EUs. If fish are able to survive in all EUs, low-level raccoon dietary exposure risks might occur but only in the most metals impacted BPMD reaches of West Fork Animas River.

9.8 Background Conditions

It is well-established that there are significant sources of background metal loading within the BPMD watershed (Mineral Creek, Cement Creek, and the Animas River above Silverton) and metals contamination from acid rock drainage was common in some parts of the watershed prior to mining (Church *et al.*, 1999). Church *et al.* (1999) assessed sediment and overbank soils data from more than 50 BPMD sites and 500 samples to determine pre-mining geochemical conditions in the upper Animas River watershed down to the Oxbow Park area near Durango. Results from this evaluation show that historical mining resulted in a substantial increase in metals in fine sediments from those that occurred pre-mining. However, sediments that dated back to pre-mining conditions were still elevated with respect to typical crustal levels.

9.8.1 Previous investigations

Mast *et al.* (2007) provides the most compressive assessment of background metals concentrations in BPMD surface waters. However, results from this study exemplify the complexity and site-specific nature of characterizing water quality impacts of metals from background sources.

Mast *et al.* (2007) investigated background weathering of naturally mineralized rock and respective effects on water quality throughout the upper Animas River watershed. Results of this study show that natural weathering processes of mineralized geological materials can contribute substantial amounts of metals and acidity to streams in unmined areas. As such, background water quality is strongly controlled by regional geology; particularly in areas with hydrothermally altered and mineralized propylitized bedrock. Propylitized bedrock underlies more than 90% of the study area, however, only a fraction of this bedrock is hydrothermally altered, heavily mineralized, and a major source of mineral deposition in the area. Mast *et al.* (2007) identified weak sericite-pyrite, quartz-sericite-pyrite, and acid sulfate as the predominant alteration assemblages in the BPMD. As seen *in Figure 1 Animas River watershed study area, with distribution of major alteration assemblages* in Mast *et al.* (2007), these three alteration assemblages are scattered throughout the BPMD with larger localized and mixed assemblages occurring in several sub-watersheds. Isolated pockets of intense alteration assemblages led to the heterogenous distribution of background contamination sources and subsequent generation of acidic, metals rich waters.

Mast *et al.* (2007) chemically characterized 146 sites in unmined and minimally mine-impacted areas throughout the BPMD to identify and quantify dissolved constituent contributions from background weathering of hydrothermally altered rock. Importantly, sampling site density was uneven across the watershed and resulted in clusters of sampling sites in areas with more intense alteration assemblages (weak sericite-pyrite, quartz-sericite-pyrite, and acid sulfate) in places like the Red Tributary in Middle Fork Mineral Creek and Prospect Gulch in Cement Creek. Site selection also spanned a wide range of flow regimes ranging from small seeps and springs to the mouths of large tributary creeks. Note that some of these sites are located near the same

monitoring stations used in this BERA as reference EUs; specifically, Bear Creek (EU-R1), Mill Creek (EU-R2), Maggie Gulch (EU-R3), Minnie Gulch (EU-R4), and Picayne Gulch (EU-R5).

Water quality and chemistry results revealed wide variation in chemical composition among sampling sites; see *Table 2 Summary statistics for dissolved constituent concentrations in background water-quality samples (category I–II) in the Animas River watershed study area* in Mast *et al.* (2007). Wide variability in water chemistry reflects the diversity of geological settings within the watershed. The metals beryllium, chromium, cadmium, lead, lithium, nickel, and vanadium were detected in less than 90 percent of the samples, however, aluminum, barium, copper, iron, manganese, strontium, and zinc were detected in a majority of samples. Many of these commonly detected metals were measured at concentrations above respective acute and chronic WQC within heavily mineralized areas with low pH. High maxima are not unexpected given the targeting of sampling towards major alteration assemblages. Even with targeting of intense alteration assemblages, summary statistics from the USGS sampling illustrate that for many metals of ecological concern, median values were found to be below or close to detection limits (e.g. cadmium, copper, iron, nickel, lead, and zinc).

Metal concentration is only one factor determining the influence of a given background source on instream receiving waters and respective impacts to aquatic communities. For example, sources with small flow volumes may constitute negligible loading influence on receiving streams, even at very high metals concentrations. As noted above, sampling sites exhibited very large variability in discharge, ranging from 0.001 to 7.46 cubic feet per second (*Table 2* of Mast *et al.* 2007). Significant variability in metal concentration and discharge limits large- or even small-scale characterization of background conditions without conducting detailed loading analyses. As such, metals concentrations need to be analyzed with respect to source and receiving water discharge rates to accurately assess contribution of background contamination at a given BPMD location.

The Mast *et al.* (2007) study also concluded that general characterization of background conditions and differentiation between non-mining and mining-affected dissolved constituents is challenging for several reasons. The most complicating factor in characterizing background water chemistry on a basin-wide scale is the complex geology and heterogenous distribution of natural source materials (hydrothermally altered, propylitized bedrock) in the BPMD. The spatial overlap of mining in areas with magmatism, mineralization, hydrothermal alteration, and fracturing within the BPMD makes differentiating between mining and natural impacts on water difficult. The more than 5,300 mine-related sites scattered throughout the BPMD and limited information on the extent of underground workings of inactive mines and their effect on ground-water hydrology and chemistry further compound this issue. As such, water chemistry at discrete locations within the BPMD will likely be impacted by a combination of natural and anthropogenic acid rock drainage sources. Ideally, water chemistry data that predate historical mining activities could be used to assess background conditions, but this type of information is not generally available because of the long history of mining within the study area. The Church *et al.* (1999) geochemical sediment study described in the introduction of this section is as close

to this ideal as possible, but still only provides information on discrete locations and cannot be generalized to larger areas.

9.8.2 Summary

As exemplified in the above summary of Mast *et al.* (2007), the substantial spatial variability in geology, mineralization, and alteration would make breaking up the assessment area into many sub-watersheds necessary to adequately characterize background throughout the BPMD. The costs and time necessary to do this within all sub-watersheds and locations within the BPMD would be significant and not be necessary for forthcoming RI/FS actions. At this point, EPA knows that this type of analysis would be helpful for some sub-watersheds and less relevant for others from a contaminant loading standpoint. For example, if zinc is a concern at a given location in the BPMD the focus of zinc source background investigation would be on upstream sub-watersheds which are the biggest Zn loaders, not all upstream sub-watersheds in the entire BPMD. It may then be important, within those select sub-watersheds, to differentiate between background and natural sources of zinc with additional study before selecting remediation actions. In contrast, within a given sub-watershed, primary metal-loading sources may be negligible, obviously anthropogenic or previously documented as natural (e.g. the Red Tributary), making detailed differentiation between types of sources unnecessary for decision-making.

As drafted, this BERA provides a snapshot of diverse environmental factors that are currently limiting aquatic life in the many sub-watersheds within the BPMD. This is the same approach taken by Besser *et al.* (2007) and SGC (Formation Environmental, 2018) BPMD ecological risks assessments. At the scale of the assessment area and current stage of the RI/FS process, this approach provides important information for risk managers and is an efficient approach to obtaining that information. A detailed assessment of background risks is not supported by EPA (1994; 2002a,c; 2018e) guidance on characterizing background conditions during risk assessment stages of the RI/FS process. The goal of background evaluations at this stage is to provide risk managers enough information to begin evaluating their statutory authority under the CERCLA; specifically, to determine and manage the current and potential threats to human health and the environment that may be posed by hazardous substances, pollutants, and contaminants at a site (EPA, 2002c).

9.8.3 Path forward

The risk assessment is one tool of many for decision-makers to use in deciding path forward during the RI/FS process. This BERA will help decision-makers to identify and target areas where remediation has the possibility of reducing ecological risk below thresholds. EPA is currently developing a contaminant/source loading tool to identify areas/sources of significant loading of metals of ecological concern for specific points on streams with a hydrological nexus to those areas/sources. This tool relies on the wealth of environmental chemistry information collected from hundreds of monitoring stations located throughout the BPMD, including from

sites that were not considered in this BERA. These additional monitoring locations are frequently located above and below potential point sources, dilution points, and receiving water confluences. For those areas identified as significant loaders of metals of ecological concern, a concerted effort to discriminate between background and anthropogenic loading could occur if deemed necessary for remedial actions being considered. It is anticipated that the loading tool will also be used to predict how reductions in loading of conservatively transported metals (e.g. zinc, manganese, and cadmium) from source areas would reduce concentrations in streams with a downstream hydrological nexus to those sources.

9.9 Uncertainty Analysis

Uncertainty is inherent in any ecological risk assessment due to incomplete or inadequate knowledge about a number of key input parameters. This lack of knowledge is usually addressed by making conservative assumptions based on guidance and best professional judgment that carry associated biases. The major uncertainties and related biases associated with this BERA are discussed below.

9.9.1 Community-level receptors

- Some of the upper Animas River watershed reaches above the Mineral Creek confluence may never have supported healthy and diverse aquatic life communities before mining activities started in the 19th century (Church *et al.*, 1999). Since these habitats may have always been influenced by natural sources of acid rock drainage, risks identified in this BERA and the Upper Animas BERA may not reflect negatively on current conditions in these three waterways. This situation represents a major uncertainty, which would have to be considered as part of any future risk management decision-making; ideally via site-specific background conditions analyses and depending on remedial actions being considered. Despite this uncertainty, it appears highly likely that mining activities since the 19th century have substantially increased aquatic receptor exposure to, and risk, from metals to levels beyond those that would have occurred without mining (Church *et al.*, 1999). Comparative analysis between minimally mine-impacted reference EUs and non-reference EU also support that mining activities have increased risks to aquatic receptors.

- Many of the EUs evaluated in this BERA are represented by environmental chemistry data collected at a single monitoring location (**Figure 1-3**). While many of these locations are situated towards the downstream end of each EU, sampling results may not reflect the EU as a whole and could fail to identify elevated risks associated with contamination hot spots further upstream within an EU. This scenario represents an unknown but significant uncertainty, especially in large heterogeneous EUs such as the upper South Fork Animas River (EU-11) and Middle Fork Mineral Creek (EU-06) that have discrete sources of metals contamination. In these cases, exposure estimates obtained from a single downgradient monitoring location may be biases high when compared to locations above contamination sources or biased low when located just downstream from point sources. It should be

recognized that over 200 additional long-term surface water and sediment monitoring locations are located throughout the BPMD and not assessed herein. These monitoring locations are strategically situated to bracket various mine features, contaminant sources, and tributary influences and respective data will be used in future RI/FS planning activities.

- The exposure estimates for surface water, pore water, sediment, and dietary items are derived from relatively small datasets for select EUs. Small EU-specific datasets are particularly pervasive in pore water exposure assessments. For example, only one pore water sample is used to derive the pore water EPCs in EU-04, -05, -06, -08, -11, -12, -13, -15, -16, -17, -19, and every reference EU (**Appendix 9**). For these and other EU-specific small datasets (three to five data points), a UCL-based RME could not always be derived and maximum values had to be used instead. By definition, the RME and CTE exposure estimates are the same for the EU datasets that contain only one observation. Assessing risks based on small datasets reduces the level of confidence assessing risks and the amount of inference that can be applied to the affected EUs. Reduced inference is particularly important for single-point surface and pore water samples as opposed to composite sampling and field studies that are integrated over space and time. Co-evaluation of multiple lines of evidence associated with each risk assessment endpoint can greatly reduce this uncertainty.

- Silver in surface and pore water is retained as a COPEC for aquatic community-level receptors for many EUs even though this metal is not measured above its detection limit in all but a single surface water sample. When silver is not detected, the screening-level HQs are calculated using half of the highest MDL divided by the hardness-dependent chronic benchmark. These chronic benchmarks are lower than half of the MDL and resulted in HQs ranging from 0.6 to 49 in surface and pore water COPEC tables (**Appendix 8 and 9**). It is not known if risks from chronic silver exposure is real since the actual concentrations of silver in these samples is unknown. This data limitation represents an uncertainty which may need to be addressed as part of the risk management process. Again, co-evaluation of multiple lines of evidence associated with each risk assessment endpoint can greatly reduce this uncertainty.

- Surface and pore water risk estimates based on current CDPHE aluminum and cadmium table value standards may be biased high and low, respectively. EPA has recently revised recommended criteria for these two metals and revised criteria are substantially different than those used in this Aquatic BERA. For example, the EPA (2018d) chronic aluminum criteria at a dissolved organic carbon concentration of 0.5 mg/L, hardness of 50 mg of $CaCQ_3$/L, and pH of 6.5 is 160 µg/L or 350 µg/L at pH 7. The CDPHE standard for the same hardness levels and pH values are 87 µg/L and 189 µg/L; about two times lower than EPA criteria. As such, surface and pore water chronic exposure aluminum HQs reported here would be lower than those reported herein. The CDPHE cadmium standards were last updated in 2005 and based on information available at that time. EPA (2016b) updated chronic cadmium criteria are lower than those calculated using the CDPHE standards equations. At a hardness of 50 mg of $CaCO_3$/L the EPA (2016b) chronic cadmium criterion (0.426 µg/L) is about twice that

of the CDPHE standard (0.252 µg/L). Therefore, adoption of more recently updated EPA criteria would likely lower chronic cadmium HQs for surface and pore water reported herein.

- Risk characterization analyses could not identify COPECs or assess community-level risks to BMIs and fish from exposure to aluminum, antimony, barium, beryllium, cobalt, iron, molybdenum, and vanadium in pore water for the Durango Reach because pore water samples were not analyzed for TRM. In addition, no pH measurements are available for Durango reach pore water samples. Of these contaminants, pH, aluminum, beryllium, and iron are pore water COPECs in BPMD EUs. Of these BPMD COPECs, pH, aluminum, and iron are shown to have high risk to BMIs (**Table 9.3**). It is unknown, if these COPECs would also impact the Durango Reach BMIs. But other lines of evidence suggest that the Durango Reach pore water might not be significantly impacted by metals. For example, only a handful of DM-based pore water COPECs are selected for Durango Reach EUs, and the ensuing CTE low-effect HQs are relatively low. This point is also supported by relatively low sediment CTE low-effect HQs derived for these metals in sediment samples collected from this reach (**Table 9.1**). In summary, the lack of pH and TRM analytical data for Durango Reach pore water represents a potentially substantial uncertainty and as a whole, potentially biases risk lower than what would be predicted if more pore water contaminants are included. However, other lines of evidence suggest that Durango Reach sediments generally have relatively low concentrations of metals.

- Surface water hardness data are not available for all hydroperiods in all EUs evaluated in this BERA. This was especially evident for the pre-runoff hydroperiod in most of the EUs (**Table 8.1**). This was primarily associated with the difficulties in accessing sampling locations during the earliest portion of the available and short field season. As such, many of the highest elevation EUs are missing pre-runoff hardness information. It is unknown if these high elevation reaches would experience the same trend of higher pre-runoff hydroperiod hardness than runoff hydroperiod hardness. However, one could assume that the pre-runoff conditions are similar to those experienced during post-runoff since both hydroperiods represent low- or base-flow conditions. Similarities in hardness are evident between the two hydroperiods; see **Table 8.1**. Pore water exposure risks were not evaluated with respect to hydroperiods but there may be some uncertainties associated with the small hardness datasets. For example, only a single hardness measurement was available for 16 of the 26 EUs evaluated in the Aquatic BERA. Similar to what is described in the third uncertainty bullet in this section, risks based on small datasets reduces the level of confidence in assessing associated risks and the amount of inference that can be applied to the affected EUs. Fortunately, co-evaluation of other lines of evidence such as BMI survey results can greatly reduce this uncertainty. If deemed necessary for future risk management decisions, additional hardness data should be collected for affected EUs and hydroperiods to reduce the uncertainties associated with limited hardness information.

- Risk to community-level receptors is assessed using a metal-by-metal HQ analysis. The HQs are not summed to calculate a hazard index (HI), because this approach assumes that metals

toxicity is additive. It is not anticipated that all the inorganic COPECs evaluated in this BERA would exert their toxic effects on one and the same biological function, which is a basic requirement for calculating HIs. On the other hand, it is possible that some of the COPECs may in fact exert additive toxicity, in which case the metal-by-metal HQ approach would underestimate certain risks. This observation applies equally to the wildlife evaluation where all the receptors are assumed to be exposed to multiple metals. Therefore, risks associated with mixed metal exposures cannot be evaluated using HQ-based risk endpoints. Note, however, that this BERA assesses toxicity testing and field survey-based endpoints which provide a way to characterize integrated exposure risks, at least for BMIs and fish.

- Only one benthic species (the amphipod *H. azteca*) was used for the sediment toxicity tests. Even though this species is considered sensitive to metals exposure, it is not known how much more or less sensitive it is compared to the benthic invertebrate species typically found in the EU reaches evaluated in this BERA, particularly the EPT species. At a minimum, the fact that the amphipods detected significant toxicity in all but eight of the 41 field-collected sediment samples show that the test species is sensitive to the chemical conditions found in those samples.

- All of the sediment toxicity tests lasted for 10 days, which is not long enough to represent the longer-term chronic exposures more likely to be experienced by the BMIs in the field. Also, the two toxicity endpoints evaluated in the tests (i.e., survival and biomass) do not include reproductive effects, which can be quite sensitive. However, for this BERA, the uncertainties associated with relatively short exposures and lack of reproductive endpoints are considered to be small because significant toxicity responses were observed in all but eight of the field-collected sediment samples used in the toxicity tests. Because reproductive effects can occur at lower exposures, and more severe effects were found in the majority of the tests, it is not expected that additional toxicity testing for chronic and reproductive effects would provide additional information about incidence of toxicity, except in the eight EUs where 10-day toxicity tests failed to identify toxicity. Nevertheless, relying on acute and sub-chronic toxicity tests likely negatively biased results and greater toxicity would likely be observed in tests using longer exposure durations.

- Sediment toxicity tests exposed amphipods to field-collected sediment samples and clean overlying laboratory water. This exposure scenario may not reflect actual field conditions where native waters containing mining-derived metals can influence sediment chemistry or exert direct toxicity. This scenario has the potential to influence sediment, overlying water, and pore water chemistry, bioavailability, and toxicity during the tests. **Table 9.5** clearly shows that metals moved from the sediments into the overlying and pore water. This release may have been the result of changing metals speciation caused by mixing the sediments in preparation of the tests or pouring well buffered oxygen-rich renewal water into the test chambers. The high metal levels measured in the pore water samples show that metals in the in the sediment samples occurred at levels that were potentially toxic. It is uncertain whether or not the same exposure conditions would occur in native waters or if test conditions were

more or less stressful than what would occur in the field. If exposure to native overlying water (in addition to sediments) resulted in higher pore water metals concentrations, then current tests results may be biased low due to lower metals exposures in laboratory-based tests. This uncertainty may be relatively small because other lines of evidence, such as the MSI (2017b) BMI survey results identified BMI community impairment at locations with low amphipod survival and biomass.

- Juvenile rainbow trout were used in the surface water toxicity tests. This species is directly relevant to the fish populations found in the Animas River. Rainbow trout (and particularly juvenile life stages) are considered quite sensitive to the presence of metals in surface water. Hence, the uncertainty associated with their response to the acute exposures in the laboratory is minimal. However, 96-hour tests did not assess toxicity from chronic exposures experienced by fish populations in the Animas River. The lack of an acute response in juvenile rainbow trout at many of the EUs does not imply that a toxic response would not be present under longer-term chronic exposures in the laboratory. This data gap would have represented a large uncertainty by itself but is partially mitigated by the results of historic and 2016 fisheries surveys. The results from those surveys provides an integrated measure of trout risks based on real-world exposures in the field. As a result, the uncertainty associated with the lack of chronic toxicity information to juvenile rainbow trout exposed to surface water in the laboratory is considered small. Nevertheless, current risks associated with 96-hour tests results are biased low when compared to longer tests or real-world exposure regimens.

- No juvenile trout acute toxicity tests were conducted using surface water samples collected from the Durango Reach, therefore, the acute trout toxicity measurement endpoint cannot be evaluated for Durango EUs. This uncertainty is likely minor since other lines of evidence suggested that the surface water flowing through the Durango Reach is unlikely to be acutely toxic to juvenile trout. The strongest line of evidence comes from CPW (2010; 2014; 2015; 2016) fish surveys, which have routinely observed early life-stage trout and sensitive native fish species throughout the Durango Reach. They would not likely occur if Durango Reach waters are acutely toxic to trout. However, it should be recognized that the current chemical and biological datasets cannot be used to inform how much *better* the current fish community might be without the presence of contamination from the BPMD. Hence, some uncertainty remains as to the health of the native fish species in the Durango Reach.

- The BMI risks derived from analytical chemistry data are based only on metal concentrations measured in sediment and pore water. It is reasonable to expect that BMIs living on and within this substrate are also exposed, at least in part, to metals present in the overlying surface water. This surface water exposure pathway is not explicitly evaluated for BMI communities in this BERA. Note that the risk from surface water exposure to BMIs would have been identical to that conducted for fish because both aquatic community-level receptor groups would have been evaluated using the same set of surface water screening benchmarks.

Hence, the risk of surface water exposure to the BMI community was indirectly evaluated and is known (see **Tables 9.7 and 9.8**).

- The USGS (2018) fish habitat assessments and surveys were conducted in reaches with optimal fish habitat, which was a decision that was made to increase chances of detecting fish if they were present within surveyed reaches and to evaluate whether or not any suitable habitat is present within each surveyed EU. As such, results are inherently biased high and not be characteristic of the entire EU reach in which they were conducted. Further, surveyed reaches could also be geographically isolated by complete or partial fish barriers (physical and chemical) that would limit colonization and/or create a potential genetic bottleneck due to habitat limitations on population size. This uncertainty more likely affects EUs that span large sections of heterogeneous instream habitats or higher elevation EUs with steep stream reaches. If fish community-based remedial actions are selected as measurable remediation goals, detailed habitat analyses would have to be conducted in all hydraulically connected reaches to identify limiting factors for sustaining stable fish communities.

- Multiple stressors may adversely affect fish communities in the assessment area. Two major stressors include exposure to surface water contaminated from abandoned mines or background acid rock drainage and habitat constraints such as cold temperatures, limited connectivity, and lack of diverse instream macrohabitats. In stream reaches like those characterized in Lower South Fork Animas River (EU-13) and Burrows Gulch (EU-19), multiple lines of evidence indicate that surface water is toxic to fish and likely responsible for the absence of trout. However, habitat may also limit trout survival and recruitment within these reaches (**Table 9.11**). Because these two stressors may be confounded, it is plausible that reduction of chemical stressors through remediation may not lead to trout survival / recruitment because poor habitat could still prove to be limiting. As such, any remedial actions should consider consequences associated with all potential stressors that could impact remediation goals.

- Trout have been stocked throughout the BPMD and Durango Reach study area for many years prior to conducting surveys evaluated herein. Therefore, observations of fish in a given EU may not be enough evidence that an EU can support a viable fish community. Fish can move from areas where they were stocked or naturally reproducing into survey reaches. This uncertainty is diminished when fish are observed during multiple surveys and seasons/hydroperiods. Observations of more than one life-stage, especially early life-stage, can provide evidence of a viable fish community. It is important to note that brook trout are not regularly stocked in the study area. Therefore, where present, brook trout are likely naturally reproducing or transients from reproducing communities in EUs where they were observed.

9.9.2 Wildlife receptors

- Food chain models rely in part on published sediment-to-biota accumulation regression equations or uptake factors, instead of field-collected tissue samples to estimate COPEC levels in BMIs, fish and plants. The evidence presented in this report suggests that literature-derived values for BMIs were poor predictors of site-specific tissue levels and likely overestimated tissue concentrations (**Appendix 6**). Fortunately, a full suite of site-specific tissue data is available for BMI prey for most EUs and sediment-to-invertebrate and sediment-to-fish modeling was possible for some COPECs at some EUs. When applied, these data and models greatly reduced this uncertainty. Sediment-to-plant regression models and uptake factors are derived from terrestrial studies because no reliable studies have been published to measure sediment-to-plant contaminant uptake. It is not known if or how metal uptake in plants differs between soil and sediment, resulting in uncertainty about actual risk to the omnivorous birds and the herbivorous mammals feeding on aquatic plants. Nevertheless, the most conservative bioaccumulation factors are used to estimate metals concentrations in wildlife dietary items which likely positively biased exposure and risks. Use of accumulation models to predict wildlife prey tissue exposure also becomes uncertain when sediment contamination is so great that it may be directly toxic to the prey itself. Similarly, predicted tissue concentrations based on very high metals concentrations may be well above measured values used to build dietary item sediment-to-tissue models. These two scenarios likely positively bias wildlife exposure estimates and associated risks.

- BMIs were primarily collected for residue analysis in September 2016. These samples provided measured (versus estimated) tissue data for use in the food chain modeling for American dipper and mallard for most of the EUs evaluated herein. It is not known how much or if metal levels fluctuate in benthic tissue throughout the year. Also, with only a single sample to work from in each EU, most of the EU RME and CTE BMI tissue concentrations used in EDD calculations are identical to each other. While exposure estimates based on measured site-specific sampling reduces uncertainty associated with modeled concentrations, the scale of inference is limited to a single point in time and does not provide a range of possible EPCs. Since the dynamics of BMI metals accumulation is unknown at this time, biases associated with using data from a single point in time is also unknown. However, September is late in the growing season giving BMIs the longest timeframe possible to accumulate metals. If this is the case, respective exposure estimates may be biased high. Since BMI tissues samples were composites made from different taxa collected throughout a sampling reach, they reasonably characterize the average concentration of metals accumulated by BMIs. Since this BERA focused on CTE-based or average exposure risk characterization results, not having paired RME/CTE exposure/risk estimates is considered a relatively minor issue.

- All wildlife exposure modeling assumes that each EU reach was a wildlife receptor's entire home range and forage range (i.e., AUF = 1.0). This assumption is not unrealistic, given that most EU reaches were about 1 to 2 river miles in length and is within reasonable home

ranges for most of the studied receptors (EPA, 1993). Receptors may migrate from the BPMD to lower elevations during winter months. Wildlife receptors are likely only exposed when rivers and creeks are ice free. Given the short ice-free season, wildlife exposure may be overestimated. However, it is likely that the length of environmental exposures is longer than those used in toxicity tests used to generate TRVs which may reduce this uncertainty. It is also important to note that wildlife assessment endpoints are based on maintaining receptor populations. A population of a non-colonial receptors would likely encompass a larger geographical area than single individuals and potentially habitats within a single EU. If population home ranges are larger than the EU reaches evaluated herein, EU specific risks may not characterize actual risks to respective populations. Nevertheless, large home range population risks could be qualitatively assessed using multiple, geographically connected EUs. Secondly, any risks identified in a single EU could be detrimental to some extent to respective populations. In these cases, any population risks evaluated using a single EU would likely be biased low; especially when connected to less contaminated EUs.

- The exposure modeling includes sediment ingestion. The substrate composition of the Animas River at and below Silverton includes large fractions of gravel, pebble, and small cobble, instead of the fine sands and silts that were targeted during sampling and expected to be accidentally ingested by wildlife receptors during feeding. The actual incidental sediment ingestion may be substantially lower than assumed in the food chain models when site-specific conditions are considered. Given that most wildlife receptor risks estimates are based on fine fraction sediments, this uncertainty may be significant. Therefore, wildlife risks that are driven by sediment contamination may be biased high.

- The current exposure estimates assume that fish are present throughout the entire study area and are available to support piscivorous wildlife receptor populations evaluated in this BERA. This assumption is not supported by site-specific fish community survey data. Surveys show that fish do not occur in many EUs and would therefore not be available in the quantities needed to support viable wildlife receptor populations as assumed in the food chain models. As such, risks to piscivorous wildlife may be more hypothetical than real in EUs that lack fish prey. In these situations, piscivorous wildlife risks are biased high since they would not be exposed via dietary pathway.

- The effects assessment for the wildlife receptors use published no- and low-effect TRVs to measure COPEC toxicity. The assessment endpoints focus on preserving populations, whereas TRVs are derived from data on individuals or small groups of a test species. Extrapolating individual effects to higher levels of ecological organization is inherently uncertain, particularly because these extrapolations are applied across non-related species (e.g., chicken to belted kingfisher, or mouse to muskrat). The degree of uncertainty with this approach is unknown but may be large. Nevertheless, TRVs used herein are based on toxicity studies that reported adverse effects on reproduction and growth, which represent two endpoints that are expected to adversely affect wildlife populations over time.

- The wildlife TRVs are applied to all birds or mammals and are not specific to any particular species. This means that the same COPEC-specific TRVs are used for the American dipper, mallard, and belted kingfisher. It is unknown how much more, or less, sensitive these three receptors species might be when compared to the test species employed to generate the TRVs used in this BERA. Using "one-size-fits-all" TRVs creates uncertainty about the actual toxicity of a COPEC to the target wildlife receptor. However, the TRV-derivation process is conservative by design, such that it appears more likely that the wildlife risks are overestimated rather than underestimated. Since difference in wildlife species sensitivities is largely unknown, use of conservative "one-size-fits-all" TRVs is justified and likely protective of all relevant wildlife species in the study area. Potential biases associated with this assessment methodology likely result in identifying greater levels of risk for most, if not all, species that could be exposed to BPMD contamination sources.

- This BERA uses an avian low-effect TRV for lead that is substantially lower than what was proposed in the BERA work plan (EPA, 2016d); 3.26 mg of lead/kg BW/day verses 44.6 mg of lead/kg BW/day. The TRV used herein is from the same study used to derive the No Observable Adverse Effect Level (NOAEL)-based EcoSSL (EPA 2005c). These levels were obtained from Edens and Garlich (1983) who reported the lowest NOAEL with a bounded LOAEL for reproduction among five bird species and nine separate studies. This is the second to lowest NOAEL-LOAEL bounded dose rate observed among toxicity studies in the EcoSSL database that effected bird reproduction due to lead exposure and represents a highly conservative approach to assessing risks. The use of the lower TRV for lead is justified since the sensitivity of ecological important and endangered southwestern willow flycatcher is unknown and the conservative TRV is likely protective of any sensitive bird species. This low-effect TRV was also recommended for use by the EPA Region 8 USFWS liaison for this site.

- The risk analysis assumes that 100% of the COPECs concentration measured by the chemical analyses represents the bioavailable fraction accessible for uptake by the ecological receptors. Many physical, chemical, and site-specific factors affect metals bioavailability in mine waste contaminated exposure media, including soil particle size, sulfide content, pH, weathering history, and mineralogical composition among others (Schaider *et al.*, 2007). Bioavailability rates can also be species- and individual-specific. It is not possible to accurately predict what the actual bioavailability might be for the metals measured in BPMD exposure media without further testing. Given the relatively low-level wildlife risks presented herein, further testing is no warranted. If such information was available, site-specific bioavailability is excepted be less than the assumed 100%. Hence, the current assumption of 100% bioavailability is expected to overestimate risk to the four terrestrial receptor groups.

- This BERA assesses risks to the endangered southwestern willow flycatcher using a surrogate species, the American dipper. While both species have similar life-histories and use the same general habitats, there're differences between the two that may affect exposure/risk

outcomes (Sedgwick, 2000; Willson and Kingery, 2011). Southwestern willow flycatcher migrates to and from breeding habitat in the spring and the fall. They brood in tree nests near water. As their name implies, flycatchers glean flying insects on the wing or by hovering over riparian vegetation. American dipper are true aquatic birds that do not migrate far distances from summer breeding habitats. They also feed on flying insects, but also prey on aquatic insects by dipping and diving their head underwater. Dipper can also move small rocks and debris from the stream bottom to get food. Dipper build nests out of moss and woven vegetation under bridges or cliff bands near water. Given dipper's underwater feeding strategy, they might have greater exposures to contaminated sediments and floodplain soils than flycatchers. Dipper also have shorter migrations than flycatchers that are long-distance migrators who spend winters south in Mexico and Central America. Since dipper often migrate to lower elevations in the same watershed they may have protracted exposures to site contaminants. As such, dipper exposure to site contaminants would likely be greater than flycatcher. Therefore, dipper risks outcomes reported herein likely overestimate flycatcher risks. It should be noted that a level of conservatism is routinely built into risk assessments for T&E species. As such, the current overestimation of T&E species risks is justifiable.

SECTION 10 SUMMARY AND CONCLUSIONS

The BPMD is a large area with high elevation terrestrial and aquatic habitats that are potentially impacted by 100 years of boom or bust mining operations and associated waste management practices and naturally mineralized soils, sediment, and water. These sources have high potential to impact local aquatic communities when invertebrates, fish, and wildlife are exposed to metals contaminated sediments, water, and dietary items that came in contact or intermingled with mineralized material.

In April 2016, EPA placed 48 mining-related features located throughout the BPMD on the NPL, thereby turning the BPMD into a Superfund site. This designation started the RI/FS process that included drafting this Aquatic BERA. Information presented in this risk assessment is intended to provide an overview of risks over a large geographical area. This overview, in part, will guide future risk management decisions when selecting and implementing cleanup actions. This BERA focuses on assessing risks in aquatic habitats located in the Animas River watershed upgradient from Silverton, the entire Mineral Creek watershed, and in an approximate 20-mile lower Animas River reach just above and through the City of Durango. This risk assessment builds upon the Upper Animas BERA (EPA, 2019). The Upper Animas BERA focused on aquatic habitats located in the Animas River from Silverton down to Bakers Bridge (which is the approximate beginning of the Durango Reach), Cement Creek, and lower Mineral Creek. Together these two aquatic risk assessments provide continuous characterization of aquatic risks to mine-related contamination from the headwaters of the BPMD to about 50 river miles down the Animas River through the City of Durango.

The current Aquatic BERA assesses community-level risks for invertebrates and fish and species-specific risks for five representative model wildlife species. Risk characterization uses exposure data obtained from sediment, pore water, surface water, and BMI and fish tissue samples collected from BPMD and Durango Reach EUs from spring 2009 to fall 2017. Field collected sediments and surface waters were used in laboratory toxicity tests to further assess BMI and fish risks. Finally, field BMI and fish habitat assessments and community survey results identify limiting factors and measurable risks to aquatic communities. Measurement endpoint results associated with these data and surveys all generally agree with each other.

The remainder of this section summarizes risk characterization results for each of the Aquatic and Upper Animas BERA EUs. **Table 10.1** also provides a summary of results for each of the risk endpoints evaluated in this BERA and provides final risk characterization conclusions for each EU. Similar to the following summaries, **Table 10.1** summarizes Upper Animas BERA results for EUs not otherwise evaluated herein. As described in Section 6.9 Upper Animas BERA, summaries reflect actions taken herein to homogenize results between the two BERAs.

10.1 Mineral Creek watershed

- EU-01 Lower Mineral Creek
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to arsenic, iron, lead, manganese, and zinc in sediment.
    - Low-level risk to the BMI community from chronic exposure to aluminum and low pH in pore water; moderate-level risk to BMI community from chronic exposure to iron in pore water
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to M34 sediments (November 2012 test and October 2016 test).
    - Impaired BMI aquatic life use designation with low BMI density and diversity.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low risk to the aquatic community from chronic exposure to cadmium, iron, mercury, and zinc in surface water; moderate-level risk from chronic exposure to aluminum and low pH in surface water.
    - Significantly reduced survival in two of the three tests with juvenile rainbow trout exposed for 96 hours to M34 surface water.
    - Historically devoid of fish; however, the fall 2016 survey found rainbow and brook trout to be present at the time of the survey.
    - Habitat assessments indicated that this EU was not intermittent and was thermally suitable for cutthroat and brook trout.
  - ***Wildlife receptors***
    - Low-level risks from lead exposure to American dipper; low-level risk from selenium exposure to belted kingfisher, muskrat, and raccoon.

- EU-02 Lower Mineral Creek
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to arsenic, iron, lead, and zinc in sediment.
    - Low-level risk to the BMI community from chronic exposure to cadmium, copper, and zinc; high-level risk from chronic exposure to aluminum, iron, lead, and low pH in pore water.
    - Complete mortality in amphipods exposed for 10 days to M27 sediments.
    - Impaired BMI aquatic life use designation with very low BMI density and diversity.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to cadmium, copper, lead, and zinc in surface water; moderate-level risk from chronic exposure to iron and low pH in surface water; high-level risk from chronic exposure to aluminum in surface water.
    - Significant reduction in survival of juvenile rainbow trout exposed for 96 hours to M27 surface water.
    - Historically devoid of all trout species; not surveyed in fall 2016.

- Habitat assessments indicated that this EU was not intermittent and was thermally suitable for cutthroat and brook trout.

➢ ***Wildlife receptors***

- Low-level risks from lead exposure to American dipper and belted kingfisher.

- EU-03 Mineral Creek

➢ ***BMI community***

- Low-level risks to the BMI community from exposure to arsenic, cadmium, lead, manganese, and zinc in sediment.
- Low-level risk to the BMI community from chronic exposure to cadmium, zinc, and low pH in pore water; moderate-level risk from chronic exposure to aluminum and iron in pore water.
- Significant reduction in survival and biomass in amphipods exposed for 10 days to M14B sediments.
- Higher MMI score (gray zone), but still impaired BMI aquatic life use designation due to low diversity.

➢ ***Water-column invertebrates, fish, and amphibians***

- Low-level risk to the aquatic community from chronic exposure to cadmium, copper, iron, and zinc in surface water; moderate-level risk from chronic exposure to aluminum and lead in surface water.
- No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to M14B surface water.
- Historically devoid of fish; however, the fall 2016 survey found brook trout.
- Habitat assessments indicated that this EU was not intermittent.

➢ ***Wildlife receptors***

- Low-level risks from lead exposure to American dipper.

- EU-04 Upper Mineral Creek

➢ ***BMI community***

- Low-level risk to the BMI community from exposure to arsenic, cadmium, copper, and manganese in sediment; high-level risk from exposure to lead and zinc in sediment.
- Low-level risk to the BMI community from chronic exposure to cadmium, copper, and zinc in pore water.
- Significant reduction in survival and biomass in amphipods exposed for 10 days to M10A sediments.
- In attainment of aquatic life use designation.

➢ ***Water-column invertebrates, fish, and amphibians***

- Low-level risk to the aquatic community from chronic exposure to aluminum, cadmium, and copper in surface water; moderate-level risk from chronic exposure to zinc in surface water; high-level risk from chronic exposure to lead in surface water.
- No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to M10A surface water.

- Historically devoid of fish; not surveyed in fall 2016.
- Habitat assessments indicated that this EU was not intermittent and was thermally suitable for cutthroat and brook trout.

➢ ***Wildlife receptors***

- High-level risk from lead exposure and low-level risk from copper exposure to American dipper; moderate-level risk from lead exposure to belted kingfisher; low-level risk from lead exposure to mallard and muskrat.

- EU-05 South Fork of Mineral Creek

➢ ***BMI community***

- No actionable risks to the BMI community exposed to sediment.
- Low-level risk to the BMI community from chronic exposure to cadmium in pore water; moderate-level risk from chronic exposure to aluminum in pore water; high-level risk from chronic exposure to iron and low pH in pore water.
- Significant reduction in survival and growth in amphipods exposed for 10 days to M28 sediments.
- In attainment of aquatic life use designation.

➢ ***Water-column invertebrates, fish, and amphibians***

- Low-level risk to the aquatic community from chronic exposure to aluminum in surface water.
- No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to M28 surface water.
- Rainbow and brook trout observed in historic and fall 2016 surveys.
- Habitat assessments indicated that this EU was not intermittent but may not be thermally suitable for cutthroat trout.

➢ ***Wildlife receptors***

- Low-level risk from selenium exposure to belted kingfisher.

- EU-06 Middle Fork Mineral Creek

➢ ***BMI community***

- Low-level risk to the BMI community from exposure to iron in sediment.
- Low-level risk to the BMI community from chronic exposure to cadmium in pore water; moderate-level risk from chronic exposure to aluminum in pore water; high-level risks from chronic exposure to iron and low pH in pore water.
- Complete mortality in amphipods exposed for 10 days to M20 sediments.
- Impaired BMI aquatic life use designation with very low BMI density.

➢ ***Water-column invertebrates, fish, and amphibians***

- Low-level risk to the aquatic community from chronic exposure to cadmium in surface water; moderate-level risk from chronic exposure to aluminum in surface water; high-level risk from chronic exposure to iron and low pH in surface water.
- Significant reduction in survival of juvenile rainbow trout exposed for 96 hours to M20 surface water.
- Historically void of fish; not surveyed in fall 2016.

- Habitat assessments indicated that this EU was not intermittent but may not be thermally suitable for cutthroat trout.

➢ ***Wildlife receptors***

- No wildlife receptor risk because all the CTE low-effect HQs fell below 1.0.

- EU-R1 Bear Creek (lower Mineral Creek tributary)

➢ ***BMI community***

- Low-level risk to the BMI community from exposure to manganese in sediment.
- Low-level risk to the BMI community from chronic exposure to aluminum and low pH in pore water.
- Significant reduction in biomass, but not survival, in amphipods exposed for 10 days to M30 sediments.
- In attainment of aquatic life use designation with relatively high BMI density and diversity.

➢ ***Water-column invertebrates, fish, and amphibians***

- No actionable risk to the aquatic community from chronic exposure to surface water.
- No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to M30 surface water.
- No fish observed in historic fish or the fall 2016 surveys. The lack of fish was likely due to unsuitable instream habitat features such as steep gradients, lack of holding pools, physical isolation, and substrate transport during high flow events (ARSG, 2000; Horn, 1988).

➢ ***Wildlife receptors***

- No wildlife receptor risk because all the CTE low-effect HQs fell below 1.0

- EU-R2 Mill Creek (upper Mineral Creek tributary)

➢ ***BMI community***

- Low-level risk to the BMI community from exposure to lead and manganese in sediment.
- Low-level risk to the BMI community from chronic exposure to low pH in pore water.
- Significant reduction in survival and biomass in amphipods exposed for 10 days to M08 sediments.
- In attainment of aquatic life use designation with relatively high BMI density and diversity.

➢ ***Water-column invertebrates, fish, and amphibians***

- Low-level risk to the aquatic community from chronic exposure to aluminum, beryllium, and lead in surface water.
- No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to M08 surface water.
- No fish observed in historic surveys; brook trout observed during the fall 2016 survey.

- The fish survey reach was not intermittent and remained unfrozen during winter but was likely not thermally suitable for recruitment of cutthroat trout.

➢ ***Wildlife receptors***
- Low-level risk from lead exposure to American dipper

10.2 Cement Creek and the Animas River between Arrastra Creek and Bakers Bridge

- Cement Creek
  - ➢ ***BMI community***
    - Low-level risk to the BMI community from exposure to iron, lead, and manganese in sediment.
    - Significant reduction in survival (0%) and biomass in amphipods exposed for 10 days to CC48 sediments
    - Impaired BMI aquatic life use designation.
  - ➢ ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to lead, manganese, and beryllium; moderate risks from zinc, copper, and cadmium exposure; and high-level risks from low pH, aluminum. and iron in surface water.
    - Significant reduction in survival (0%) of juvenile rainbow trout exposed for 96 hours to CC48 surface water.
    - No fish observed in historic surveys.
  - ➢ ***Wildlife receptors***
    - Low-level risk from lead exposure to American dipper

- Animas River between Cement and Arrastra creeks
  - ➢ ***BMI community***
    - Low-level risk to the BMI community from exposure to copper, cadmium, and silver; moderate-levels risks from manganese and zinc; and high-level risks from lead in sediment.
    - Low-level risk to the BMI community from chronic exposure to lead and silver; moderate-level risk from manganese and copper; and high-level risks from cadmium and zinc in pore water.
    - Variable reduction in survival (56 to 78%) and significantly reduced biomass in amphipods exposed for 10 days to A68 and A60 sediments.
    - Impaired BMI aquatic life use designation.
  - ➢ ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to zinc, cadmium, manganese, and copper and moderate risks from aluminum exposure in surface water.
    - Variable reduction in survival (68 to 100%) of juvenile rainbow trout exposed for 96 hours to A68 and A60 surface waters.
    - Trout observed in historic surveys.
  - ➢ ***Wildlife receptors***
    - Low-level risk from copper and lead exposure to American dipper

- Low-level risk from lead exposure to kingfisher, muskrat, and raccoon

- Animas River between Mineral and Cement creeks (Silverton reach)
  - ***BMI community***
    - No sediment-based BMI community risk analyses for this EU
    - No BMI surveys for this EU
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to low pH, zinc, cadmium, manganese, and iron and high-level risks from aluminum exposure in surface water.
  - ***Wildlife receptors***
    - Wildlife risks not assessed for this EU reach

- Animas River just below Mineral Creek confluence
  - ***BMI community***
    - No sediment-based BMI community risk analyses for this EU
    - No BMI surveys for this EU
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to low pH, iron, cadmium, and zinc, and high-level risks from aluminum exposure in surface water.
  - ***Wildlife receptors***
    - Wildlife risks not assessed for this EU reach

- Animas River below Mineral Creek (upper Canyon reach)
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to lead, manganese, zinc, iron, and arsenic in sediment.
    - Low-level risk to the BMI community from chronic exposure to cadmium and silver and moderate-level risk from zinc in pore water.
    - Variable reduction in survival (36 to 70%) and significantly reduced biomass in amphipods exposed for 10 days to A72 sediments.
    - Impaired BMI aquatic life use designation.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to zinc, cadmium, copper, and manganese; moderate risks from low pH and iron; and high-level risks from aluminum exposure in surface water.
    - Significant reduction in survival (0 to 3%) of juvenile rainbow trout exposed for 96 hours to A72 surface waters.
    - Trout observed in only one historic survey conducted in 2005; fish absent during all other surveys conducted in 1992, 1998, and 2010.
  - ***Wildlife receptors***
    - Low-level risk from lead exposure to American dipper and kingfisher

- Animas River near Elk Creek confluence (middle Canyon reach)
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to lead, manganese, zinc, iron, and copper in sediment.
    - Low-level risk to the BMI community from chronic exposure to zinc, cadmium and beryllium and high-level risk from silver in pore water.
    - Variable reduction in survival (5 to 74%) and significantly reduced biomass in amphipods exposed for 10 days to A73 and A73B sediments.
    - Impaired BMI aquatic life use designation.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to cadmium and iron; moderate-level risks from zinc; and high-level risks from aluminum exposure in surface water.
    - No significant reduction in survival (98 to 100%) of juvenile rainbow trout exposed for 96 hours to A73 and A73B surface waters.
    - Trout observed in historic surveys.
  - ***Wildlife receptors***
    - Low-level risk from lead, copper, and selenium exposure to American dipper
    - Low-level risks from lead exposure to kingfisher

- Animas River near Cascade Creek confluence (lower Canyon reach)
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to zinc, manganese, lead, copper, cadmium, and iron in sediment.
    - Low-level risk to the BMI community from chronic exposure to silver, zinc, and cadmium in pore water.
    - Variable reduction in survival (49 to 76%) and significantly reduced biomass in amphipods exposed for 10 days to A75B and A75D sediments.
    - In attainment of aquatic life use designation.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to zinc, cadmium, and iron and high-level risks from aluminum exposure in surface water.
    - No significant reduction in survival (100%) of juvenile rainbow trout exposed for 96 hours to A75B surface waters.
    - Trout observed in historic surveys.
  - ***Wildlife receptors***
    - Low-level risk from copper and lead exposure to American dipper

- Animas River near Bakers Bridge
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to lead, cadmium, copper, and iron; moderate-level risk from manganese; and high-level risk from zinc in sediment.

- Low-level risk to the BMI community from chronic exposure to silver and manganese in pore water.
- Variable reduction in survival (76 to 86%) and significantly reduced biomass in amphipods exposed for 10 days to Bakers Bridge sediments.
- In attainment of aquatic life use designation.

➢ ***Water-column invertebrates, fish, and amphibians***

- Low-level risk to the aquatic community from chronic exposure to zinc, iron, and cadmium and moderate-level risks from aluminum exposure in surface water.
- No significant reduction in survival (100%) of juvenile rainbow trout exposed for 96 hours to Bakers Bridge surface water.
- Trout observed in historic surveys.

➢ ***Wildlife receptors***

- Low-level risk from lead exposure to American dipper

10.3 BPMD Animas River watershed

- <u>EU-07 Animas River from Arrastra to Cunningham Creek</u>

➢ ***BMI community***

- Low-level risk to the BMI community from exposure to cadmium, copper, and silver in sediment; moderate-level risks from exposure to manganese, lead, and zinc in sediment.
- Low-level risk to the BMI community from chronic exposure to aluminum, cadmium, copper, iron, lead, manganese, and zinc in pore water.
- Significant reduction in survival and biomass in amphipods exposed for 10 days to A55 sediments (November 2014 test) and A56 sediment (September 2014 and October 2016); no significant reduction in survival or biomass in amphipods exposed for 10 days to A56 sediment (October 2012 test).
- Higher MMI score (within the gray zone), but still impaired BMI aquatic life use designation due to low diversity.

➢ ***Water-column invertebrates, fish, and amphibians***

- Low-level risk to the aquatic community from chronic exposure to cadmium and zinc in surface water.
- No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A56 surface water in October 2012 and 2016.
- Rainbow and brook trout observed in historic fish surveys; not surveyed in fall 2016.
- Habitat assessments indicated that this EU was not intermittent.

➢ ***Wildlife receptors***

- High-level risk from lead exposure and low-level risk from copper exposure to American dipper; low-level risk from lead exposure to mallard, belted kingfisher, and muskrat.

- EU-08 Cunningham Creek
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to lead in sediment.
    - Low-level risk to the BMI community from chronic exposure to iron in pore water; moderate-level risk from chronic exposure to aluminum in pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to A48 sediments.
    - In attainment (not impaired) BMI aquatic life use designation.
  - ***Water-column invertebrates, fish, and amphibians***
    - No actionable risk to the aquatic community from chronic exposure to surface water.
    - No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A48 surface water.
    - Cutthroat, rainbow and brook trout observed in historic fish surveys; cutthroat and brook trout observed in the fall 2016 survey.
    - Habitat assessments indicated that this EU was not intermittent and was thermally suitable for brook and cutthroat trout; physical habitat potential was rated "Good".
  - ***Wildlife receptors***
    - Low-level risk from lead exposure to American dipper; low-level risk from lead and selenium exposure to belted kingfisher.

- EU-09 Animas River from Cunningham Creek to Minnie Gulch
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to cadmium, copper, and silver in sediment; moderate-level risk from exposure to manganese and zinc in sediment; high-level risk from exposure to lead in sediment.
    - Low-level risk to the BMI community from chronic exposure to aluminum, cadmium, iron, and zinc in pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to A45 sediments.
    - In attainment (not impaired) BMI aquatic life use designation.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to aluminum, cadmium, copper, and low pH in surface water; moderate-level risk from chronic exposure to zinc in surface water.
    - No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A45 surface water.
    - Rainbow and brook trout observed in historic fish surveys; brook trout observed in the fall 2016 survey.
    - Habitat assessments indicated that this EU was not intermittent and was thermally suitable for brook and cutthroat trout; physical habitat potential was rated "Good".
  - ***Wildlife receptors***
    - Low-level risk from copper exposure and moderate-level risk from lead exposure to American dipper; low-level risk from lead exposure to muskrat.

- EU-10 Animas River from Minnie Gulch to South Fork Animas River
  - ***BMI community***
    - Low-level risks to the BMI community from exposure to arsenic, cadmium, copper, and silver in sediment; moderate-level risk from exposure to zinc in sediment; high-level risks from exposure to lead and manganese in sediment.
    - Low-level risk to the BMI community from chronic exposure to cadmium, zinc, and low pH in pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to A40 sediments.
    - In attainment (not impaired) BMI aquatic life use designation.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to aluminum and copper in surface water; moderate-level risk from chronic exposure to cadmium and zinc in surface water.
    - No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A40 surface water.
    - No fish observed in historic fish.
    - Habitat assessments indicated that this EU was not intermittent.
  - ***Wildlife receptors***
    - Moderate-level risk from lead exposure and low-level risk from copper exposure to American dipper; moderate-level risk from lead exposure and low-level risk from selenium exposure to belted kingfisher; low-level risk from lead exposure to muskrat.

- EU-11 Upper South Fork Animas River
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to iron, lead, and manganese in sediment.
    - Low-level risk to the BMI community from chronic exposure to iron in pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to A36 sediments.
    - Impaired BMI aquatic life use designation.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to aluminum in surface water.
    - No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A36 surface water.
    - Not historically surveyed; no fish observed in the fall 2016 survey.
    - Habitat assessments indicated that this EU was not intermittent and was not thermally suitable for cutthroat trout.
  - ***Wildlife receptors***
    - Low-level risk from lead exposure to American dipper; low-level risk from selenium exposure to belted kingfisher.

- EU-12 Eureka Gulch
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to cadmium, copper, and lead in sediment; moderate-level risks from exposure to manganese and zinc in sediment.
    - Low-level risk to the BMI community from chronic exposure to zinc in pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to A37 sediments.
    - In attainment (not impaired) BMI aquatic life use designation.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to aluminum and copper in surface water; moderate risk from chronic exposure to cadmium in surface water; high-level risk from chronic exposure to zinc in surface water.
    - No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A37 surface water.
    - No fish observed in historic fish or the fall 2016 surveys.
    - Habitat assessments indicated that this EU was not intermittent and was thermally suitable for brook but not cutthroat trout; physical habitat potential was rated "Fair".
  - ***Wildlife receptors***
    - Low-level risk from lead and copper exposure to American dipper; low-level risk from lead and selenium exposure to belted kingfisher.

- EU-13 Lower South Fork Animas River
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to cadmium, copper, iron, manganese, and zinc in sediment; moderate-level risk from exposure to lead in sediment.
    - No actionable risk to the BMI community chronically exposed to pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to A34 sediments.
    - In attainment (not impaired) BMI aquatic life use designation.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to aluminum, cadmium, copper, and lead in surface water; moderate-level risk from chronic exposure to zinc in surface water.
    - No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A34 surface water.
    - No fish observed in historic fish or the fall 2016 surveys.
    - Habitat assessments indicated that this EU was not intermittent and was thermally suitable for brook but not cutthroat trout; physical habitat potential was rated "Poor".
  - ***Wildlife receptors***
    - Low-level risk from lead exposure to American dipper; low-level risk from lead and selenium exposure to belted kingfisher.

- EU-14 Animas River from South Fork Animas to West Fork Animas River
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to arsenic, cadmium, and copper in sediment; moderate-level risk from exposure to lead, manganese, and zinc in sediment.
    - Low-level risk to the BMI community from chronic exposure to beryllium, copper, iron, lead, and manganese; moderate-level risk from chronic exposure to low pH in pore water; high-level risk from chronic exposure to aluminum, cadmium, and zinc in pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to A33 sediments.
    - Impaired BMI aquatic life use designation.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to beryllium, copper, lead, and manganese in surface water; moderate-level risk from chronic exposure to aluminum in surface water; high-level risks from chronic exposure to cadmium, zinc, and low pH in surface water.
    - No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A33 surface water.
    - No fish observed in historic fish or the fall 2016 surveys.
    - Habitat assessments indicated that this EU was not intermittent and was thermally suitable for brook and cutthroat trout; physical habitat potential was rated "Good".
  - ***Wildlife receptors***
    - Moderate-level risk from lead exposure to American dipper; low-level risk from lead exposure to belted kingfisher and muskrat.

- EU-15 Lower West Fork Animas River
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to cadmium, copper, and zinc in sediment; moderate-level risk from exposure to manganese in sediment; high-level risk from exposure to lead in sediment.
    - Low-level risk to the BMI community from chronic exposure to beryllium and copper in pore water; moderate-level risk from chronic exposure to iron, lead, and low pH in pore water; high-level risk from chronic exposure to aluminum, cadmium, and zinc in pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to A10 sediments.
    - Impaired BMI aquatic life use designation and a very low density.
  - ***Aquatic invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to beryllium, copper, and lead in surface water; moderate-level risk from chronic exposure to manganese and low pH in surface water; high-level risks from chronic exposure to aluminum, cadmium, and zinc in surface water.

- Significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A10 surface water.
- No fish observed in historic fish or the fall 2016 surveys.
- Habitat assessments indicated that this EU was not intermittent and was thermally suitable for brook but not cutthroat trout; physical habitat potential was rated "Good".

➢ ***Wildlife receptors***

- High-level risk from lead exposure and low-level risk from copper exposure to American dipper; moderate-level risk from lead exposure to American kingfisher; low-level risk from lead exposure to muskrat and raccoon.

- <u>EU-16 Placer Gulch</u>

➢ ***BMI community***

- Low-level risk to the BMI community from exposure to arsenic and silver in sediment; moderate-level risk from exposure to cadmium and copper in sediment; high-level risk from exposure to lead, manganese, and zinc in sediment.
- Low-level risk to the BMI community from chronic exposure to aluminum, copper, lead, and low pH in pore water; moderate-level risk from chronic exposure to cadmium in pore water; high-level risk from chronic exposure to zinc in pore water.
- Significant reduction in survival and biomass in amphipods exposed for 10 days to A20 sediments.
- Impaired BMI aquatic life use designation and a very low density.

➢ ***Water-column invertebrates, fish, and amphibians***

- Low-level risk to the aquatic community from chronic exposure to manganese and low pH in surface water; moderate-level risk from chronic exposure to aluminum, copper, and lead in surface water; high-level risks from chronic exposure to cadmium and zinc in surface water.
- No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A20 surface water.
- No fish observed in historic fish or the fall 2016 surveys.
- Habitat assessments indicated that this EU was not intermittent and was thermally suitable for brook but not cutthroat trout; physical habitat potential was rated "Fair".

➢ ***Wildlife receptors***

- Low-level risk from copper exposure and high-level risk from lead exposure to American dipper; low-level risk from lead exposure to mallard; low-level risk from selenium exposure and high-level risk from lead exposure to belted kingfisher; low-level risk from copper exposure and moderate-level risk from lead exposure to muskrat; low-level risk from lead exposure to raccoon.

- <u>EU-17 Upper West Fork Animas River (California Gulch)</u>

➢ ***BMI community***

- Low-level risk to the BMI community from exposure to copper, lead, and zinc in sediment; moderate-level risk from exposure to manganese in sediment.

- Low-level risk to the BMI community from chronic exposure to beryllium, copper, and iron in pore water; high-level risk from chronic exposure to aluminum, cadmium, manganese, and zinc in pore water.
- Significant reduction in survival and biomass in amphipods exposed for 10 days to A15 sediments.
- Impaired BMI aquatic life use designation and a very low density.

➢ ***Water-column invertebrates, fish, and amphibians***

- Low-level risk to the aquatic community from chronic exposure to beryllium, copper, and lead in surface water; moderate-level risk from chronic exposure to low pH in surface water; high-level risk from chronic exposure to aluminum, cadmium, manganese, and zinc in surface water.
- Significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A15 surface water.
- Not historically surveyed; no fish observed in the fall 2016 survey.
- Habitat assessments indicated that this EU was not intermittent and was thermally suitable for brook but not cutthroat trout; physical habitat potential was rated "Fair".

➢ ***Wildlife receptors***

- Low-level risk from copper exposure and lead exposure to American dipper.

- <u>EU-18 North Fork Animas River from West Fork Animas River to Burrows Gulch</u>

➢ ***BMI community***

- Low-level risk to the BMI community from exposure to arsenic, cadmium, lead, manganese, and zinc in sediment.
- Low-level risk to the BMI community from chronic exposure to copper, iron, and lead in pore water; moderate-level risk from chronic exposure to low pH in pore water; high-level risk from chronic exposure to aluminum, cadmium, and zinc in pore water.
- Significant reduction in survival and biomass in amphipods exposed for 10 days to A08 sediments.
- Impaired BMI aquatic life use designation and a very low density.

➢ ***Water-column invertebrates, fish, and amphibians***

- Low-level risk to the aquatic community from chronic exposure to beryllium, copper, and manganese in surface water; moderate-level risk from chronic exposure to lead and low pH in surface water; high-level risks from chronic exposure to aluminum, cadmium, and zinc in surface water.
- Significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A08 surface water.
- No fish observed in historic fish or the fall 2016 surveys.
- Habitat assessments indicated that this EU was thermally suitable for brook trout; physical habitat potential was rated "Fair".

➢ ***Wildlife receptors***

- Low-level risk from lead and copper exposure to American dipper; low-level risk from lead exposure to belted kingfisher.

- EU-19 Burrows Gulch
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to arsenic, cadmium, copper, lead, and zinc in sediment; high-level risk from exposure to manganese in sediment.
    - Low-level risk to the BMI community from chronic exposure to beryllium, iron, lead, and manganese in pore water; moderate-level risk from chronic exposure to copper and low pH in pore water; high-level risk from exposure to aluminum, cadmium, and zinc in pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to A07 sediments.
    - Impaired BMI aquatic life use designation.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to beryllium and manganese in surface water; moderate-level risk from chronic exposure to low pH in surface water; high-level risks from chronic exposure to aluminum, cadmium, copper, lead, and zinc in surface water.
    - Significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A07 surface water.
    - No fish observed in historic fish or the fall 2016 surveys.
    - Habitat assessments indicated that this EU was not intermittent and was thermally suitable for brook but not cutthroat trout; physical habitat potential was rated "Poor".
  - ***Wildlife receptors***
    - Low-level risk from lead exposure to American dipper and belted kingfisher.

- EU-R3 Maggie Gulch (Animas River, EU-09 tributary)
  - ***BMI community***
    - Low-level risk to the BMI community exposed to manganese in sediment.
    - No actionable risk to the BMI community chronically exposed to pore water.
    - Significant reduction in biomass, but not survival, in amphipods exposed for 10 days to A43 sediments.
    - In attainment of aquatic life use designation with relatively high BMI density and diversity.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to aluminum in surface water.
    - No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A43 surface water.
    - Brook and cutthroat trout observed during historic and the fall 2016 fish surveys.
    - The Fish survey reach was thermally suitable for both brook and cutthroat trout and the instream habitat was rated "good".
  - ***Wildlife receptors***
    - No wildlife receptor risk because all the CTE low-effect HQs fell below 1.0

- U-R4 Picayne Gulch (Animas River, EU-14 tributary)
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to arsenic, cadmium, lead, manganese, and zinc in sediment.
    - No actionable risks to the BMI community chronically exposed to pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to A26 sediments.
    - In attainment of aquatic life use designation with relatively high BMI density and diversity.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to aluminum in surface water.
    - No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A43 surface water.
    - No fish observed in historic surveys; not surveyed in fall 2016.
    - No instream habitat assessments or thermal suitability data were collected for this EU.
  - ***Wildlife receptors***
    - No wildlife receptor risk because all the CTE low-effect HQs fell below 1.0.

- EU-R5 North Fork Animas River (reach above EU-18)
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to arsenic and manganese in sediment.
    - Low-level risk to the BMI community from chronic exposure to cadmium, iron, and low pH in pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to A05 sediments.
    - In attainment of aquatic life use designation with relatively high BMI density and diversity.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to beryllium and lead in surface water; moderate-level risks from chronic exposure to aluminum and zinc in surface water, and high-level risks from chronic exposure to cadmium in surface water.
    - No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to A05 surface water.
    - Stocked rainbow trout observed during historic fish surveys; brook trout observed during fall 2016 fish survey.
    - The fish survey reach is thermally suitable for brook trout but not cutthroat trout; the instream habitat was rated “fair”.
  - ***Wildlife receptors***
    - Low-level risk from lead exposure to American dipper.

10.4 Durango Reach EUs

- EU-DR01 Upper Reach
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to lead, manganese, and zinc in sediment.
    - Low-level risk to the BMI community from chronic exposure to manganese in pore water.
    - Significant reduction in survival (James Ranch) and biomass (James Ranch and 32nd bridge [September 2014] in amphipods exposed for 10 days to EU-DR01sediment samples. No significant changes in survival or biomass was observed in amphipods exposed for 10 days to the sediment sample collected from 32nd Bridge [September 2017].
    - BMI survey MMI scores reported by MSI (2016; 2017a) were generally lower than the CDPHE (2010) attainment threshold MMI score of 50. James Ranch fall 2015 and 2016 MMI scores were above the attainment threshold.
  - ***Water-column invertebrates, fish, and amphibians***
    - Low-level risk to the aquatic community from chronic exposure to iron and mercury in surface water; high-level risks from chronic exposure to aluminum in surface water.
    - No acute toxicity tests conducted with EU-DR01 surface waters.
    - Rainbow, brown, and brook trout and sensitive native species observed in historic fish surveys; not surveyed in 2016.
  - ***Wildlife receptors***
    - Low-level risk from lead and selenium exposure to American dipper; low-level risk from selenium exposure to belted kingfisher.

- EU-DR02 Lower Reach
  - ***BMI community***
    - Low-level risk to the BMI community from exposure to lead, manganese, and zinc in sediment.
    - Low-level risk to the BMI community from chronic exposure to manganese in pore water.
    - Significant reduction in survival (Purple Cliffs [September 2014]) and biomass (Lightner Creek [September 2014] and Purple Cliffs [September 2014]) in amphipods exposed for 10 days to EU-DR02 sediment samples. No significant changes in survival or biomass was observed in amphipods exposed for 10 days to the sediment samples collected from Rotary Park, Lightner Creek [September 2017] and Purple Cliffs [September 2017].
    - BMI survey MMI scores reported by MSI (2016; 2017a) were generally lower than the CDPHE (2010) attainment threshold MMI score of 50. Purple Cliffs fall 2015 MMI score was above the attainment threshold.

- ***Water-column invertebrates, fish, and amphibians***
  - Low-level risk to the aquatic community from chronic exposure to mercury in surface water; moderate-level risk from chronic exposure to aluminum and iron in surface water.
  - No acute toxicity tests conducted with EU-DR02 surface waters.
  - Rainbow and brown brook trout observed in historic fish surveys; not surveyed in 2016.
- ***Wildlife receptors***
  - Low-level risk from lead exposure to American dipper.

- EU-R6 Hermosa Creek (Durango Reach tributary)
  - ***BMI community***
    - No actionable risk to the BMI community exposed to sediment.
    - No actionable risk to the BMI community chronically exposed to pore water.
    - Significant reduction in survival and biomass in amphipods exposed for 10 days to sediments collected from HC01 in October 2016. Significant reduction in biomass, but not survival, in amphipods exposed for 10 days to sediments collected from HC02 in September 2017.
    - In attainment of aquatic life use designation with relatively high BMI density and diversity.
  - ***Water-column invertebrates, fish, and amphibians***
    - No actionable risk to the aquatic community from chronic exposure to surface water.
    - No significant reduction in survival of juvenile rainbow trout exposed for 96 hours to HC01 surface water.
    - Cutthroat trout observed in historic fish surveys; not surveyed in fall 2016.
    - No instream habitat assessments or thermal suitability data collected for this EU.
  - ***Wildlife receptors***
    - Low-level risk from zinc exposure to belted kingfisher

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Figures

Figure ES-1
Bonita Peak Mining District
Exposure Units and Reference Areas

Sample Location

- EU-01 (Mineral Creek)
- EU-02 (Mineral Creek)
- EU-03 (Mineral Creek)
- EU-04 (Mineral Creek)
- EU-05 (South Fork of Mineral Creek)
- EU-06 (Middle Fork of Mineral Creek)
- EU-07 (Animas River)
- EU-08 (Cunnigham Creek)
- EU-09 (Animas River)
- EU-10 (Animas River)
- EU-11 (Upper South Fork of Animas River)
- EU-12 (Eureka Gulch)
- EU-13 (South Fork of Animas River)
- EU-14 (Animas River)
- EU-15 (West Fork of Animas River)
- EU-16 (Placer Gulch)
- EU-17 (Upper West Fork of Animas River)
- EU-18 (North Fork of Animas River)
- EU-19 (Burrows Creek)
- Reference Areas
- Previously Studied
- Counties

Map Date: February 15, 2019

Data Sources:
Rivers and Streams: CDOW (2004)
Sample Locations: U.S. EPA (2018)
Exposure Units and Reference Areas: U.S. EPA (2019)
Counties: U.S. Census Bureau (2014)
Basemap: ESRI World Top Web Service (2019)

Map Projection: UTM Zone 13 N, WGS84, Meters

0 1 2 Miles

Area of Interest

Figure ES-2
Bonita Peak Mining District
Durango Reach Exposure Units and Reference Area

HC01
HC02
James Ranch
Oxbow Park
32nd St Bridge
Rotary Park
Lightner Creek
Purple Cliffs
Hermosa Creek
EU-DR01
EU-DR02
Animas River
Durango
Buck (hollow) Cr
Buck (hollow) Cr North
Tripp Gulch
Elkhorn Canyon
Coon Creek
Coon Creek South Fk
Youngs Canyon
Stevens Creek
Shearer Creek West Fk
Shearer Creek
Red Creek
Red Creek First Fk
Freed Canyon
Kroeger Canyon
Haflin Canyon
Woodard Canyon
MISSIONARY RIDGE
Mud Spring Creek
Spring Creek
Florida River #1b
Florida River #1a
Long Hollow (lower)
Dry Creek
Lone Pine Gulch
Brice Draw
Wilson Gulch
R E A Canyon
Big Canyon
Horse Gulch
Falls Creek
Smith Creek
Castle Creek
Junction Cr #2
Junction Cr
Rock Spring Draw
Quinn Creek
Ernest Canyon
First Trail Canyon
Sliderock Canyon
Chicago Gulch
Walls Gulch
Elk Creek
Lightner Creek #2
Deep Creek
Sawmill Canyon
Lightner Creek Dry Fk
Lightner Creek #1
Dry Gulch
Coal Gulch
Cherry Gulch
Sheep Springs Gulch
Wildcat Canyon
Basin Creek
Animas City Mountain
Barnroof Point
Perins Peak
Twin Buttes
Cape Horn
Rands Point
Sliderock Mountain
Red Hill
Bald Knob
Falls Creek Main
Dalton Ranch Golf Club
Hillcrest Golf Club
Baldy Mountain
Animas River
San Juan River
Florida River
Junction Creek
Junction Creek Rd
Spring Creek
Florida Rd
Main Ave
CR 203
Missionary Ridge Rd
Red Rim
Mira Sol Dr
Rincon Ridge Rd
Jenkins Ranch Rd
Lake Durango Dr
Oak Dr
Ridge Rd
Spring Rd
Colonial Dr
Coal Gulch Mine Rd
Designation Ranch Rd
Nusbaum Rd
Zuzkey Meadow Dr
Elk Meadow Dr
Long Hollow
E Pioneer Dr
Dumas Dr
Dumas Rd
Baldy Mtn
Soltas Rd
Hwy 160
Hwy 550
9588 ft
9858 ft
9413 ft
8020 ft
7296 ft

Sample Location

EU-DR01 (Animas River)

EU-DR02 (Animas River)

Reference Area

Streams

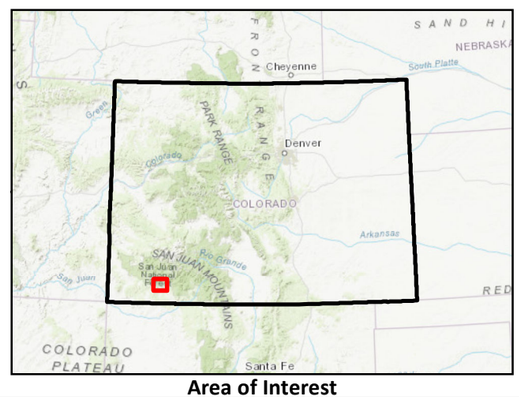
Map Date: February 15, 2019

Data Sources:
Rivers and Streams: CDOW (2004)
Sample Locations: U.S. EPA (2018)
Exposure Units and Reference Areas: U.S. EPA (2019)
*Basemap:*ESRI World Topo Web Service (2019)

Map Projection: UTM Zone 13 N, WGS84, Meters

N
W E
S

0 1 2 Miles



Area of Interest

Figure 1-1
Bonita Peak Mining District
National Priorities List Sites

Dewitt Mine
Ben Butler Mine
Boston Mine
Red Cloud Mine
London Mine
Vermillion Mine
Columbus Mine
Sunbank Group Mine
Frisco/Bagley Tunnel
Joe and Johns Mine
Mountain Queen Mine
Grand Mogul Mine
Sunnyside Mine Pool Study Area
Lark Mine
Longfellow Mine
Mogul Mine
Sunnyside Mine
American Tunnel
Silver Wing Mine
Junction Mine
Clipper Mine
Tom Moore Mine
Koehler Tunnel
Ben Franklin Mine
Gold King Mine
Terry Tunnel
Silver Ledge Mine
Henrietta Mine
Senator Mine
Red and Bonita Mine
Prospect Gulch Study Area
Mammoth Tunnel
Natalie/Occidental Mine
Wynona Mine
Forest Queen Mine
Anglo Saxon Mine
Kittimack Tailings
Brooklyn Mine
Yukon Tunnel (Gold Hub)
Mayflower Mill Repository #1
Howardsville Colo Goldfields Tailings
Paradise Mine
Mayflower Mill Repository #2
Little Nation Mine
Mayflower Mill Repository #4
Aspen Mine
Amy Tunnel
Pride of the West Mine
Bandora Mine
Mayflower Mill Repository #3

Mine Sites
Animas River
Cement Creek
Cunningham Creek
Mineral Creek

Map Date: February 15, 2019

Data Sources:
Rivers and Streams: CDOW (2004)
*Mines:*USGS (2000)
*Basemap:*ESRI Wrold Topo Web service (2019)

Map Projection: UTM Zone 13 N, WGS84, Meters

0 1 2 Miles

Area of Interest

Figure 1-2
Bonita Peak Mining District
Overview Map of the Study Area and Associated Waterways

Upper Animas River

Cement Creek

Mineral Creek

California Gulch

North Fork Animas River

North Fork Cement Creek

Mid Fork Cement Creek

Animas River South Fork

Cement Creek

South Fork Cement Creek

Animas River

Mid Fork Mineral Creek

Mineral Creek

South Mineral Creek

Arrastra Creek

Cunningham Creek

Animas River

Silverton

Minor Streams

Major Streams

Assessment Area

Upper Animas River

Cement Creek

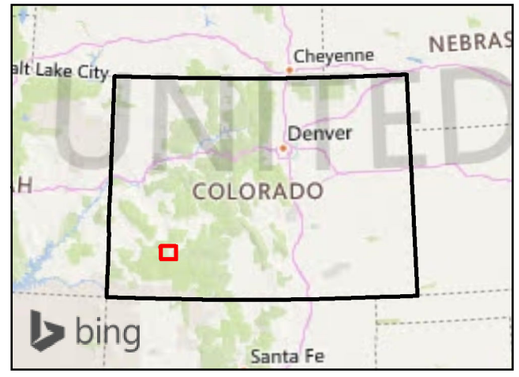
Mineral Creek

Map Date: February 1, 2018

Data Sources:
Streams: CDOW (2004)
Assessment Areas & Sub Watershed: USDA (2013)
Imagery: USDA NAIP (2017)

Map Projection: UTM Zone 13 N, WGS84, Meters

0 1 2 Miles



Area of Interest

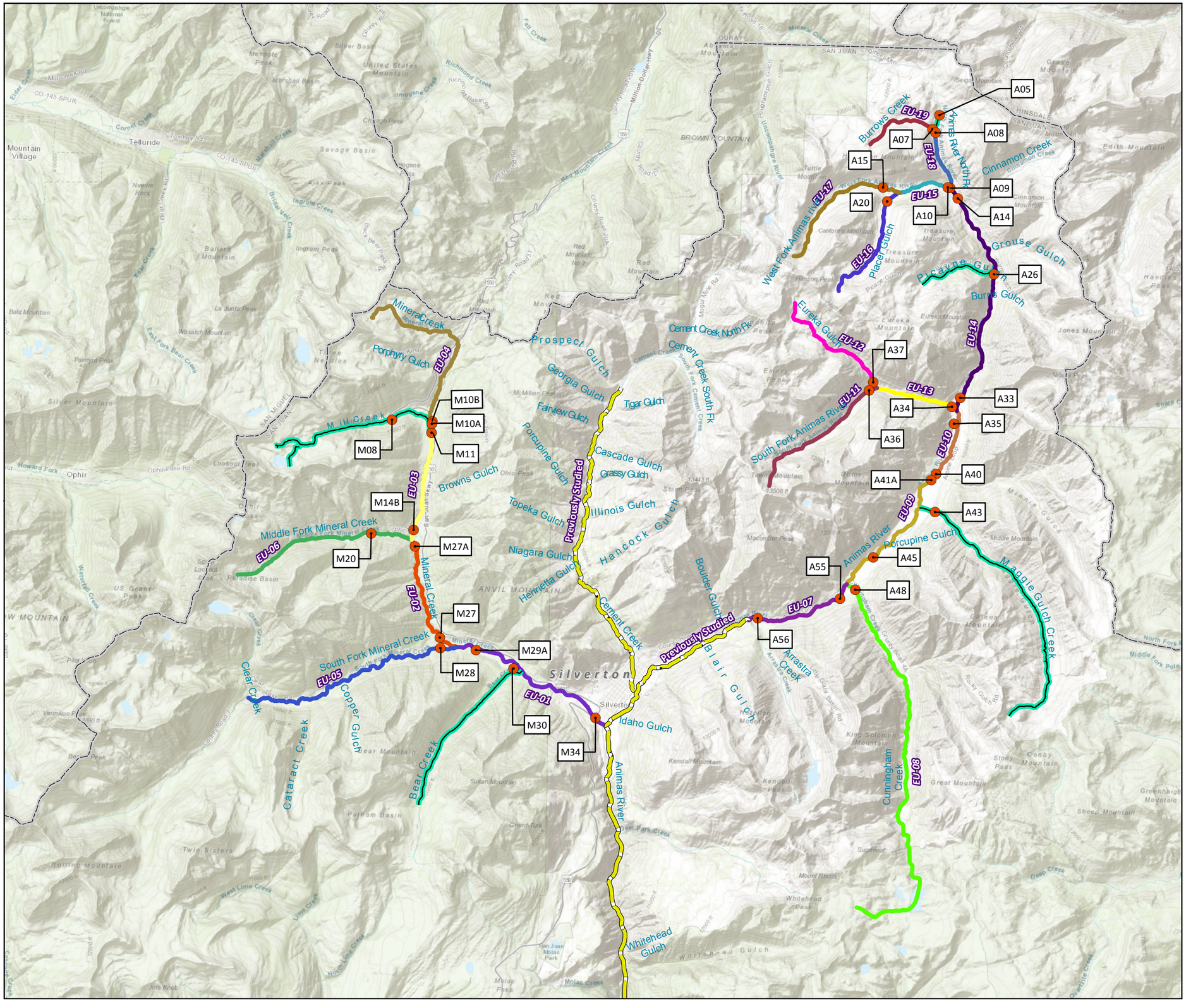


Figure 1-3
Bonita Peak Mining District
Exposure Units and Reference Areas

- Sample Location
- EU-01 (Mineral Creek)
- EU-02 (Mineral Creek)
- EU-03 (Mineral Creek)
- EU-04 (Mineral Creek)
- EU-05 (South Fork of Mineral Creek)
- EU-06 (Middle Fork of Mineral Creek)
- EU-07 (Animas River)
- EU-08 (Cunnigham Creek)
- EU-09 (Animas River)
- EU-10 (Animas River)
- EU-11 (Upper South Fork of Animas River)
- EU-12 (Eureka Gulch)
- EU-13 (South Fork of Animas River)
- EU-14 (Animas River)
- EU-15 (West Fork of Animas River)
- EU-16 (Placer Gulch)
- EU-17 (Upper West Fork of Animas River)
- EU-18 (North Fork of Animas River)
- EU-19 (Burrows Creek)
- Reference Areas
- Previously Studied
- Counties

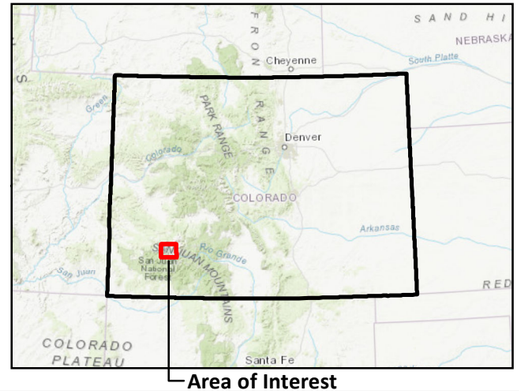
Map Date: February 15, 2019

Data Sources:
Rivers and Streams: CDOW (2004)
Sample Locations: U.S. EPA (2018)
Exposure Units and Reference Areas: U.S. EPA (2019)
Counties: U.S. Census Bureau (2014)
Basemap: ESRI World Top Web Service (2019)

Map Projection: UTM Zone 13 N, WGS84, Meters

N
W E
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0 1 2 Miles



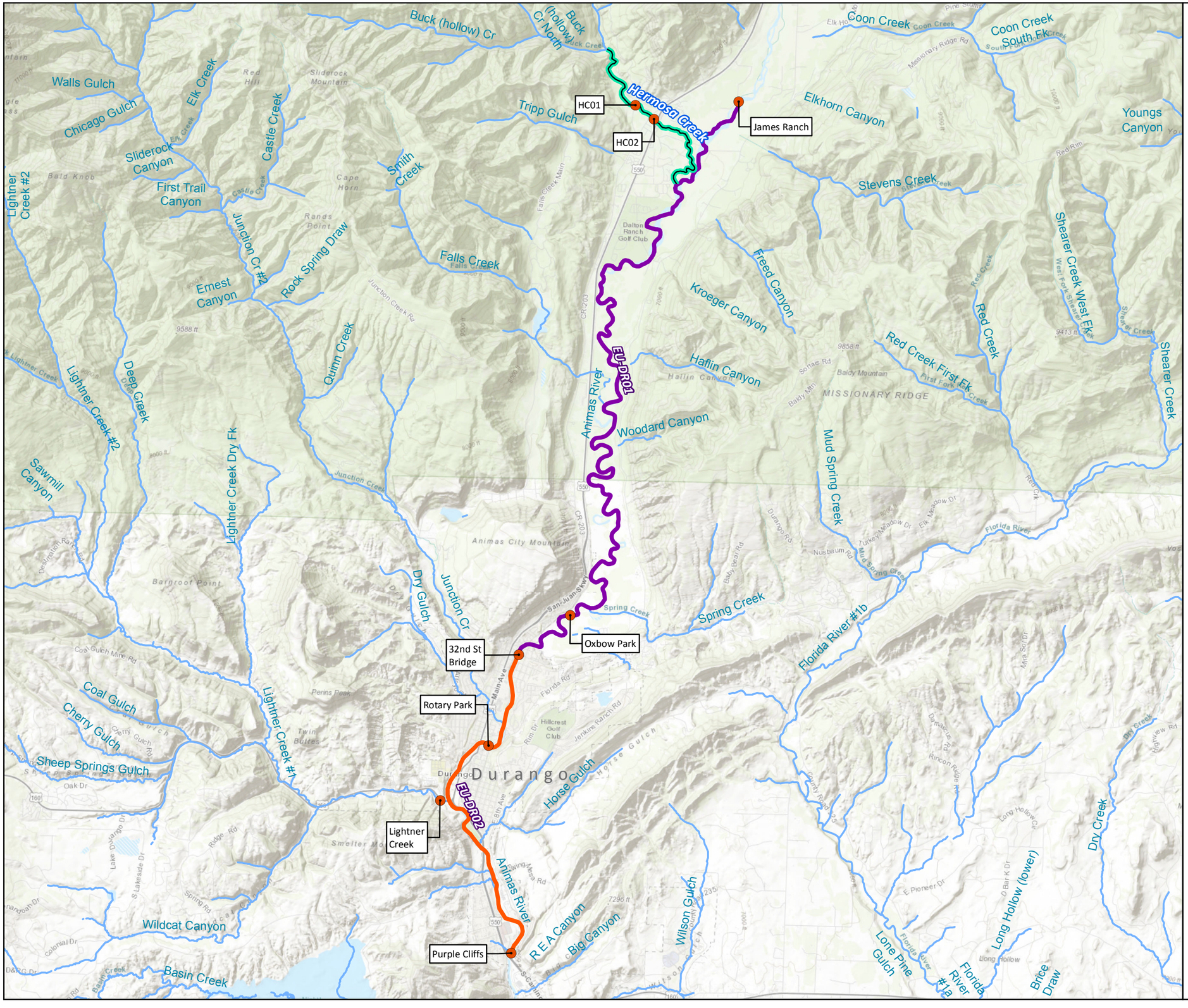


Figure 1-4
Bonita Peak Mining District
Durango Reach Exposure Units and Reference Area

- Sample Locations
- EU-DR01 (Animas River)
- EU-DR02 (Animas River)
- Reference Area
- Streams

Map Date: February 15, 2019

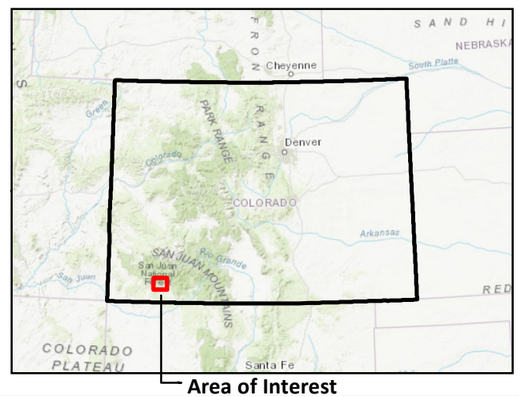
Data Sources:
Rivers and Streams: CDOW (2004)
Sample Locations: U.S. EPA (2018)
Exposure Units and Reference Areas: U.S. EPA (2019)
*Basemap:*ESRI World Topo Web Service (2019)

Map Projection: UTM Zone 13 N, WGS84, Meters

TechLaw

N W E S

0 1 2 Miles



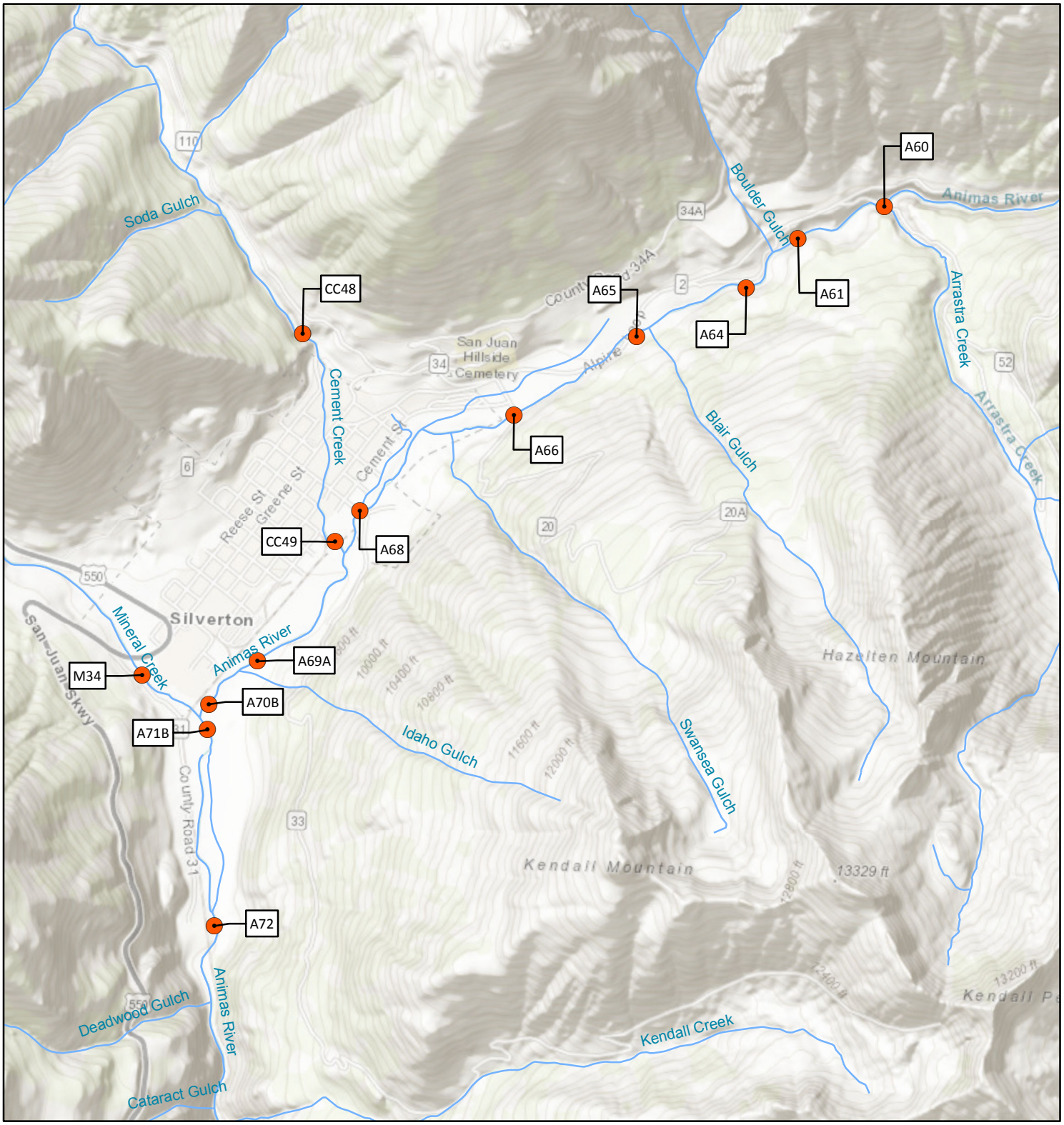


Figure 3-1
Sampling Locations on the Animas River Upstream and Across from Silverton, CO

Sample Locations

Rivers and Streams

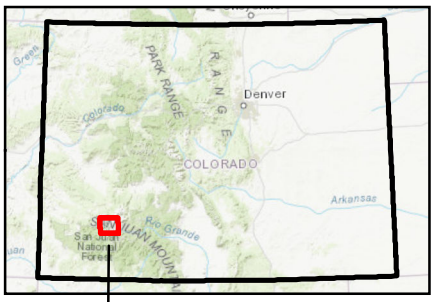
0 2,000 Feet

N

Date: February 15, 2019.

Data Sources:
Sample Locations - U.S. EPA Region 8 (2018);
Streams - CDOW (2004);
Basemap - ESRI World Topo Web Service (2019).

Map Projection: UTM, Meters, 13 North, WGS84.



Area iof Interest

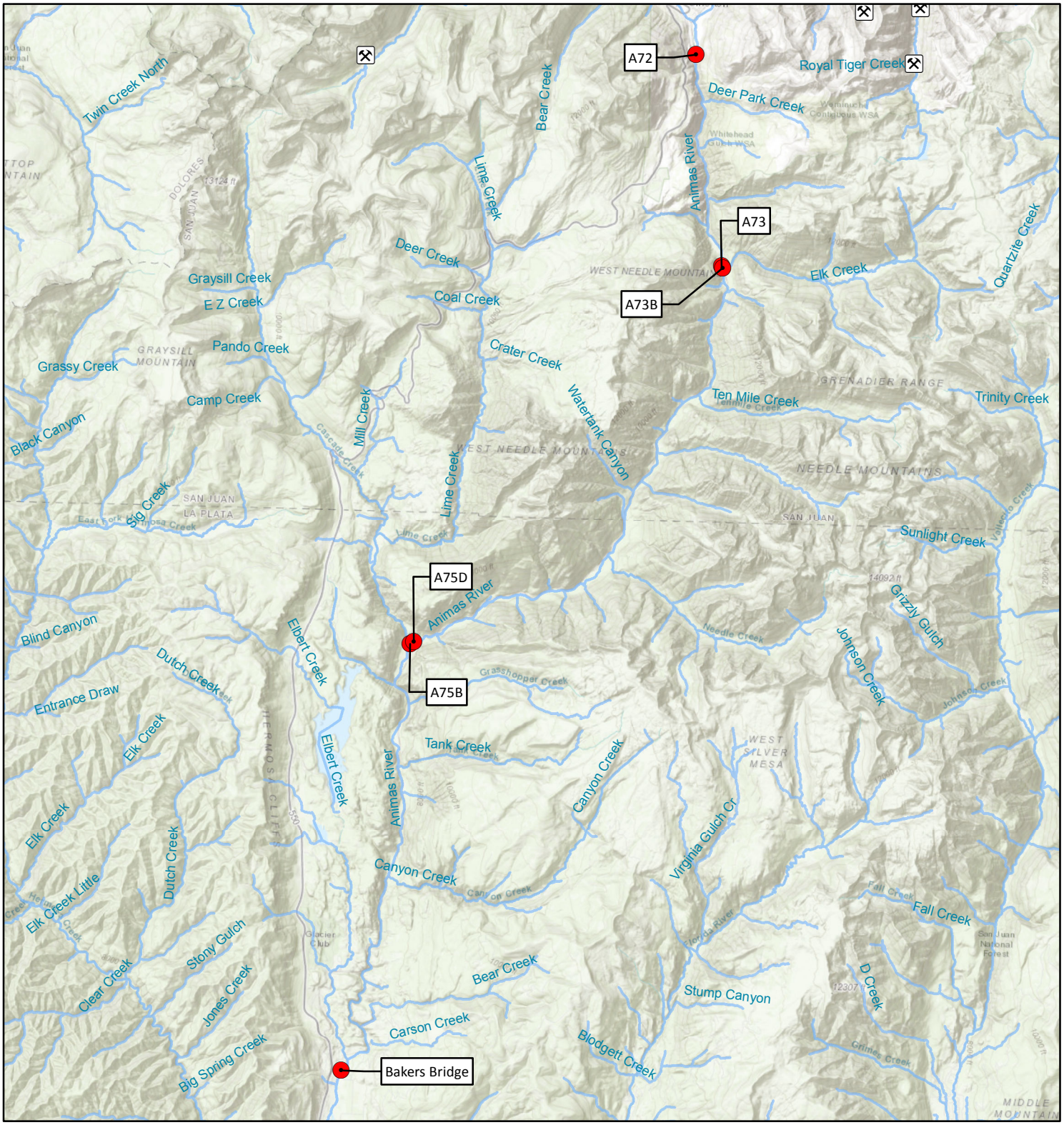


Figure 3-2
Sampling Locations on the Animas River Downstream from Silverton, CO

Date: February 15, 2019.

Data Sources:
Sample Locations - U.S. EPA Region 8 (2018);
Streams - CDOW (2004);
Basemap - ESRI World Topo Web Service (2019).

Map Projection: UTM, Meters, 13 North, WGS84.

FIGURE 4-1

Conceptual Site Model for Aquatic Habitats and Receptors Evaluated in the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

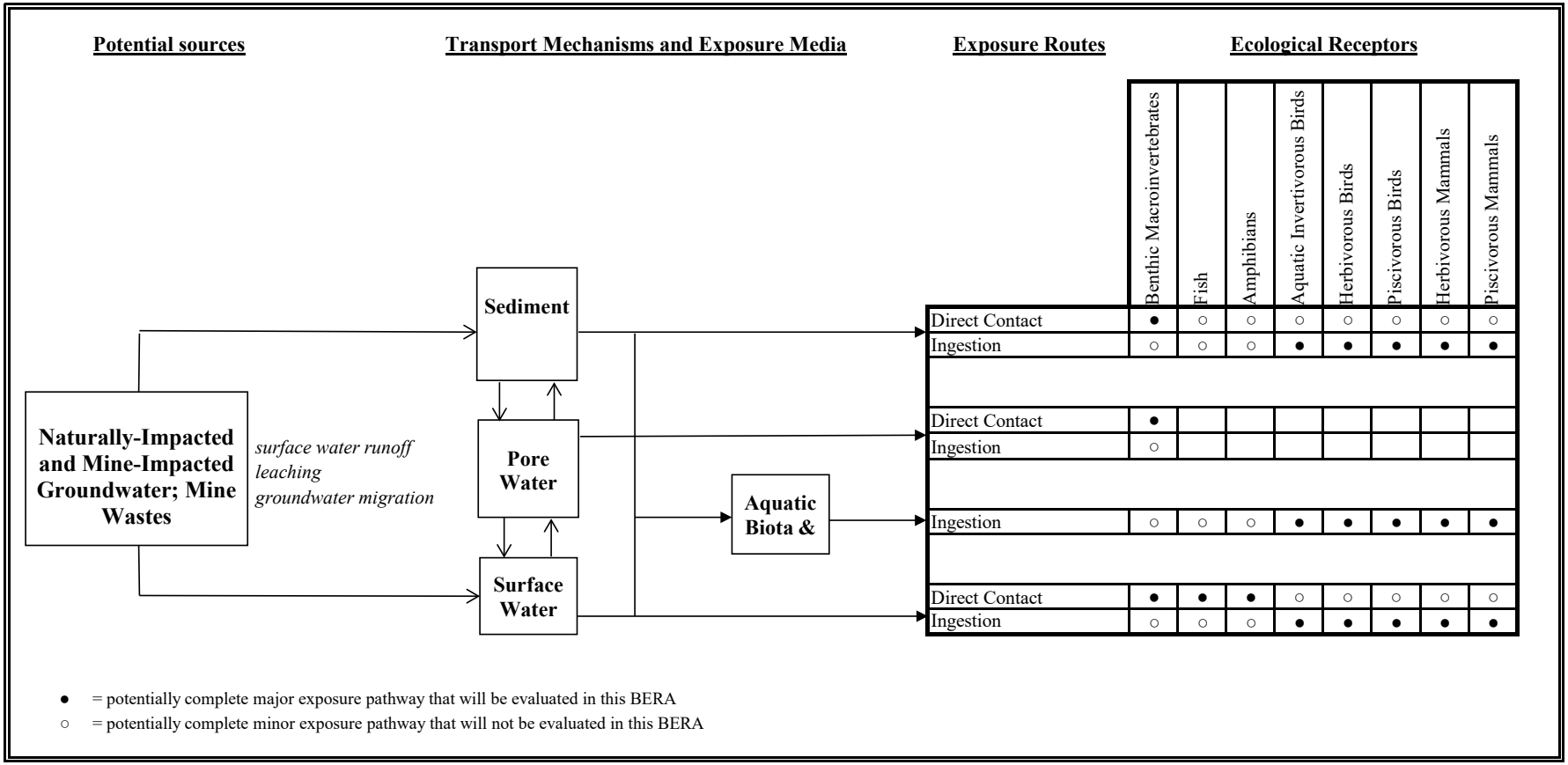
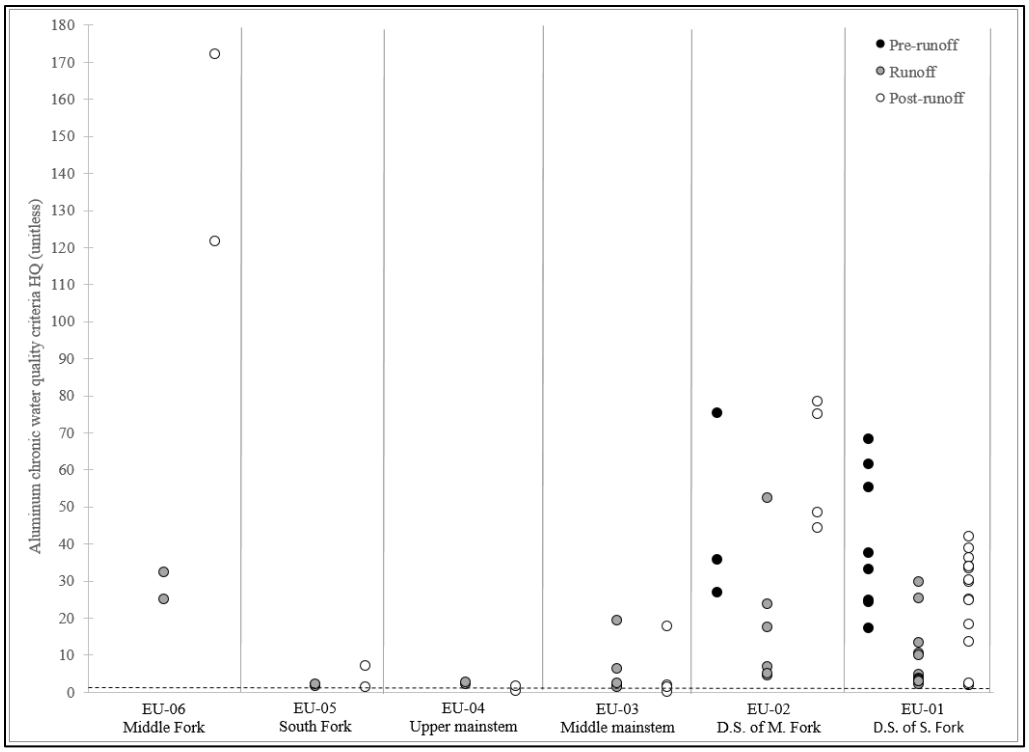


Figure 8-1 Chronic Aluminum (Al) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). Hardness-dependent HQs were derived for each surface water sample collected among the three hydroperiods using CDPHE (2017c) chronic water quality criteria. Sampling points that are above the dashed line indicate that Al concentrations were greater than respective chronic criteria; sampling point beneath the dashed line indicate that Al concentrations were less than respective thresholds.

a)



b)

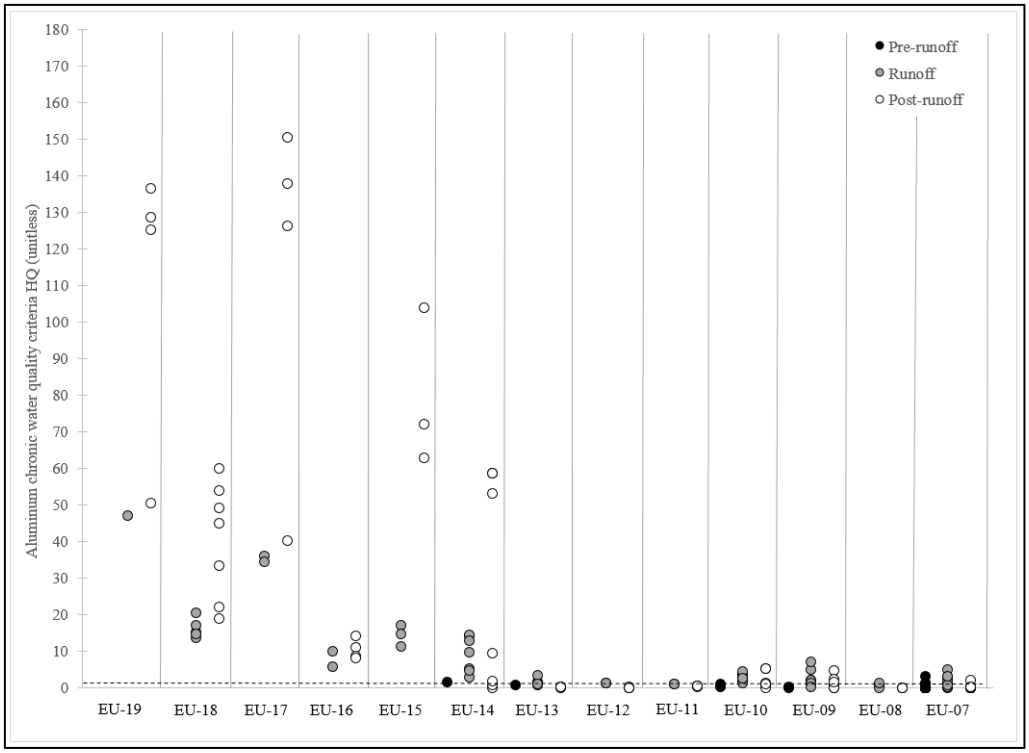
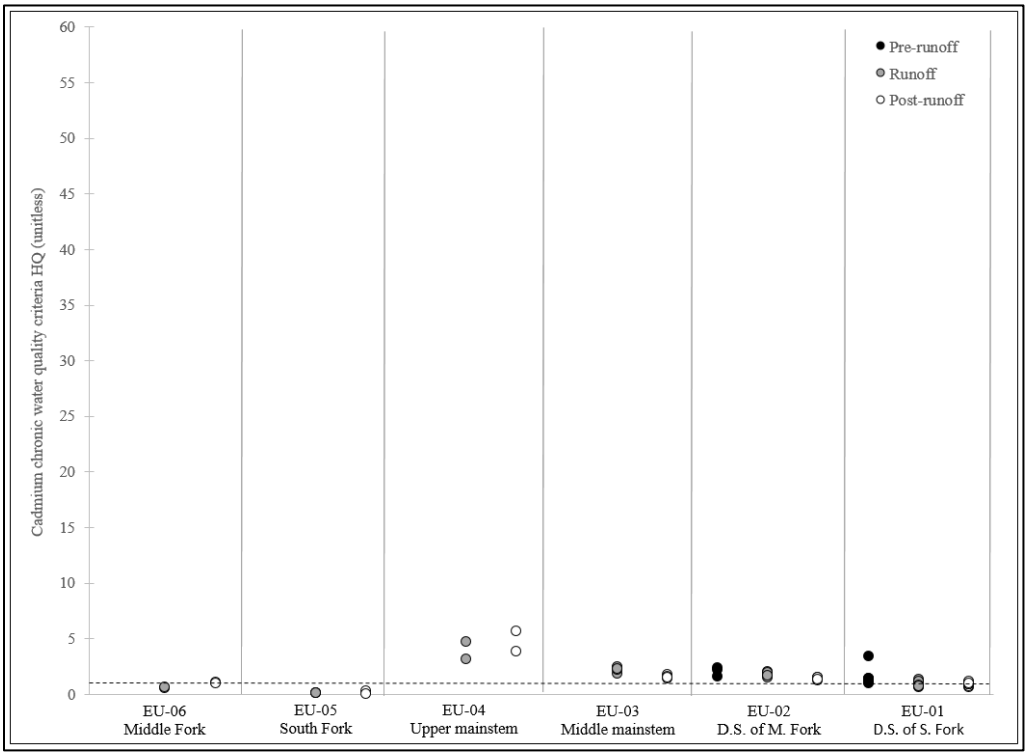


Figure 8-2 Chronic Cadmium (Cd) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). Hardness-dependent HQs were derived for each surface water sample collected among the three hydroperiods using CDPHE (2017c) chronic water quality criteria. Sampling points that are above the dashed line indicate that Cd concentrations were greater than respective chronic criteria; sampling point beneath the dashed line indicate that Cd concentrations were less than respective thresholds.

a)



b)

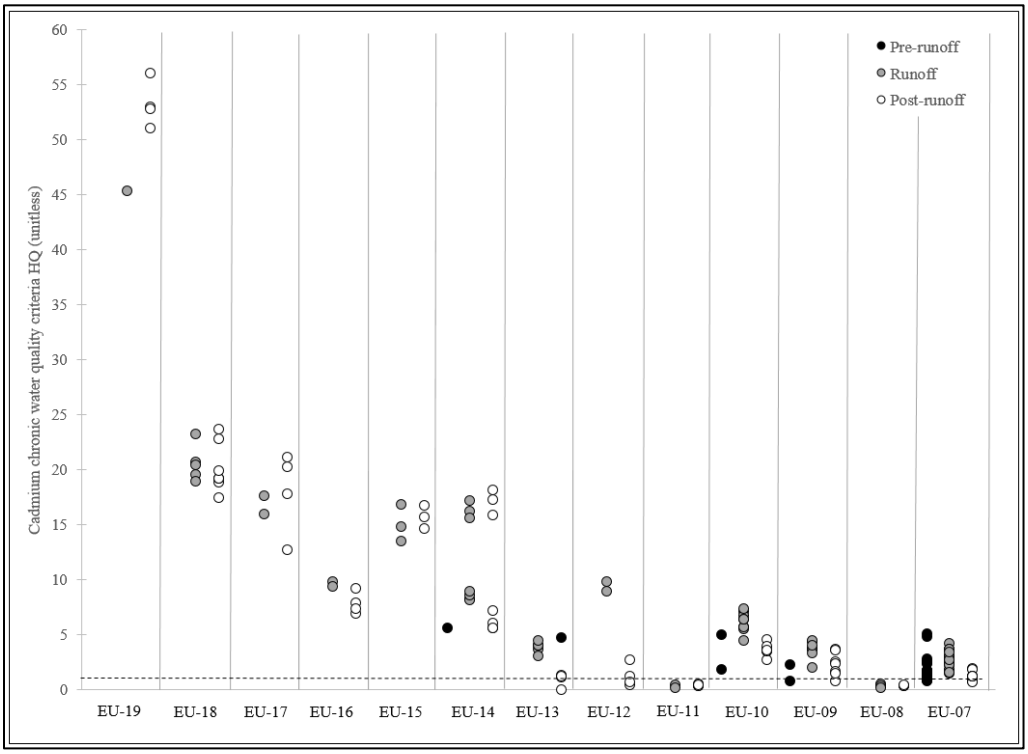
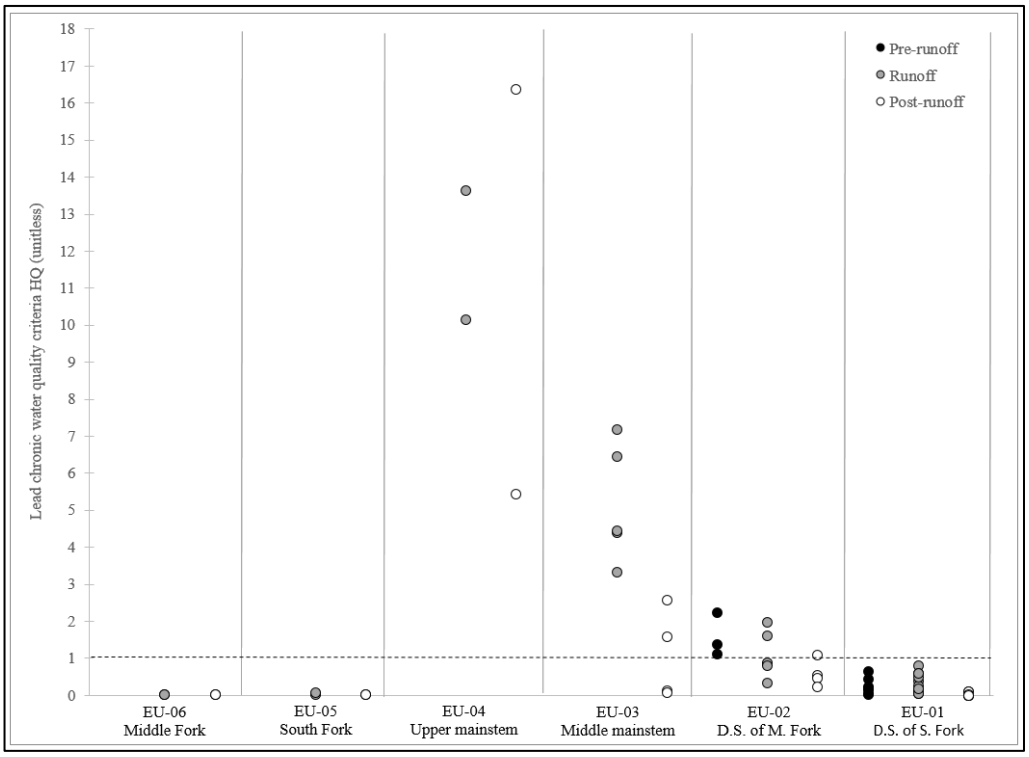


Figure 8-3 Chronic Lead (Pb) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). Hardness-dependent HQs were derived for each surface water sample collected among the three hydroperiods using CDPHE (2017c) chronic water quality criteria. Sampling points that are above the dashed line indicate that Pb concentrations were greater than respective chronic criteria; sampling point beneath the dashed line indicate that Pb concentrations were less than respective thresholds.

a)



b)

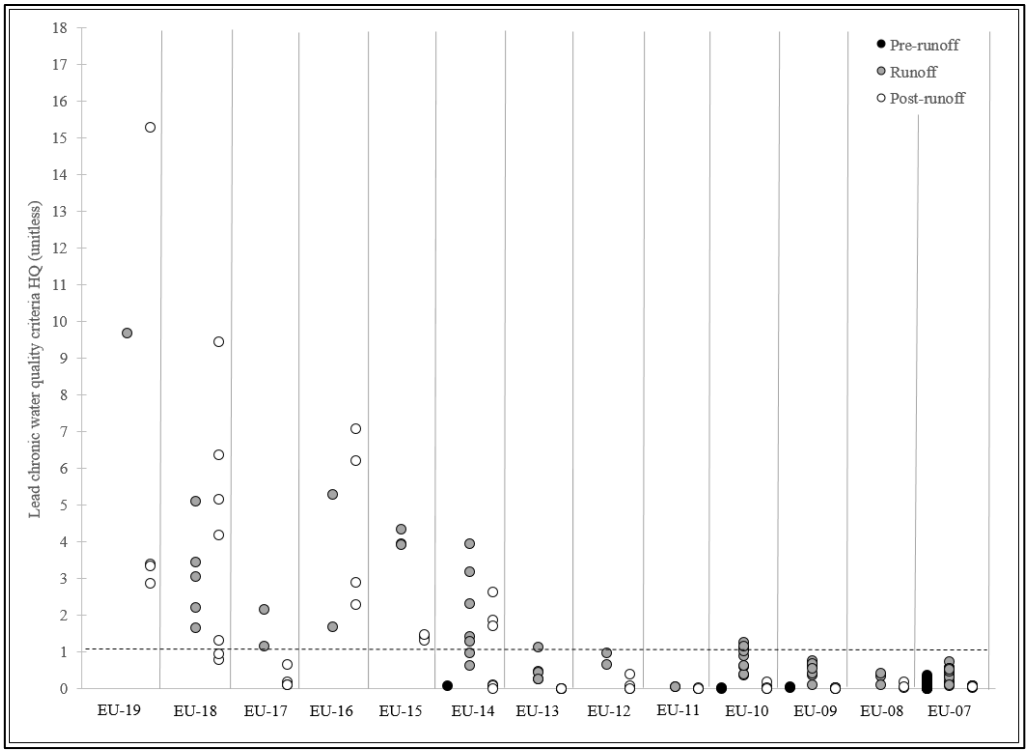
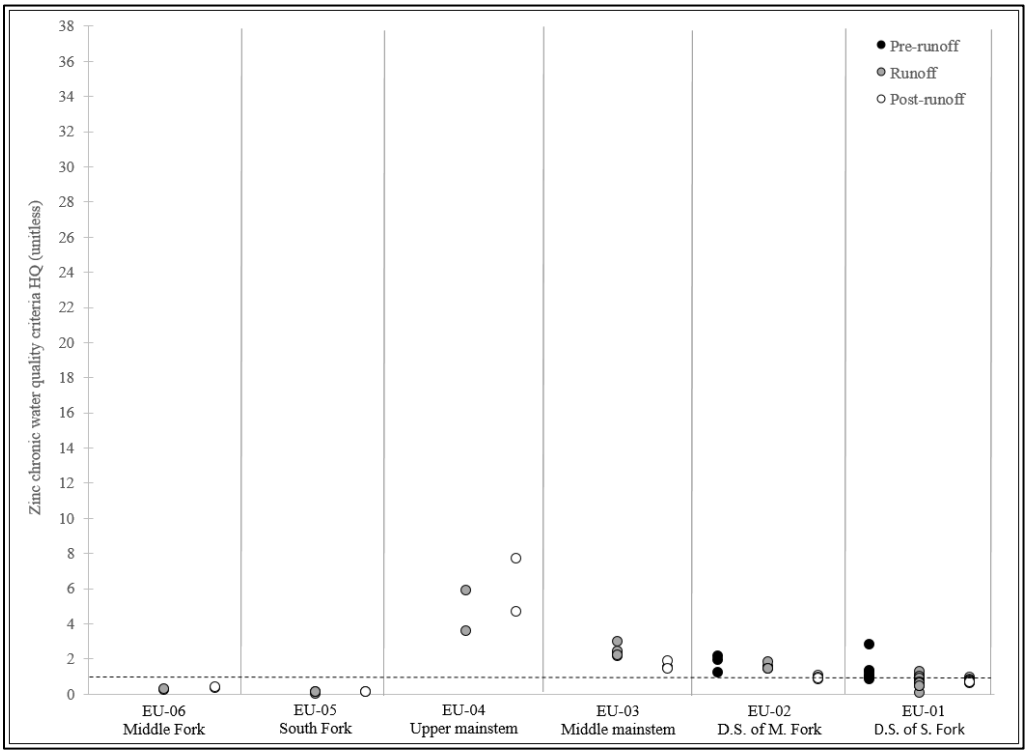


Figure 8-4 Chronic Zinc (Zn) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). Hardness-dependent HQs were derived for each surface water sample collected among the three hydroperiods using CDPHE (2017c) chronic water quality criteria. Sampling points that are above the dashed line indicate that Zn concentrations were greater than respective chronic criteria; sampling point beneath the dashed line indicate that Zn concentrations were less than respective thresholds.

a)



b)

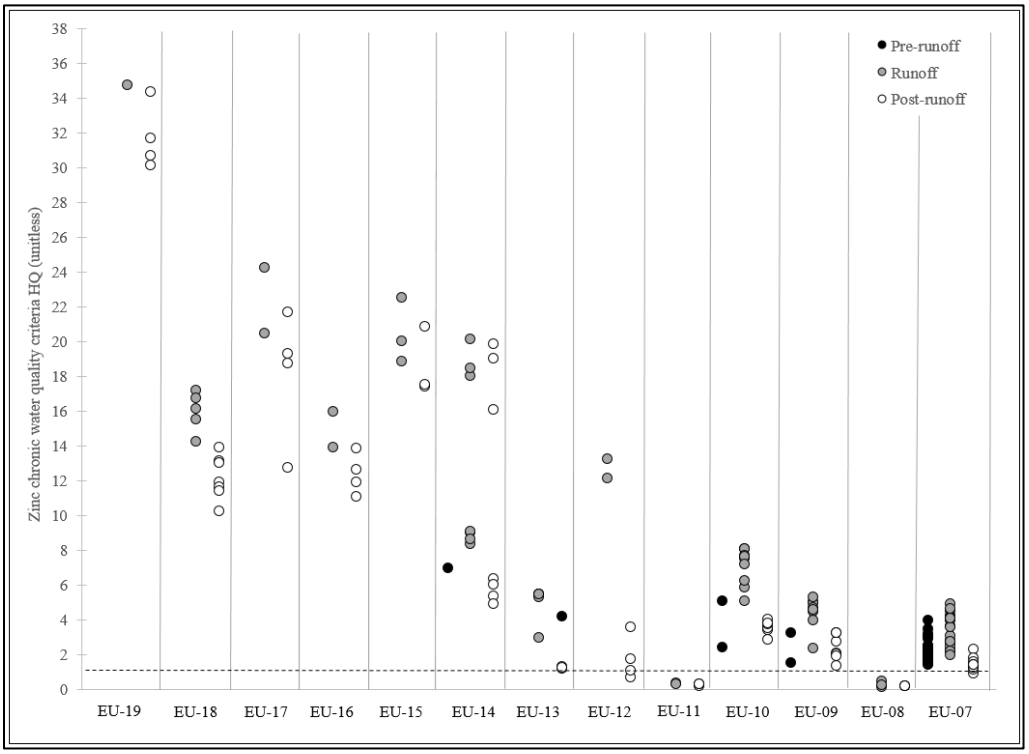
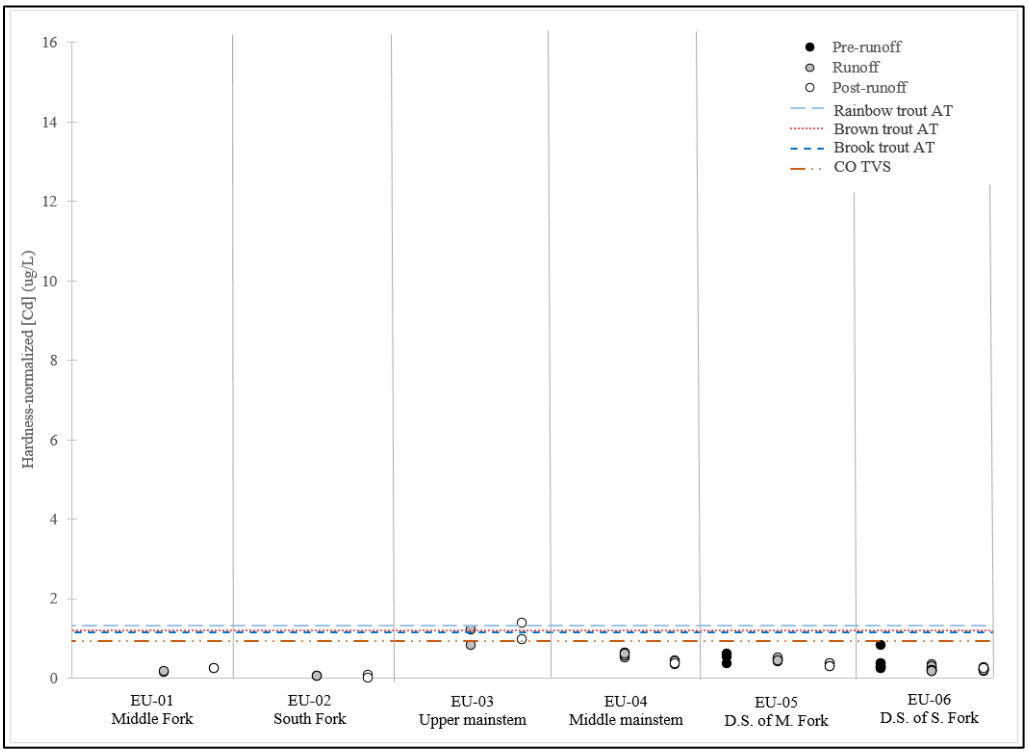


Figure 9-1 Hardness-Normalized Cadmium (Cd) Concentrations, Trout Species-Specific Acute Thresholds (ATs), and Colorado Chronic Table Value Standard (CO TVS) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). Cd concentrations in each surface water sample, ATs, and CO TVS were normalized to a common, 50 mg/kg hardness using trout AT threshold equation parameters developed for the Upper Animas River Baseline Ecological Risk Assessment (Attachment 1). The chronic Co TVS was obtained from (CDPHE, 2017c). Note that cutthroat trout Cd AT equation was not available.

a)



b)

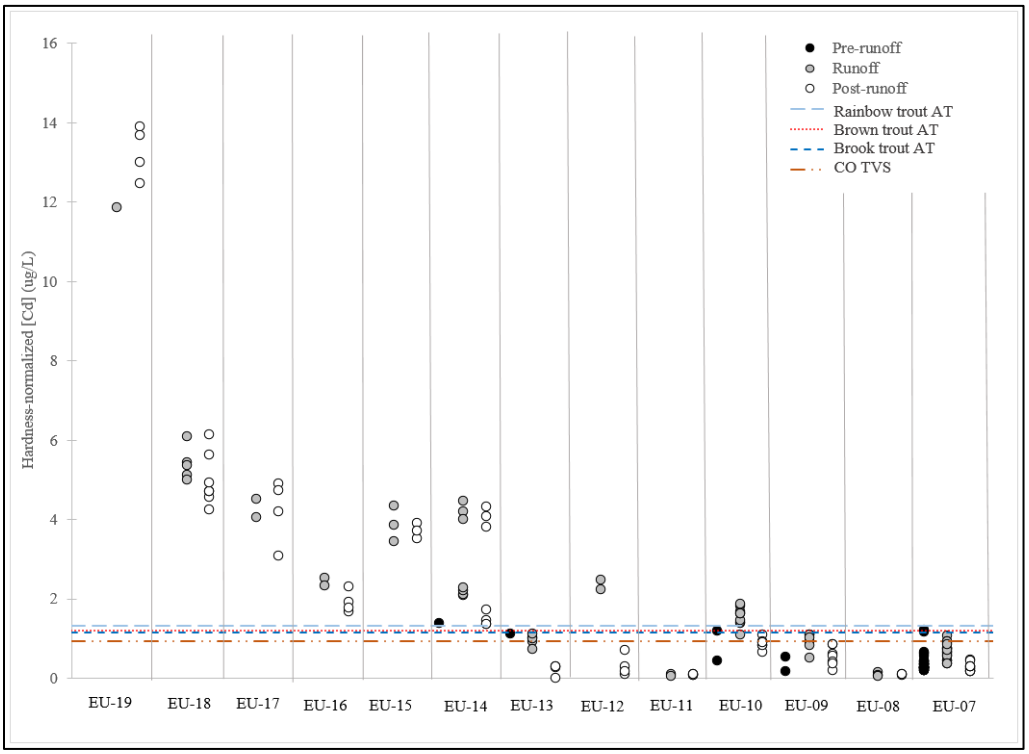
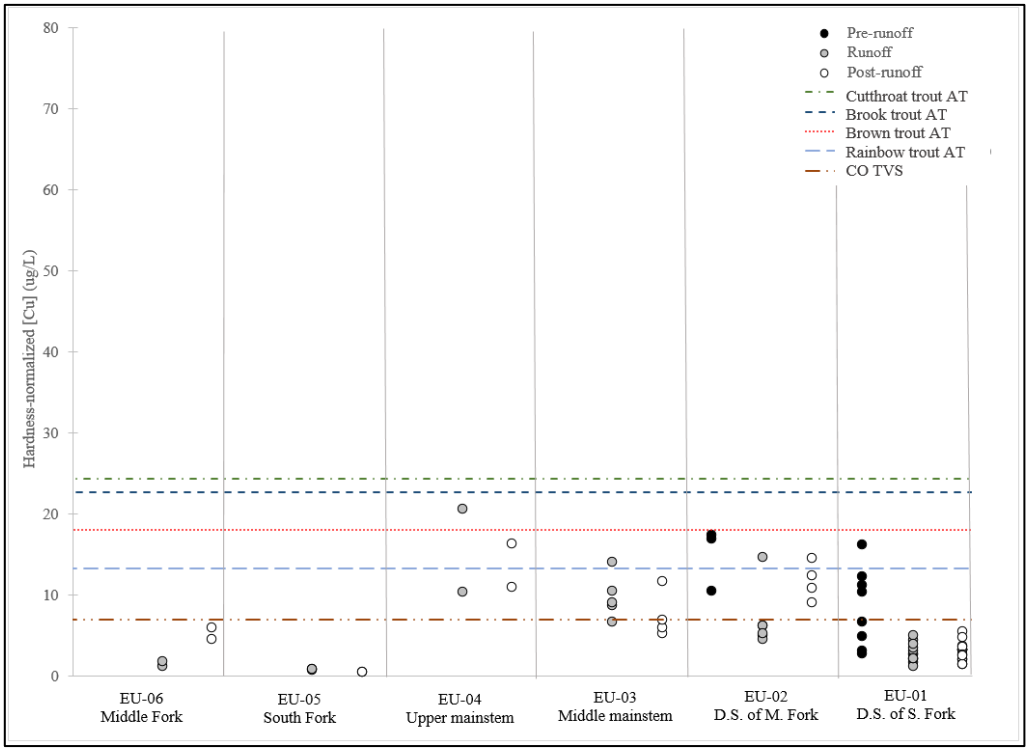


Figure 9-2 Hardness-Normalized Copper (Cu) Concentrations, Trout Species-Specific Acute Thresholds (ATs), and Colorado Chronic Table Value Standard (CO TVS) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). Cu concentrations in each surface water sample, ATs, and CO TVS were normalized to a common, 50 mg/kg hardness using trout AT threshold equation parameters developed for the Upper Animas River Baseline Ecological Risk Assessment (Attachment 1). The chronic Cu TVS was obtained from (CDPHE, 2017c).

a)



b)

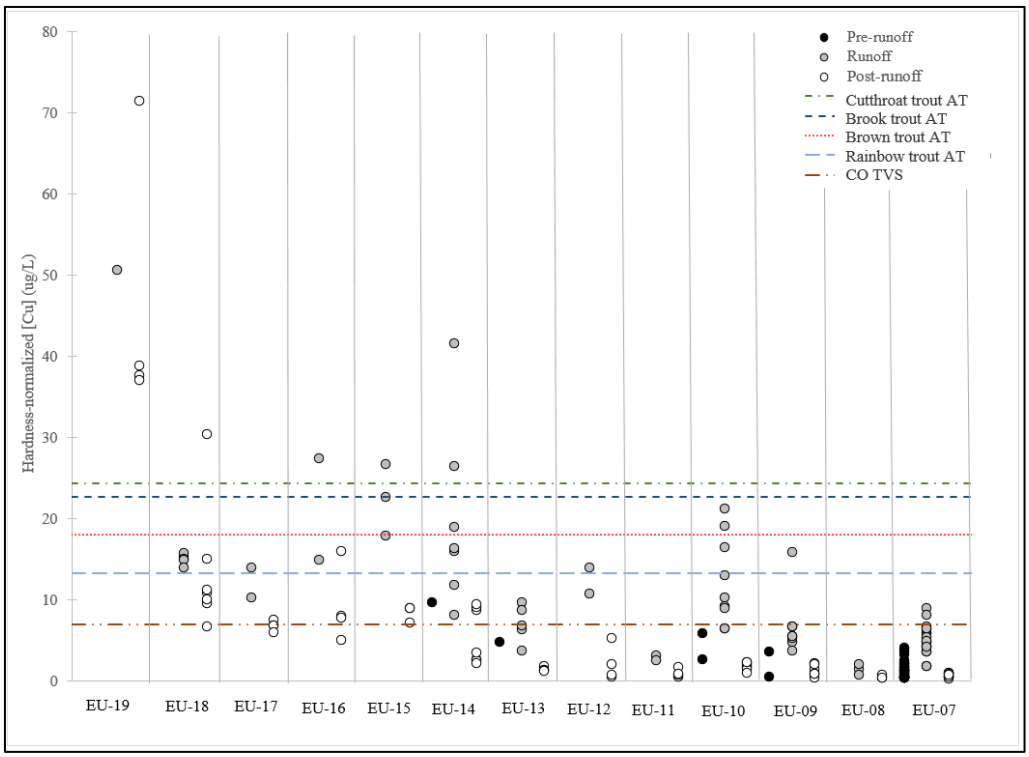
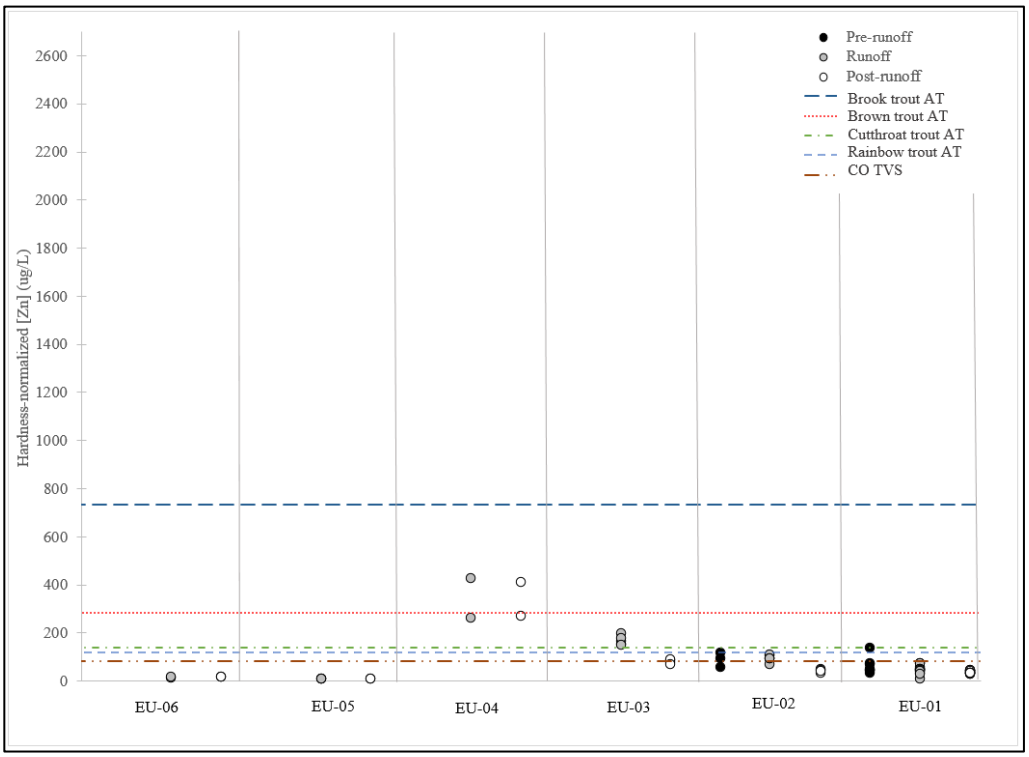
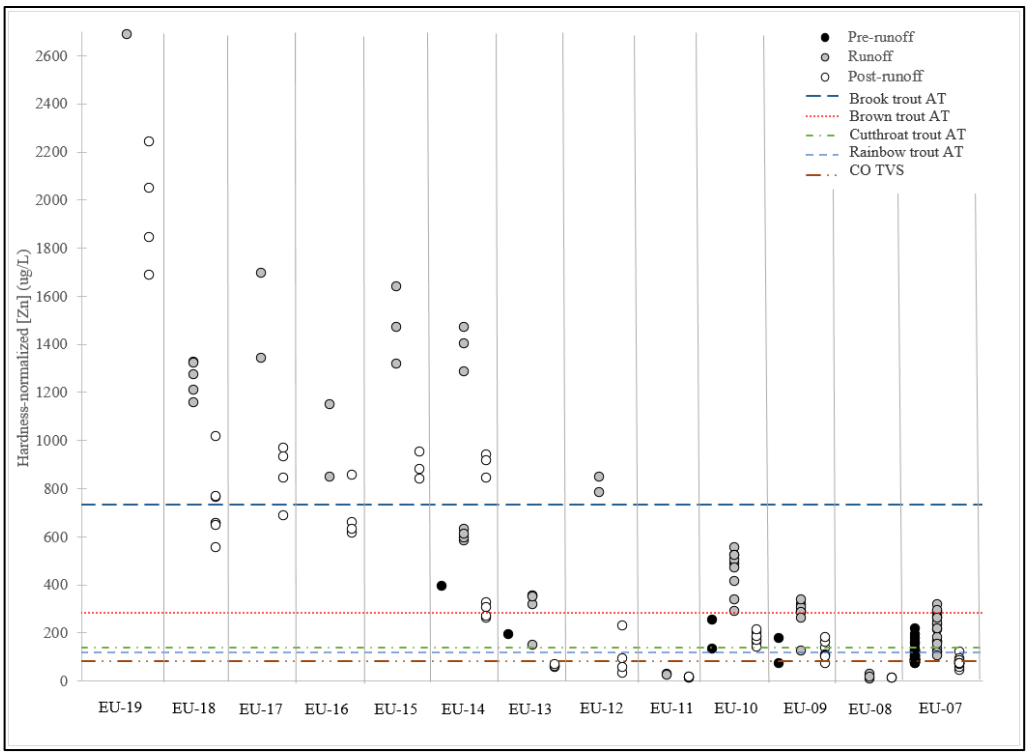


Figure 9-3 Hardness-Normalized Zinc (Zn) Concentrations, Trout Species-Specific Acute Thresholds (ATs), and Colorado Chronic Table Value Standard (CO TVS) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). Zn concentrations in each surface water sample, ATs, and CO TVS were normalized to a common 50 mg/kg hardness using trout AT threshold equation parameters developed for the Upper Animas River Baseline Ecological Risk Assessment (Attachment 1). The chronic Co TVS was obtained from (CDPHE, 2017c).

a)



b)



Executive Summary Table

Table ES-1 Final Risk Characterization Summary For Each Assessment Endpoint and Exposure Unit (EU). Hazard quotient (HQ)-based risk characterization focused on Central Tendency Exposure (CTE) low-effect or chronic results since these HQs represent the highest levels of risk.

Exposure unit	Exposure unit description	BENTHIC MACROINVERTEBRATES				HABITAT[1]	WATER-COLUMN INVERTEBRATES AND FISH			WILDLIFE SPECIES[2]				
		Low-effect sediment HQs[3]	Chronic pore water HQs[4]	Sed. tox. test[5]	BMI comm. Survey[6]	BMI/Fish	Chronic surface water HQs[4]	Acute tox. test	Fish pres./abs.[7]	Am. Dipper	Mallard	Kingfisher	Muskrat	Raccoon
MINERAL CREEK WATERSHED														
EU-01	Lower mainstem Mineral Creek	Low risk	Mod. risk	Highly toxic	Impaired	Suboptimal / NA	Mod. risk	Low toxicity	Trout present	Low risk	Acceptable risk	Low risk	Low risk	Low risk
EU-02	Lower mainstem Mineral Creek	Low risk	High risk	Highly toxic	Impaired	Suboptimal / NA	High risk	Highly toxic	No fish	Low risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk
EU-03	Mid. mainstem Mineral Creek	Low risk	Mod. risk	Moderately toxic	Impaired	Optimal / NA	Mod. risk	Not acutely toxic	Trout present	Low risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
EU-04	Upper mainstem Mineral Creek	High risk	Low risk	Moderately toxic	Not impaired	Suboptimal / NA	High risk	Not acutely toxic	No fish	High risk	Low risk	Mod. risk	Low risk	Acceptable risk
EU-05	South Fork Mineral Creek	Acceptable risk	High risk	Low toxicity	Not impaired	Optimal / NA	Low risk	Not acutely toxic	Trout present	Acceptable risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk
EU-06	Middle Fork Mineral Creek	Low risk	High risk	Highly toxic	Impaired	Optimal / NA	High risk	Highly toxic	No fish	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
UPPER ANIMAS BERA EUs														
NA	Cement Creek	Low risk	NA	High risk	Impaired	NA / NA	High risk	Highly toxic	No fish	Low risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
NA	Animas R. above Cement Cr. to Arrastra Cr.	High risk	High risk	Low toxicity	Impaired	NA / NA	Mod. risk	Not acutely toxic	Trout present	High risk	Acceptable risk	Low risk	Low risk	Low risk
NA	Animas R. between Cement Cr. and Mineral Cr.	NA	NA	NA	NA	NA / NA	High risk	NA	NA	NA	NA	NA	NA	NA
NA	Animas R. 300 ft. below Mineral Cr.	NA	NA	NA	NA	NA / NA	High risk	NA	NA	NA	NA	NA	NA	NA
NA	Animas R. 3,500 feet below Mineral Cr.	Low risk	Mod. risk	Low toxicity	Impaired	NA / NA	High risk	Highly toxic	Trout present	Low risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk
NA	Animas R. at Elk Cr. confluence	Low risk	High risk	Moderately toxic	Impaired	NA / NA	High risk	Not acutely toxic	Trout present	Low risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk
NA	Animas R. at Cascade Cr. confluence	Low risk	Low risk	Low toxicity	Not impaired	NA / NA	High risk	Not acutely toxic	Trout present	Low risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
NA	Animas R. at Bakers Bridge	High risk	Low risk	Not toxic	Not impaired	NA / NA	Mod. risk	Not acutely toxic	Trout present	Low risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
ANIMAS RIVER - UPPER REACHES AND TRIBUTARIES														
EU-07	Mainstem - Arrastra G. to Cunningham Cr.	Mod. risk	Low risk	Moderately toxic	Impaired	Optimal / NA	Low risk	Not acutely toxic	Trout present	High risk	Low risk	Low risk	Low risk	Acceptable risk
EU-08	Cunningham Creek	Low risk	Mod. risk	Low toxicity	Not impaired	Suboptimal / Good	Acceptable risk	Not acutely toxic	Trout present	Low risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk
EU-09	Mainstem - Cunningham Cr. to Minnie G.	High risk	Low risk	Low toxicity	Not impaired	Suboptimal / Good	Mod. risk	Not acutely toxic	Trout present	Mod. risk	Acceptable risk	Acceptable risk	Low risk	Acceptable risk
EU-10	Mainstem - Minnie G. to South Fork Animas R.	High risk	Low risk	Low toxicity	Not impaired	Suboptimal / NA	Mod. risk	Not acutely toxic	No fish	Mod. risk	Acceptable risk	Mod. risk	Low risk	Acceptable risk
EU-11	Upper South Fork Animas River	Low risk	Low risk	Moderately toxic	Impaired	Optimal / NA	Low risk	Not acutely toxic	No fish	Low risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk
EU-12	Eureka Gulch	Mod. risk	Low risk	Moderately toxic	Not impaired	Suboptimal / Fair	High risk	Not acutely toxic	No fish	Low risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk
EU-13	Lower South Fork Animas River	Mod. risk	Acceptable risk	Low toxicity	Not impaired	Optimal / Poor	Mod. risk	Not acutely toxic	No fish	Low risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk
EU-14	Mainstem - S. Fork to W. Fork Animas River	Mod. risk	High risk	Low toxicity	Impaired	Optimal / Good	High risk	Not acutely toxic	No fish	Mod. risk	Acceptable risk	Low risk	Low risk	Acceptable risk
EU-15	Lower West Fork Animas River	High risk	High risk	Highly toxic	Impaired	Optimal / Good	High risk	Highly toxic	No fish	High risk	Acceptable risk	Mod. risk	Low risk	Low risk
EU-16	Placer Gulch	High risk	High risk	Low toxicity	Impaired	Optimal / Fair	High risk	Low toxicity	No fish	High risk	Low risk	High risk	Mod. risk	Low risk
EU-17	Upper West Fork Animas River	Mod. risk	High risk	Highly toxic	Impaired	Optimal / Fair	High risk	Highly toxic	No fish	Low risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
EU-18	N. Fork Animas River to Burrows Cr.	Low risk	High risk	Moderately toxic	Impaired	Suboptimal / Fair	High risk	Highly toxic	No fish	Low risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk
EU-19	Burrows Gulch	High risk	High risk	Moderately toxic	Impaired	Optimal / Poor	High risk	Highly toxic	No fish	Low risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk
ANIMAS RIVER - DURANGO REACH														
EU-DR01	James Ranch to 32nd St. Bridge	Low risk	Low risk	Low toxicity	Impaired	NA / NA	High risk	NA	Trout present[8]	Low risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk
EU-DR02	32nd St. Bridge to Purple Cliffs	Low risk	Low risk	Low toxicity	Impaired	NA / NA	Mod. risk	NA	Trout present[8]	Low risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
REFERENCE EXPOSURE UNITS														
EU-R1	Mineral Creek trib. - Bear Creek	Low risk	Low risk	Low toxicity	Not impaired	Optimal / NA	Acceptable risk	Not acutely toxic	No fish	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
EU-R2	Mineral Creek trib. - Mill Creek	Low risk	Low risk	Low toxicity	Not impaired	Optimal / NA	Low risk	Not acutely toxic	Trout present	Low risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
EU-R3	Animas River trib - Maggie Gulch	Low risk	Acceptable risk	Low toxicity	Not impaired	Optimal / Good	Low risk	Not acutely toxic	Trout present	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
EU-R4	Animas River trib - Picayne Gulch	Low risk	Acceptable risk	Low toxicity	Not impaired	Optimal / NA	Low risk	Not acutely toxic	No fish	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
EU-R5	Animas River trib - Upper N. Fork Animas River	Low risk	Low risk	Low toxicity	Not impaired	Optimal / Fair	High risk	Not acutely toxic	Trout present	Low risk	Acceptable risk	Acceptable risk	Acceptable risk	Acceptable risk
EU-R6	Durango Reach trib. - Hermosa Creek	Acceptable risk	Acceptable risk	Low toxicity	Not impaired	Suboptimal / NA	Acceptable risk	Not acutely toxic	Trout present	Acceptable risk	Acceptable risk	Low risk	Acceptable risk	Acceptable risk

BMI = Benthic Macroinvertebrate; COPEC = Contaminant of Potential Ecological Concern; NA = Not Assessed; BERA = Baseline Ecological Risk Assessment

[1] BMI habitat ratings were based on average Barbour et al. (1999) habitat evaluation parameter scores obtained from respective Mountain Studies Institute BMI assessment reports; Fish habitat ratings were obtained from Table 15 in the USGS (2018) Fish Habitat and Community Survey Data Report; fish habitat ratings were based on physical habitat parameters (gradient/slope, depth, substrate composition, bank stability, riparian composition, and presence of pools and large woody debris) measured and observed in each survey reach.

[2] All wildlife risks based on CTE low-effect, toxicity reference value HQs

[3] Risk based on CTE low-effect, ecological screening value HQs

[4] Risk based on CTE chronic, ecological screening value HQs

[5] Only summarizes the most recent, December 2017 sediment test results when less recent tests were also conducted

[6] Impairment status based on Colorado Multi-Metric Index scores being above or below respective sampling location impairment threshold

[7] Summarizes 2016 and historic fish survey results

[8] Based on multiple historic and recent Colorado Parks and Wildlife fish surveys conducted throughout the Durango Reach

Color code definitions*:

Lightest	All CTE HQs <1.0 or tox. test survival >80% or not impaired (BMIs) or trout present in historic and 2016 fish surveys
	At least one COPEC CTE HQ >1.0 but <5.0 or tox. test survival <80% but >50% or trout present in either historic or 2016 fish surveys but not during both
	At least one COPEC CTE HQ >5.0 but <10.0 or tox. test survival <50% but >20% or BMI community impaired or fish absent
Darkest	At least one COPEC CTE HQ >10.0 or tox. test survival <20%

* Note that it is understood that risk does not increase in a linear fashion with increasing HQs. As such, relative risk terminology was only used to qualitatively highlight differences in risk and should not be interpreted beyond this intended use.

Tables

Table 6.1 Exposure Parameters for Wildlife Receptors Selected for Use in the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment Food Chain Modeling

Wildlife species	Body weight (kg)	Ingestion rates			Dietary composition (%)			Home range
		Food (kg/kg BW-day, dw)	Water (L/kg BW-day)	Sediment (kg/kg BW-day, dw)	Aquatic invert.	Fish	Aquatic plants	
Insectivorous birds								
American dipper (*Cinclus mexicanus*)	0.054[o]	0.176[a]	0.155[g]	0.0176[h]	100[l]	--	--	From 50 yards up to half a mile[m]
Omnivorous birds								
Mallard (*Anas platyrhynchos*)	1.162[p]	0.0519[b]	0.056[g]	0.00104[i]	50[l]	--	50[l]	111 hectares[n]
Piscivorous birds								
Belted kingfisher (*Ceryle alcyon*)	0.147[q]	0.158[c]	0.11[g]	0.0014[j]	--	100[l]	--	2.25 km[n]
Herbivorous mammals								
Muskrat *(Ondatra zibethicus)*	1.17[r]	0.0839[d]	0.0975[f]	0.00839[h]	--	--	100[l]	0.13 hectares[n]
Piscivorous mammals								
Raccoon *(Procyon lotor)*	5.78[s]	0.036[e]	0.0831[f]	0.003414[k]	--	100[l]	--	9.19 km[n]

[a] Calculated using IR_{food} (g dw/day) = 0.63*BW(g)$^{0.683}$, adjusted to 1.0 kg of receptor (see Table 3 [passerines] on p. 29R in Nagy, 2001)

[b] Calculated using IR_{food} (g dw/day) = 0.301*BW(g)$^{0.751}$, adjusted to 1.0 kg of receptor (see eq. 3-5 [non-passerines] on p. 3-5 in EPA, 1993)

[c] Calculated using IR_{food} (g dw/day) = 0.849*BW(g)$^{0.663}$, adjusted to 1.0 kg of receptor (see Table 3 [carnivorous birds] on p. 29R in Nagy, 2001)

[d] Calculated using IR_{food} (g dw/day) = 0.577*BW(g)$^{0.727}$, adjusted to 1.0 kg of receptor (see eq. 3-9 [herbivores] on p. 3-6 in EPA, 1993)

[e] Calculated using IR_{food} (g dw/day) = 0.153*BW(g)$^{0.834}$, adjusted to 1.0 kg of receptor (see Table 2 [carnivores] on p. 28R in Nagy, 2001)

[f] Calculated using IR_{water} (L/day) = 0.099*BW(kg)$^{0.90}$, adjusted to 1.0 kg of receptor (see eq. 3-17 [all mammals] on p. 3-10 in EPA, 1993)

[g] Calculated using IR_{water} (L/day) = 0.059*BW(kg)$^{0.67}$, adjusted to 1.0 kg of receptor (see eq. 3-15 [all birds] on p. 3-8 in EPA, 1993)

[h] Best professional judgment (value represents 10% of food intake on a dry-weight basis)

[i] Table 4-4 in EPA, 1993 (value represents 2% of food intake on a dry-weight basis)

[j] Used in Carpenter Snow Creek Ecological Risk Assement (EPA, 2016c)

[k] The estimated % soil in the diet (dw) of raccoons is estimated at 9.4% as shown in Table 4-4 on p. 4-20 in EPA (1993)

[l] Best profesional judgment based on the needs of the BERA

[m] Montana Field Guide. 2019. Available at http://fieldguide.mt.gov/speciesDetail.aspx?elcode=ABPBH01010

[n] EPA. 1993. Wildlife exposure factors handbook. EPA/600/R-93/187a

[o] Mean BW of average adult male (57 g) and adult female (51 g) American dippers; Alaska Department of Fish and Game. 2008 (http://www.adfg.alaska.gov/static/education/wns/american_dipper.pdf)

[p] EPA, 1993

[q] Average of three mean BW values for adult male and female belted kingfishers (EPA, 1993)

[r] Silva and Downing, 1995

[s] Average of seven mean BW values for adult male and female raccoons (EPA, 1993)

-- = Not applicable

BW = Body weight

dw = dry weight

Table 6.2 Summary of Acute (96-hr) Juvenile Rainbow Trout Aquatic Toxicity Test Reference Toxicity (Zinc Sulfate) Test Performance and Conditions					
Test date	**LC50**	**LCL**	**UCL**	**Dilution water type**	**Feeding regime**
October 2012	163	147	181	Moderately hard reconstituted water	Not fed
November 2012	129	118	142	Moderately hard reconstituted water	Not fed
April 2013	216	195	239	Moderately hard reconstituted water	Fed once daily
October 2016	172	153	192	Soft reconstituted water	Fed once daily

All concentration units in µg/L

LC50 = Modeled zinc concentration in which 50% of the test organisms would die

LCL = Lower 95th percentile confidence level

UCL = Upper 95th percentile confidence level

Table 6.3 Sediment-to-Benthic Macroinvertebrate (BMI) Regression Models and Uptake Factors Used in Food Chain Modeling When Site-Specific BMI Tissue Chemistry Data Were Unavailable

Analyte	Sediment-to-BMI regression models (dry weight)		Sediment-to-BMI regression uptake factors (dry weight)		
	Model[a]	Source	Value	Basis	Source
Arsenic	$C_i = 10^{(-0.292 + 0.754*(\text{Log Csd}))}$	Bechtel Jacobs, 1998a	--		
Cadmium	$C_i = 10^{(-0.314+0.513*(\text{Log Csd}))}$	Bechtel Jacobs, 1998a	--		
Chromium	$C_i = 10^{(0.2092+0.365*(\text{Log Csd}))}$	Bechtel Jacobs, 1998a	--		
Copper	--		0.824	Geomean	Bechtel & Jacobs, 1998a
Lead	$C_i = 10^{(-0.515 + 0.653*(\text{Log Csd}))}$	Bechtel Jacobs, 1998a	--		
Mercury	$C_i = 1.2268*(C_{sd}) + 0.1301$	Site-specific model	--		
Nickel	$C_i = 10^{(-0.44 + 0.695*(\text{Log Csd}))}$	Bechtel Jacobs, 1998a	--		
Selenium	--		1	Assumed	Upper Animas BERA
Silver	--		0.18	Mean	Hirsch, 1998
Zinc	$C_i = 4.8814*(C_{sd})^{0.4927}$	Site-specific model	--		

[a] C_i = Concentration of an analyte in invertebrate tissue (mg/kg, dry weight); C_{sd} = concentration of an analyte in the sediment (mg/kg, dry weight)

-- = Not applicable

References:

Bechtel Jacobs. 1998a. Biota sediment accumulation factors for invertebrates: review and recommendations for Oak Ridge Reservation. Prepared for U.S. Department of Energy. BJC/OR-112. August.

Hirsch, M.P. 1998. Bioaccumulation of silver from laboratory-spiked sediments in the oligochaete (Lumbriculus variegatus). Environ. Toxicol. Chem. 17:605-609.

Table 6.4 Sediment-to-Fish Tissue Regression Models and Uptake Factors Used in Food Chain Modeling When Site-Specific Fish Tissue Chemistry Data Were Unavailable

Analyte	Sediment-to-fish tissue regression models (dry-weight)		Sediment-to-fish tissue regression uptake factors (dry-weight)		
	Model[a]	Source	Value	Basis	Source
Arsenic	--		0.126	Average	Pascoe *et al.,* 1996
Cadmium	$C_f = 0.4487*(C_{sd})^{(0.3294)}$	Site-specific model	--		
Chromium	--		0.038	Average	Krantzberg and Boyd, 1992
Copper	$C_f = 0.7955*(C_{sd})^{(0.4953)}$	Site-specific model	--		
Lead	--		0.07	Average	Krantzberg and Boyd, 1992
Mercury	--		3.25	Average	Cope *et al.,* 1990
Nickel	--		1	Assumed	Upper Animas BERA
Selenium	$C_f = 1.7917*(C_{sd}) + 0.7695$	Site-specific model	--		
Silver	--		1	Assumed	Upper Animas BERA
Zinc	$C_f = 3.0009*(C_{sd})^{(0.5757)}$	Site-specific model	--		

[a] C_f = Concentration of an analyte in fish tissue (mg/kg, dry weight); C_{sd} = concentration of an analyte in the sediment (mg/kg, dry weight)

-- = Not applicable

References:

Cope, W.G., J.G. Wiener, and R.G. Rada. 1990. Mercury accumulation in yellow perch in Wisconsin seepage lakes: relation to lake characteristics. Environ. Toxicol. Chem. 9:931-940.

Krantzberg, G. and D. Boyd. 1992. The biological significance of contaminants in sediment from Hamilton Harbour, Lake Ontario. Environ. Toxicol. Chem. 11:1527-1540.

Pascoe, G.A., R.J. Blanchet, and G. Linder. 1996. Food chain analysis of exposures and risks to wildlife at a metals-contaminated wetland. Arch. Environ. Contam. Toxicol. 30:306-318.

Table 6.5 Sediment-to-Plant Tissue Regression Models and Uptake Factors Used for Use in Food Chain Modeling

Analyte	Sediment-to-plant regression models (dry weight)[a]		Sediment-to-plant regression uptake factors (dry weight)[a]		
	Model[b]	Source	Value	Basis	Source
Arsenic	$C_p = e^{(-1.992 + 0.564(\ln Csd))}$	Bechtel Jacobs, 1998b	--		
Cadmium	$C_p = e^{(-0.476 + 0.546(\ln Csd))}$	EPA, 2007d	--		
Chromium	--		0.041	Median	EPA, 2007d
Copper	$C_p = e^{(0.669 + 0.394(\ln Csd))}$	EPA, 2007d	--		
Lead	$C_p = e^{(-1.328 + 0.561(\ln Csd))}$	EPA, 2007d	--		
Mercury	$C_p = e^{(-0.996 + 0.544(\ln Csd))}$	Bechtel Jacobs, 1998b	--		
Nickel	$C_p = e^{(-2.224 + 0.748(\ln Csd))}$	EPA, 2007d	--		
Selenium	$C_p = e^{(-0.678 + 1.104(\ln Csd))}$	EPA, 2007d	--		
Silver	--		0.014	Median	EPA, 2007d
Zinc	$C_p = e^{(1.575 + 0.555(\ln Csd))}$	EPA, 2007d	--		

[a] Tissue residue levels in the above-ground vegetative portion of rooted aquatic plants were estimated using the methods developed for terrestrial plants, except that sediment exposure point concentrations were used in the calculations

[b] C_p = Concentration of an analyte in the plant; C_{sd} = concentration of an analyte in the sediment

-- = Not applicable

References:

Bechtel Jacobs. 1998b. Empirical models for the uptake of inorganic chemicals from soil by plants. Prepared for the U.S. Department of Energy. BJC/OR-133. September.

U.S. Environmental Protection Agency (EPA). 2007g. Guidance for developing ecological soil screening levels. Attachment 4-1. OSWER Directive 9285.7-55. April

Table 6.6 Surface Water Acute and Chronic Ecological Screening Values (ESVs)			
Metal	**Surface water acute ESV (µg/L)**	**Surface water chronic ESV (µg/L)**	**ESV source**
Aluminum[#]	512	73[*]	a
Antimony	2300	240	b
Arsenic	340	150	a
Barium[#]	572	100	b
Beryllium[#]	11.6	0.65	b
Cadmium[#]	0.5[^]	0.15	a
Chromium[#]	183	24	a
Cobalt	740	100	b
Copper[#]	3.6	2.7	a
Iron	--	1000	a
Lead[#]	14	0.5	a
Manganese[#]	1881	1040	a
Mercury	2.8	0.01	a (chronic); b (acute)
Molybdenum	58000	3200	b
Nickel[#]	145	16	a
Selenium	18.4	4.6	a
Silver[#]	0.19	0.01[&]	a
Thallium	94	15	a (chronic); b (acute)
Vanadium	160	27	b
Zinc[#]	45	34	a

[#] The benchmark for these hardness-dependent metals are presented for a generic surface water hardness of 25 mg/L, but was adjusted to sample- or exposure unit-specific hardnesses in the Aquatic BERA.

[*] As per the CO guidelines, the final benchmark for Al may have to be recalculated to take hardness into account depending on the pH of the surface water

[^] This acute value is derived based on the "trout" equation

[&] This chronic value is derived based on the "trout" equation

-- = Benchmark not avialable

Benchmark Sources:

a. Colorado Department of Public Health and Environment. 2017c. Water Quality Control Commission. Regulation No. 31. The basic standards and methodologies for surface water (5 CCR 1002-31)

b. Michigan Department of Environmental Quality (MDEQ). 2015. Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4. Water Quality Standards gives procedures for calculating water quality values to protect humans, wildlife and aquatic life. http://www.michigan.gov/documents/deq/wrd-swas-rule57_372470_7.pdf

Table 6.7 No-Effect and Low-Effect Sediment Ecological Screening Values (ESVs)				
Metal	**No-effect ESVs (mg/kg)**	**ESV source**	**Low-effect ESVs (mg/kg)**	**ESV source**
Aluminum	14000	f	60000	f
Antimony	12	d	--	--
Arsenic	9.79	a	33	a
Barium	48	h	--	--
Beryllium	--	--	--	--
Cadmium	0.99	a	4.98	a
Chromium	43.4	a	111	a
Cobalt	50	e	--	--
Copper	31.6	a	149	a
Iron	20000	c	40000	c
Lead	35.8	a	128	a
Manganese	460	c	1100	c
Mercury	0.18	a	1.06	a
Molybdenum	8.3	g	540	g
Nickel	22.7	a	48.6	a
Selenium	0.9	g	4.7	g
Silver	1.0	b	3.7	b
Thallium	--	--	--	--
Vanadium	27.3	g	77	g
Zinc	121	a	459	a

-- = Not applicable

Benchmark sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius* . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory. 2016. ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table 6.8 No-Effect and Low-Effect Toxicity Reference Values (TRVs) for Birds				
	No-effect TRVs		Low-effect TRVs	
Metal*	EcoSSL TRVs[a]	1996 toxicological benchmarks for wildlife[b]	Los Alamos National Laboratory (2016)[c]	1996 toxicological benchmarks for wildlife[b]
Arsenic	2.24	5.14	22.4	12.8
Cadmium	1.47	1.45	14.7	20
Chromium III	2.66	1.0	26.6	5.0
Copper	4.05	47	12.1	61.7
Lead	1.63	1.13	3.26	11.3
Mercury (inorganic)	-	0.45	-	0.9
Nickel	6.71	77.4	67.1	107
Selenium	0.29	0.5	0.579	1.0
Silver	2.02	-	20.2	-
Zinc	66.1	14.5	661	131

EcoSSL = Ecological Soil Screening Level

-- = not available

Footnotes:

* Only those metals identified as "important bioaccumulatice compounds " in Table 4-2 of EPA (2000a) are included in this table.

All units are mg/kg bw-day

Shading identifies the TRVs selected for use in the BERA

[a] EPA Eco SSL reports (http://www.epa.gov/ecotox/ecossl), as follows:

EPA, 2005a. Ecological soil screening levels for **arsenic**. Interim final. OSWER Directive 9285.7-62.

EPA, 2005b. Ecological soil screening levels for **cadmium**. Interim final. OSWER Directive 9285.7-65.

EPA, 2008. Ecological soil screening levels for **chromium**. Interim final. OSWER Directive 9285.7-66.

EPA, 2007c. Ecological soil screening levels for **copper**. Interim final. OSWER Directive 9285.7-68.

EPA, 2005c. Ecological soil screening levels for **lead**. Interim final. OSWER Directive 9285.7-70.

EPA, 2007d. Ecological soil screening levels for **nickel**. Interim final. OSWER Directive 9285.7-76.

EPA, 2007e. Ecological soil screening levels for **selenium**. Interim final. OSWER Directive 9285.7-72.

EPA, 2006. Ecological soil screening levels for **silver**. Interim final. OSWER Directive 9285.7-77.

EPA, 2007f. Ecological soil screening levels for **zinc**. Interim final. OSWER Directive 9285.7-73.

[b] Sample *et al.* , 1996, Toxicological Benchmarks for Wildlife: 1996 Revision, ES/ER/TM-86/R3, http://www.esd.ornl.gov/programs/ecorisk/documents/tm86r3.pdf (values are the toxicities measured in the test species)

[c] Los Alamos National Laboratory. 2016. Ecological screening levels. ECORISK Database. Available at: https://lanl.gov/environment/protection/eco-risk-assessment.php

Table 6.9 No-Effect and Low-Effect Toxicity Reference Values (TRVs) for Mammals				
	No-effect TRVs		Low-effect TRVs	
Metal*	EcoSSL TRVs[a]	1996 toxicological benchmarks for wildlife[b]	Los Alamos National Laboratory (2016)[c]	1996 toxicological benchmarks for wildlife[b]
Arsenic	1.04	0.126	1.66	1.26
Cadmium	0.77	1.0	7.7	10.0
Chromium III	2.4	2737[d]	24	--
Copper	5.6	11.7	9.34	15.4
Lead	4.7	8.0	8.9	80
Mercury	--	1.0	14.1	--
Nickel	1.7	40	3.4	80
Selenium	0.14	0.2	0.214	0.33
Silver	6.02	--	60.2	--
Zinc	75.4	160	754	320

All units are mg/kg bw-day

Shading identifies TRVs selected for use in the BERA

EcoSSL = Ecological Soil Screening Level

-- = Benchmark not available

* Only those metals identified as "important bioaccumulatice compounds" in Table 4-2 of EPA (2000a) are included in this table.

[a] USEPA Eco SSL reports (http://www.epa.gov/ecotox/ecossl), as follows:

EPA, 2005a. Ecological soil screening levels for **arsenic**. Interim final. OSWER Directive 9285.7-62.

EPA, 2005b. Ecological soil screening levels for **cadmium**. Interim final. OSWER Directive 9285.7-65.

EPA, 2008. Ecological soil screening levels for **chromium**. Interim final. OSWER Directive 9285.7-66.

EPA, 2007c. Ecological soil screening levels for **copper**. Interim final. OSWER Directive 9285.7-68.

EPA, 2005c. Ecological soil screening levels for **lead**. Interim final. OSWER Directive 9285.7-70.

EPA, 2007d. Ecological soil screening levels for **nickel**. Interim final. OSWER Directive 9285.7-76.

EPA, 2007e. Ecological soil screening levels for **selenium**. Interim final. OSWER Directive 9285.7-72.

EPA, 2006. Ecological soil screening levels for **silver**. Interim final. OSWER Directive 9285.7-77.

EPA, 2007f. Ecological soil screening levels for **zinc**. Interim final. OSWER Directive 9285.7-73.

[b] Sample *et al* ., 1996, Toxicological Benchmarks for Wildlife: 1996 Revision, ES/ER/TM-86/R3, http://www.esd.ornl.gov/programs/ecorisk/documents/tm86r3.pdf (values are the toxicities measured in the test species)

[c] Los Alamos National Laboratory. 2016. Ecological screening levels. ECORISK Database. Available at: https://lanl.gov/environment/protection/eco-risk-assessment.php

[d] The no-effect TRV for CrIII is as reported in the reference

Table 7.1 Summary of Surface Water Contaminants of Potential Ecological Concern for Aquatic Community-Level Receptors for Each of the 27 Exposure Units												
Exposure unit	**Location**	**pH**	**Aluminum**	**Beryllium**	**Cadmium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Silver**	**Zinc**
EU-01	Lower Mineral Creek	X	X		X		X			X	X	X
EU-02	Lower Mineral Creek	X	X		X	X	X	X			X	X
EU-03	Middle Mineral Creek	X	X		X	X	X	X			X	X
EU-04	Upper Mineral Creek		X	X	X	X		X			X	X
EU-05	South Fork Mineral Creek		X				X				X	
EU-06	Middle Fork Mineral Creek	X	X		X		X				X	
EU-07	Mainstem Animas River		X		X	X	X				X	X
EU-08	Cunningham Creek		X								X	
EU-09	Mainstem Animas River	X	X		X	X					X	X
EU-10	Mainstem Animas River		X		X	X		X	X		X	X
EU-11	Upper South Fork Animas River		X								X	
EU-12	Eureka Gulch		X		X	X					X	X
EU-13	Lower South Fork Animas River		X		X	X	X	X			X	X
EU-14	Mainstem Animas River	X	X	X	X	X		X	X		X	X
EU-15	Lower West Fork Animas River	X	X	X	X	X		X	X		X	X
EU-16	Placer Gulch	X	X		X	X		X	X		X	X
EU-17	Upper West Fork Animas River	X	X	X	X	X		X	X		X	X
EU-18	North Fork Animas River	X	X	X	X	X		X	X		X	X
EU-19	Burrows Gulch	X	X	X	X	X		X	X		X	X
EU-DR01	Animas River - upper Durango Reach		X				X			X	X	
EU-DR02	Animas River - lower Durango Reach	X	X		X		X			X	X	
EU-R1	Mineral Creek trib. - Bear Creek										X	
EU-R2	Mineral Creek trib. - Mill Creek		X	X				X			X	
EU-R3	Animas River trib - Maggie Gulch		X								X	
EU-R4	Animas River trib - Picayne Gulch		X								X	
EU-R5	Animas River trib - upper N. Fork Animas R.		X	X	X			X			X	X
EU-R6	Durango Reach trib. - Hermosa Creek											

X = Denotes that the Contaminant of Potential Ecological Concern was selected for an Exposure Unit

Table 7.2 Summary of Pore Water Contaminants of Potential Ecological Concern for Benthic Macroinvertebrate Community-Level Receptors for Each of the 27 Exposure Units											
Exposure unit	**Location**	**pH**	**Aluminum**	**Beryllium**	**Cadmium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Silver**	**Zinc**
EU-01	Lower Mineral Creek	X	X		X		X			X	
EU-02	Lower Mineral Creek	X	X		X	X	X	X		X	X
EU-03	Middle Mineral Creek	X	X		X		X			X	X
EU-04	Upper Mineral Creek				X	X				X	X
EU-05	South Fork Mineral Creek	X	X		X		X				
EU-06	Middle Fork Mineral Creek	X	X		X		X			X	
EU-07	Mainstem Animas River		X		X	X	X	X	X	X	X
EU-08	Cunningham Creek		X				X			X	
EU-09	Mainstem Animas River		X		X		X			X	X
EU-10	Mainstem Animas River	X	X		X				X	X	X
EU-11	Upper South Fork Animas River	X					X			X	
EU-12	Eureka Gulch									X	X
EU-13	Lower South Fork Animas River	X	X							X	
EU-14	Mainstem Animas River	X	X	X	X	X	X	X	X	X	X
EU-15	Lower West Fork Animas River	X	X	X	X	X	X	X		X	X
EU-16	Placer Gulch	X	X		X	X		X		X	X
EU-17	Upper West Fork Animas River		X	X	X	X	X		X	X	X
EU-18	North Fork Animas River	X	X		X	X	X	X	X	X	X
EU-19	Burrows Gulch	X	X	X	X	X	X	X	X	X	X
EU-DR01	Animas River - upper Durango Reach					X			X	X	
EU-DR02	Animas River - lower Durango Reach								X		
EU-R1	Mineral Creek trib. - Bear Creek	X	X							X	
EU-R2	Mineral Creek trib. - Mill Creek	X	X							X	
EU-R3	Animas River trib - Maggie Gulch									X	
EU-R4	Animas River trib - Picayne Gulch									X	
EU-R5	Animas River trib - upper N. Fork Animas R.	X			X		X			X	
EU-R6	Durango Reach trib. - Hermosa Creek										

X = Denotes that the Contaminant of Potential Ecological Concern was selected for an Exposure Unit

Table 7.3 Summary of Sediment Contaminants of Potential Ecological Concern for Benthic Macroinvertebrate Community-Level Receptors for Each of the 27 Exposure Units																	
Exposure unit	**Location**	**Aluminum**	**Antimony**	**Arsenic**	**Barium**	**Cadmium**	**Cobalt**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Molybdenum**	**Selenium**	**Silver**	**Vanadium**	**Zinc**
EU-01	Lower Mineral Creek	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
EU-02	Lower Mineral Creek			X	X	X		X	X	X	X			X			X
EU-03	Middle Mineral Creek			X	X	X		X	X	X	X	X		X	X		X
EU-04	Upper Mineral Creek			X		X		X	X	X	X	X					X
EU-05	South Fork Mineral Creek			X	X	X			X	X	X			X			X
EU-06	Middle Fork Mineral Creek	X		X					X	X	X			X		X	X
EU-07	Mainstem Animas River	X		X	X	X		X	X	X	X			X	X		X
EU-08	Cunningham Creek			X	X	X		X	X	X	X			X	X		X
EU-09	Mainstem Animas River	X		X	X	X		X	X	X	X	X		X	X		X
EU-10	Mainstem Animas River	X	X	X	X	X		X	X	X	X		X	X	X		X
EU-11	Upper South Fork Animas River			X	X	X		X	X	X	X		X	X	X		X
EU-12	Eureka Gulch	X		X	X	X		X	X	X	X			X	X		X
EU-13	Lower South Fork Animas River			X	X	X		X	X	X	X	X		X	X		X
EU-14	Mainstem Animas River	X		X	X	X		X	X	X	X		X	X	X		X
EU-15	Lower West Fork Animas River	X		X	X	X		X	X	X	X	X	X		X		X
EU-16	Placer Gulch		X	X	X	X	X	X	X	X	X	X	X	X	X		X
EU-17	Upper West Fork Animas River	X		X	X	X		X	X	X	X			X	X	X	X
EU-18	North Fork Animas River	X		X	X	X		X	X	X	X		X	X	X		X
EU-19	Burrows Gulch	X		X	X	X		X	X	X	X		X	X	X		X
EU-DR01	Animas River - upper Durango Reach			X	X	X		X	X	X	X				X	X	X
EU-DR02	Animas River - lower Durango Reach			X	X	X		X	X	X	X			X	X	X	X
EU-R1	Mineral Creek trib. - Bear Creek			X	X				X	X	X			X			X
EU-R2	Mineral Creek trib. - Mill Creek			X	X	X				X	X			X			X
EU-R3	Animas River trib - Maggie Gulch			X	X			X	X	X	X	X		X			X
EU-R4	Animas River trib - Picayne Gulch			X	X	X		X	X	X	X			X	X		X
EU-R5	Animas River trib - upper N. Fork Animas R.			X	X	X		X	X	X	X			X	X		X
EU-R6	Durango Reach trib. - Hermosa Creek	X			X				X					X		X	

X = Denotes that the Contaminant of Potential Ecological Concern was selected for an Exposure Unit

Table 8.1 Average and Reasonable Minimum Hardness Values Used to Derive Hardness-Dependent Surface Water Criteria Hazard Quotients (HQs)

	Pre-runoff hydroperiod							Runoff hydroperiod							Post-runoff hydroperiod						
Exposure unit	**n**	**95% UCL[a]**	**Avg.[b]**	**Difference[c]**	**Avg. diff.[d]**	**Min[e]**	**Max[f]**	**n**	**95% UCL[a]**	**Avg.[b]**	**Difference[c]**	**Avg. diff.[d]**	**Min[e]**	**Max[f]**	**n**	**95% UCL[a]**	**Avg.[b]**	**Difference[c]**	**Avg. diff.[d]**	**Min[e]**	**Max[f]**
EU-01	8	256	205	51.9	153	102	309	13	83.5	69.8	13.8	56.0	49.0	151	16	186	166	20.3	146	65.3	225
EU-02	3	NA	169	--	--	104	256	7	186	80.6	105	-24.3	47.5	200	4	NA	228	--	--	179	275
EU-03	--	--	--	--	--	--	--	5	46.1	40.0	6.13	33.9	34.8	50.0	4	NA	149	--	--	116	186
EU-04	--	--	--	--	--	--	--	2	NA	33.1	--	--	32.3	34.0	2	--	93.7	--	--	93.7	106
EU-05	--	--	--	--	--	--	--	3	NA	60.0	--	--	54.8	69.8	2	NA	110	--	--	91.2	129
EU-06	--	--	--	--	--	--	--	3	NA	85.0	--	--	74.4	90.4	3	NA	338	--	--	300	405
EU-07	39	136	131	5.00	126	93.0	157	18	83.0	84.5	-1.45	85.9	50.2	113	11	142	133	9.10	124	112	168
EU-08	--	--	--	--	--	--	--	3	NA	64.2	--	--	43.7	98.4	3	NA	123	--	--	98.2	149
EU-09	2	NA	125	--	--	102	147	8	82.9	62.9	20.0	42.9	46.2	106	7	144	130	14.3	115	90.4	150
EU-10	2	NA	122			106	138	9	62.7	53.5	9.17	44.3	39.8	80.9	7	162	166	-3.90	170	87.7	175
EU-11	--	--	--	--	--	--	--	2	NA	50.4	--	--	49.4	51.4	4	NA	175	--	--	75.0	240
EU-12	--	--	--	--	--	--	--	2	NA	51.0	--	--	50.6	51.5	4	177	121	56.9	63.6	56.6	172
EU-13	1	NA	197	--	--	197	197	5	105	71.7	32.9	38.7	49.7	132	4	NA	168	--	--	119	207
EU-14	1	NA	87.7	--	--	87.7	87.7	7	41.3	35.9	5.40	30.5	27.0	50.6	7	151	133	18.1	115	95.6	165
EU-15	--	--	--	--	--	--	--	3	NA	33.3	--	--	30.6	37.3	3	212	159	53.7	105	127	191
EU-16	--	--	--	--	--	--	--	2	NA	48.3	--	--	33.5	63.0	4	120	92.2	27.6	64.6	60.1	113
EU-17	--	--	--	--	--	--	--	2	NA	42.3	--	--	37.2	47.4	4	NA	166	--	--	103	207
EU-18	--	--	--	--	--	--	--	5	25.2	23.6	1.57	22.0	20.9	25.3	7	93.8	77.3	16.5	60.8	31.2	97.9
EU-19	--	--	--	--	--	--	--	1	NA	25.1	--	--	25.1	25.1	4	NA	65.5	--	--	31.7	87.5
EU-DR01	3	NA	192	--	--	184	200	2	NA	65.0	--	--	60.2	69.8	7	217	180	36.4	144	95.4	245
EU-DR02	6	198	171	26.7	144	116	198	7	98.1	81.8	16.4	65.4	57.3	112	12	208	189	18.9	170	121	238
EU-R1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	NA	79.0	--	--	73.3	84.7
EU-R2	--	--	--	--	--	--	--	1	NA	24.8	--	--	24.8	24.8	1	NA	56.1	--	--	56.1	56.1
EU-R3	--	--	--	--	--	--	--	2	NA	42.9	--	--	42.5	43.3	2	NA	118	--	--	99.5	136
EU-R4	--	--	--	--	--	--	--	1	NA	39.7	--	--	39.7	39.7	2	NA	234	--	--	183	285
EU-R5	--	--	--	--	--	--	--	3	NA	24.7	--	--	23.0	26.9	4	NA	75.1	--	--	28.7	101

Note: the higher of the "Avg. diff" value or "Min" value was used to represent the estimated lower bound for surface water hardness for a given hydroperiod

Highlighted concentrations were retained to adjust the hardness-based benchmarks used in calculating the surface water HQs

NA = Not available or could not reliably be calculated

n = Number of observations

-- = Hardness results unavailable for respective exposure units and hydroperiods

[a] UCL = Upper confidence limit for surface water hardness concentration

[b] Avg. = Arithmetic mean surface water hardness concentration

[c] Difference = 95% UCL - average concentration

[d] Avg. diff. = C.oncentration obtained by subtracting "Difference" from "Avg."

[e] Min = Lowest surface water hardness concentration measured in the samples collected from an exposure unit during the hydroperiod

[f] Max = Greatest surface water hardness concentration measured in the samples collected from an exposure unit during the hydroperiod period

Table 8.2 Average and Reasonable Minimum Hardness Values Used to Derive Hardness-Dependent Pore Water Criteria Hazard Quotients (HQs)

Exposure unit	n	95% UCL[a]	Avg.[b]	Difference[c]	Avg. diff.[d]	Min[e]	Max[f]
EU-01	3	248	158	90.4	67.2	116	218
EU-02	2	NA	127	NA	NA	67.6	187
EU-03	2	NA	137	NA	NA	126	148
EU-04	1	NA	100	NA	NA	100	100
EU-05	1	NA	248	NA	NA	248	248
EU-06	1	NA	305	NA	NA	305	305
EU-07	9	198	149	49.6	99.1	99.3	331
EU-08	1	NA	97.7	NA	NA	97.7	97.7
EU-09	3	143	114	29.0	85.2	94.6	127
EU-10	2	NA	135	NA	NA	133	138
EU-11	1	NA	168	NA	NA	168	168
EU-12	1	NA	115	NA	NA	115	115
EU-13	1	NA	154	NA	NA	154	154
EU-14	2	NA	119	NA	NA	113	125
EU-15	1	NA	34.4	NA	NA	34.4	34.4
EU-16	1	NA	88.1	NA	NA	88.1	88.1
EU-17	1	NA	151	NA	NA	151	151
EU-18	2	NA	84.3	NA	NA	84.0	84.7
EU-19	1	NA	67.8	NA	NA	67.8	67.8
EU-DR01	3	312	177	135	42.7	93.0	252
EU-DR02	2	NA	434	NA	NA	271	597
EU-R1	1	NA	72.5	NA	NA	72.5	72.5
EU-R2	1	NA	65.1	NA	NA	65.1	65.1
EU-R3	1	NA	100	NA	NA	100	100
EU-R4	1	NA	181	NA	NA	181	181
EU-R5	1	NA	100	NA	NA	100	100

Note: the higher of the "Avg diff" value or "Min" value was used to represent the estimated lower bound for surface water hardness

Highlighted concentrations were retained to adjust the hardness-based benchmarks used in calculating pore water HQs

NA = Not available or could not reliably be calculated

n = Number of observations

[a] UCL = Upper confidence limit for surface water hardness concentration

[b] Avg. = Arithmetic mean surface water hardness concentration

[c] Difference = 95% UCL - average concentration

[d] Avg. diff. = Concentration obtained by subtracting "Difference" from "Avg."

[e] Min = Lowest surface water hardness concentration measured in the samples collected from an exposure unit

[f] Max = Greatest surface water hardness concentration measured in the samples collected from an exposure unit

Table 9.1 Summary of Sediment Central Tendency Exposure (CTE) Low-Effect Ecological Screening Value Hazard Quotients (HQs) for Benthic Macroinvertebrates. Note that only contaminants that had at least one CTE low-effect HQ>1 in at least one exposure unit are summarized.

Exposure unit	Location	Arsenic	Cadmium	Copper	Iron	Lead	Manganese	Silver	Zinc
EU-01	Lower Mineral Creek	1.04	0.31	0.77	1.78	1.76	1.13	0.29	1.12
EU-02	Lower Mineral Creek	1.43	0.25	0.51	1.56	2.60	0.90		1.57
EU-03	Middle Mineral Creek	1.46	1.12	0.79	0.85	3.56	1.56	0.26	3.81
EU-04	Upper Mineral Creek	3.83	1.61	2.04	0.93	10.4	1.42		12.6
EU-05	South Fork Mineral Creek	0.38	0.12		0.73	0.68	0.79		0.56
EU-06	Middle Fork Mineral Creek	0.46			2.73	0.65	0.84		0.27
EU-07	Mainstem Animas River	0.63	1.94	1.79	0.65	9.63	6.97	1.23	5.87
EU-08	Cunningham Creek	0.27	0.41	0.44	0.55	3.21	0.98	0.29	0.93
EU-09	Mainstem Animas River	0.87	2.16	2.34	0.65	12.0	8.89	1.27	5.39
EU-10	Mainstem Animas River	1.34	3.31	3.36	0.73	11.2	12.4	2.39	7.69
EU-11	Upper South Fork Animas River	0.87	0.23	0.61	1.16	1.62	1.11	0.31	0.70
EU-12	Eureka Gulch	0.56	2.19	1.60	0.83	4.23	7.06	0.55	6.44
EU-13	Lower South Fork Animas River	0.76	1.40	1.49	1.06	5.03	3.68	0.60	4.23
EU-14	Mainstem Animas River	1.40	1.84	2.19	0.54	7.79	7.55	0.99	5.20
EU-15	Lower West Fork Animas River	0.97	1.31	2.04	0.60	12.1	8.38	0.95	3.37
EU-16	Placer Gulch	1.62	7.40	7.18	0.68	50.7	29.2	3.36	18.5
EU-17	Upper West Fork Animas River	0.86	0.37	1.30	0.88	1.89	5.19	0.34	1.49
EU-18	North Fork Animas River	1.24	1.22	0.57	0.42	2.90	3.04	0.39	2.04
EU-19	Burrows Gulch	1.45	1.41	1.37	0.72	3.50	10.7	0.37	1.55
EU-DR01	Animas River - upper Durango Reach	0.34	0.45	0.53	0.50	1.58	1.80	0.33	1.54
EU-DR02	Animas River - lower Durango Reach	0.29	0.46	0.48	0.49	1.31	1.71	0.26	1.63
EU-R1	Mineral Creek trib. - Bear Creek	0.38			0.44	0.42	1.21		0.56
EU-R2	Mineral Creek trib. - Mill Creek	0.30	0.46			2.57	1.56		0.94
EU-R3	Animas River trib - Maggie Gulch	0.28		0.18	0.62	0.26	1.29		0.30
EU-R4	Animas River trib - Picayne Gulch	1.75	1.79	0.24	0.46	1.62	2.18	0.39	1.95
EU-R5	Animas River trib - upper N. Fork Animas R.	1.49	0.31	0.24	0.74	0.66	4.52	0.29	0.83
EU-R6	Durango Reach trib. - Hermosa Creek				0.55				

Color code definitions:

WHITE (no value)	Not a contaminant of potential ecological concern
Lightest	HQ <1.0 or pH >6.5
	HQ >1.0 but <5.0 or pH <6.5
	HQ >5.0 but <10.0
Darkest	HQ >10.0

Table 9.2 Summary of Pore Water Central Tendency Exposure (CTE) Low Hardness Acute Ecological Screening Value Hazard Quotients (HQs) for Benthic Macroinvertebrates. Note that only contaminants that had at least one CTE low-effect HQ>1 (acute or chronic) in at least one exposure unit are summarized.

Exposure unit	Location	pH[a]	Aluminum	Beryllium	Cadmium	Copper	Lead	Manganese	Zinc
EU-01	Lower Mineral Creek	5.82	0.60		0.20				
EU-02	Lower Mineral Creek	4.05	4.02		0.32	0.88	1.02		1.34
EU-03	Middle Mineral Creek	6.06	1.18		0.45				1.76
EU-04	Upper Mineral Creek				0.97	0.74			3.67
EU-05	South Fork Mineral Creek	4.01	0.79		0.36				
EU-06	Middle Fork Mineral Creek	3.94	1.16		0.27				
EU-07	Mainstem Animas River		0.32		0.43	1.11	0.08	0.84	1.28
EU-08	Cunningham Creek		1.16						
EU-09	Mainstem Animas River		0.32		0.26				1.95
EU-10	Mainstem Animas River	6.35	0.13		1.05			0.53	3.02
EU-11	Upper South Fork Animas River		0.08						
EU-12	Eureka Gulch		0.05						1.10
EU-13	Lower South Fork Animas River	6.50	0.03						
EU-14	Mainstem Animas River	5.40	4.17	0.09	2.91	0.94	0.06	2.02	8.87
EU-15	Lower West Fork Animas River	5.46	6.09	0.10	3.39	1.65	0.38		12.8
EU-16	Placer Gulch	6.09	0.46		1.66	0.73	0.06		7.86
EU-17	Upper West Fork Animas River	-	1.97	0.07	4.42	1.52		6.71	14.5
EU-18	North Fork Animas River	4.83	2.54		5.60	1.28	0.13	0.53	9.08
EU-19	Burrows Gulch	4.63	7.06	0.06	13.9	5.59	0.13	1.80	26.1
EU-DR01	Animas River - upper Durango Reach					0.54		1.37	
EU-DR02	Animas River - lower Durango Reach							0.80	
EU-R1	Mineral Creek trib. - Bear Creek	6.30	0.29						
EU-R2	Mineral Creek trib. - Mill Creek	6.02	0.11						
EU-R3	Animas River trib - Maggie Gulch								
EU-R4	Animas River trib - Picayne Gulch								
EU-R5	Animas River trib - upper N. Fork Animas R.	5.78			0.39				
EU-R6	Durango Reach trib. - Hermosa Creek								

[a] Reported pH values are CTEs of all pH measurements collected from each EU; not HQs

Color code definitions:

WHITE (no value)	Not a contaminant of potential ecological concern
Lightest	HQ <1.0 or pH >6.5
	HQ >1.0 but <5.0 or pH <6.5 but >5.5
	HQ >5.0 but <10.0 or pH <5.5 but >4.4
Darkest	HQ >10.0 or pH <4.4

Table 9.3 Summary of Pore Water Central Tendency Exposure (CTE) Low Hardness Chronic Ecological Screening Value Hazard Quotients (HQs) for Benthic Macroinvertebrates. Note that only contaminants that had at least one CTE low-effect HQ>1 (acute or chronic) in at least one exposure unit are summarized.

Exposure unit	Location	pH[a]	Aluminum[b]	Beryllium	Cadmium	Copper	Iron	Lead	Manganese	Zinc
EU-01	Lower Mineral Creek	5.82	29.0/4.23		0.84		6.01			
EU-02	Lower Mineral Creek	4.05	92.4/28.2		1.21	1.27	39.9	26.1		1.77
EU-03	Middle Mineral Creek	6.06	63.5/8.27		1.86		8.48			2.32
EU-04	Upper Mineral Creek				3.88	1.11				4.85
EU-05	South Fork Mineral Creek	4.01	91.4/5.53		1.61		27.7			
EU-06	Middle Fork Mineral Creek	3.94	134/8.14		1.22		35.7			
EU-07	Mainstem Animas River		12.4/2.24		1.72	1.67	1.37	1.96	1.52	1.69
EU-08	Cunningham Creek		44.3/8.14				4.96			
EU-09	Mainstem Animas River		11.8/2.27		1.04		1.59			2.57
EU-10	Mainstem Animas River	6.35	7.78/0.94		4.37				0.96	3.99
EU-11	Upper South Fork Animas River		6.72/0.59				1.63			
EU-12	Eureka Gulch		2.56/0.38							1.45
EU-13	Lower South Fork Animas River	6.50	1.94/0.19							
EU-14	Mainstem Animas River	5.40	193/29.2	1.59	11.9	1.43	3.32	1.54	3.66	11.7
EU-15	Lower West Fork Animas River	5.46	55.5/42.6	1.82	12.0	2.25	5.67	9.63		17.0
EU-16	Placer Gulch	6.09	15.2/3.22		6.59	1.09		1.62		10.4
EU-17	Upper West Fork Animas River	-	137/13.8	1.22	18.6	2.37	1.79		12.1	19.1
EU-18	North Fork Animas River	4.83	78.7/17.8		22.0	1.89	1.56	3.45	0.96	12.0
EU-19	Burrows Gulch	4.63	163/49.5	1.07	53.4	8.10	1.48	3.35	3.26	34.5
EU-DR01	Animas River - upper Durango Reach					0.80			2.48	
EU-DR02	Animas River - lower Durango Reach								1.44	
EU-R1	Mineral Creek trib. - Bear Creek	6.30	7.37/2.04							
EU-R2	Mineral Creek trib. - Mill Creek	6.02	2.43/0.78							
EU-R3	Animas River trib - Maggie Gulch									
EU-R4	Animas River trib - Picayne Gulch									
EU-R5	Animas River trib - upper N. Fork Animas R.	5.78			1.57		1.78			
EU-R6	Durango Reach trib. - Hermosa Creek									

[a] Reported pH values are CTEs of all pH measurements collected from each EU; not HQs

[b] Two aluminum HQs were derived; one using the 87 µg/L default criteria and the other using the hardness-dependent criteria, respectively. Color coding refers to the hardness-dependent criteria HQ results

Color code definitions:

WHITE (no value)	Not a contaminant of potential ecological concern
Lightest	HQ <1.0 or pH >6.5
	HQ >1.0 but <5.0 or pH <6.5 but >5.5
	HQ >5.0 but <10.0 or pH <5.5 but >4.4
Darkest	HQ >10.0 or pH <4.4

Table 9.4 Summary of Amphipod 10-day Sediment Toxicity Test Performance and Low-Effect Ecological Screening Value (ESV) Sediment Hazard Quotients (HQs). Note that only contaminants of potential ecological concern that had at least one low-effect ESV HQ>1 and minimum overlying water pH values were presented.

Exposure unit	Location ID	Percent survival	Sig. reduced survival[a]	Sig. reduced biomass[a]	Min. pH	Arsenic	Cadmium	Copper	Iron	Lead	Manganese	Zinc	Test sediment collection
EU-01	M34	9%	Yes	Yes	6.17	0.64	0.21	0.61	1.56	1.19	1.11	0.70	November 2012
		10%	Yes	Yes	6.53	0.94	0.46	0.78	1.41	1.47	0.89	1.60	October 2016
EU-02	M27	0%	Yes	Yes	3.77	1.22	0.31	0.44	1.57	2.15	0.69	1.18	October 2016
EU-03	M14B	25%	Yes	Yes	3.85	2.42	1.22	0.67	1.13	3.27	0.79	4.84	October 2016
EU-04	M10A	39%	Yes	Yes	6.54	4.55	2.51	1.57	1.00	10.7	1.47	10.8	October 2016
EU-05	M28	70%	Yes	Yes	6.68	0.38	0.23	0.12	0.45	0.66	0.93	0.61	October 2016
EU-06	M20	0%	Yes	Yes	3.16	0.40	0.05	0.14	3.58	0.61	0.52	0.15	October 2016
EU-07	A55	60%	Yes	Yes	6.99	0.55	1.54	1.36	0.52	9.61	6.05	4.18	November 2014
	A56	63%	No	No	7.01	2.41	1.85	2.05	0.72	16.2	5.47	7.69	October 2012
		44%	Yes	Yes	7.03	0.61	2.33	1.64	0.54	9.22	8.41	7.02	September 2014
		49%	Yes	Yes	6.44	0.55	2.05	1.68	0.59	12.03	7.58	4.95	October 2016
EU-08	A48	55%	Yes	Yes	6.74	0.32	0.48	0.45	0.53	2.67	0.84	0.97	October 2016
EU-09	A45	50%	Yes	Yes	6.77	0.82	2.37	2.31	0.59	15.0	9.18	4.92	October 2016
	A45 Dup.	68%	Yes	Yes	6.76	0.81	2.63	2.21	0.59	15.3	9.45	5.10	October 2016
EU-10	A40	64%	Yes	Yes	5.45	1.05	3.05	2.91	0.61	17.9	12.1	5.90	October 2016
EU-11	A36	35%	Yes	Yes	6.67	1.10	0.26	0.70	1.45	3.16	1.45	0.78	October 2016
EU-12	A37	35%	Yes	Yes	6.70	0.56	2.23	1.43	0.81	4.12	6.00	5.71	October 2016
EU-13	A34	60%	Yes	Yes	6.76	0.72	1.67	1.56	1.02	6.81	4.36	4.64	October 2016
EU-14	A33	56%	Yes	Yes	6.04	4.45	2.27	2.21	0.66	10.9	7.29	6.17	October 2016
EU-15	A10	16%	Yes	Yes	6.38	1.03	1.07	1.34	0.52	10.8	5.09	2.51	October 2016
EU-16	A20	54%	Yes	Yes	6.38	1.58	5.02	4.83	0.61	40.5	15.8	13.3	October 2016
EU-17	A15	1%	Yes	Yes	5.27	0.64	0.27	0.93	0.85	1.04	4.12	1.10	October 2016
EU-18	A08	29%	Yes	Yes	5.38	3.03	2.11	0.70	0.71	3.16	4.09	2.44	October 2016
EU-19	A07	36%	Yes	Yes	4.87	0.87	0.51	0.27	0.34	1.16	2.25	0.49	October 2016
EU-DR01	James Ranch	66%	Yes	Yes	7.08	0.57	0.998	0.72	<0.01	2.27	<0.01	3.77	September 2014
	Oxbow Park	84%	No	No	7.37	0.12	0.51	0.27	0.22	1.03	2.60	1.46	September 2017
	32nd Bridge	88%	No	Yes	5.82	0.26	0.42	0.37	0.38	1.45	2.02	1.76	September 2014
		69%	No	No	7.37	0.11	0.44	0.23	0.22	1.02	2.35	1.44	September 2017
EU-DR02	Rotary Park	81%	No	No	7.67	0.13	0.40	0.29	0.23	1.15	2.34	1.51	September 2017
	Rotary Park Dup.	74%	No	No	7.47	0.15	0.45	0.27	0.28	1.34	2.39	1.64	September 2017
	Lightner Creek	74%	No	Yes	6.13	0.31	0.64	0.28	0.45	0.72	1.05	1.15	September 2014
		79%	No	No	7.77	0.14	0.38	0.17	0.25	0.83	1.78	1.19	September 2017
	Purple Cliffs	31%	Yes	Yes	6.98	0.21	0.22	0.13	0.37	0.28	0.36	0.34	September 2014
		76%	No	No	7.77	0.26	0.54	0.65	0.47	4.70	2.25	5.14	September 2017
EU-R1	M30	76%	No	Yes	6.79	0.32	0.13	0.17	0.34	0.34	0.97	0.46	October 2016
EU-R2	M08	58%	Yes	Yes	6.74	1.20	0.996	0.29	0.60	5.72	2.47	1.82	October 2016
EU-R3	A43	78%	No	Yes	5.86	0.33	0.19	0.20	0.68	0.30	1.35	0.46	October 2016
EU-R4	A26	63%	Yes	Yes	6.18	1.53	0.40	0.30	0.79	0.79	3.67	0.93	October 2016
EU-R5	A05	69%	Yes	Yes	6.72	1.92	1.71	0.26	0.51	1.78	2.48	1.95	October 2016
EU-R6	HC01	3%	Yes	Yes	6.64	0.04	0.04	0.08	0.26	0.05	0.29	0.09	October 2016
	HC02	65%	No	Yes	7.92	0.05	0.03	0.03	0.12	0.03	0.19	0.04	September 2017

[a] Identifies which tests had a statistically significant reduction in survival or biomass than respective control test

Color code definitions:

Lightest	Test survival > 80% or HQ <1.0 or pH >6.5
	Test survival <80% but >50% or HQ >1.0 but <5.0 or pH <6.5 but >5.5
	Test survival <50% but >20% or HQ >5.0 but <10.0 or pH <5.5 but >4.4
Darkest	Test survival <20% or HQ >10.0 or pH <4.4

Table 9.5 Summary of Amphipod 10-day Sediment Toxicity Test Performance and Chronic Ecological Screening Value (ESV) Pore Water Hazard Quotients (HQs). Note that only Contaminants of Potential Ecological Concern (COPEC) that had at least one chronic ESV HQ>1 were presented.

Exposure unit	Location ID	Percent survival	Sig. reduced survival[a]	Sig. reduced biomass[a]	Aluminum	Cadmium	Copper	Iron	Lead	Manganese	Zinc	Test sediment collection
EU-01	M34	9%	Yes	Yes	NA	0.69	0.46	NA	0.04	4.64	0.21	November 2012
		10%	Yes	Yes	NA	2.38	1.52	NA	0.29	1.05	0.58	October 2016
EU-02	M27	0%	Yes	Yes	NA	15.1	8.71	NA	30.4	12.7	9.92	October 2016
EU-03	M14B	25%	Yes	Yes	NA	13.8	10.0	NA	43.2	4.96	12.7	October 2016
EU-04	M10A	39%	Yes	Yes	NA	11.3	2.71	NA	3.91	0.98	6.01	October 2016
EU-05	M28	70%	Yes	Yes	NA	0.35	0.51	NA	0.06	4.995	0.11	October 2016
EU-06	M20	0%	Yes	Yes	NA	10.1	0.62	NA	0.71	26.9	2.40	October 2016
EU-07	A55	60%	Yes	Yes	NA	0.26	1.46	NA	2.70	2.79	0.24	November 2014
	A56	63%	No	No	NA	3.48	6.67	NA	13.3	11.1	0.45	October 2012
		44%	Yes	Yes	NA	2.75	5.19	NA	3.02	6.34	1.05	September 2014
		49%	Yes	Yes	NA	5.21	1.15	NA	0.21	0.49	2.58	October 2016
EU-08	A48	55%	Yes	Yes	NA	5.00	1.53	NA	2.32	0.84	0.30	October 2016
EU-09	A45	50%	Yes	Yes	NA	2.21	0.87	NA	0.16	0.04	1.81	October 2016
	A45 Dup	68%	Yes	Yes	NA	2.37	1.004	NA	0.35	0.05	1.75	October 2016
EU-10	A40	64%	Yes	Yes	NA	0.78	0.88	NA	0.10	0.01	0.98	October 2016
EU-11	A36	35%	Yes	Yes	NA	1.38	1.03	NA	0.06	2.19	0.12	October 2016
EU-12	A37	35%	Yes	Yes	NA	2.17	2.52	NA	0.62	0.04	1.39	October 2016
EU-13	A34	60%	Yes	Yes	NA	3.54	1.45	NA	0.47	0.43	0.75	October 2016
EU-14	A33	56%	Yes	Yes	NA	1.88	1.24	NA	0.49	0.04	1.37	October 2016
EU-15	A10	16%	Yes	Yes	NA	21.6	2.17	NA	5.34	9.52	2.62	October 2016
EU-16	A20	54%	Yes	Yes	NA	15.6	2.28	NA	5.53	1.04	9.67	October 2016
EU-17	A15	1%	Yes	Yes	NA	22.6	3.13	NA	1.76	9.24	14.0	October 2016
EU-18	A08	29%	Yes	Yes	NA	65.0	0.56	NA	0.71	10.5	1.85	October 2016
EU-19	A07	36%	Yes	Yes	NA	86.6	4.85	NA	4.16	6.90	15.1	October 2016
EU-DR01	James Ranch	66%	Yes	Yes	NA	2.15	1.19	NA	0.20	4.58	0.32	September 2014
	Oxbow Park	84%	No	No	3.96[b]	0.22	0.23	13.0	0.01	0.01	0.07	September 2017
	32nd Bridge	88%	No	Yes	NA	0.42	0.17	NA	0.15	2.11	0.17	September 2014
		69%	No	No	1.22	0.52	0.70	2.39	0.24	3.19	0.14	September 2017
EU-DR02	Rotary Park	81%	No	No	4.85[b]	0.55	0.20	14.3	0.01	1.50	0.18	September 2017
	Rotary Park Dup.	74%	No	No	1.98[b]	0.66	0.20	6.32	0.02	1.55	0.23	September 2017
	Lightner Creek	74%	No	Yes	NA	0.09	0.09	NA	0.06	0.82	0.08	September 2014
		79%	No	No	4.19[b]	0.21	0.17	13.1	0.01	0.36	0.12	September 2017
	Purple Cliffs	31%	Yes	Yes	NA	0.10	0.13	NA	0.05	0.15	0.11	September 2014
		76%	No	No	2.66[b]	0.16	0.27	9.38	0.06	0.99	0.09	September 2017
EU-R1	M30	76%	No	Yes	NA	0.37	1.54	NA	0.22	2.38	0.08	October 2016
EU-R2	M08	58%	Yes	Yes	NA	3.32	2.07	NA	0.61	0.30	0.50	October 2016
EU-R3	A43	78%	No	Yes	NA	0.47	0.88	NA	0.05	1.10	0.03	October 2016
EU-R4	A26	63%	Yes	Yes	NA	0.17	0.34	NA	0.04	1.66	0.08	October 2016
EU-R5	A05	69%	Yes	Yes	NA	3.04	2.35	NA	2.35	0.44	0.80	October 2016
EU-R6	HC01	3%	Yes	Yes	NA	0.08	0.10	NA	0.01	0.06	0.03	October 2016
	HC02	65%	No	Yes	55.4[b]	0.06	0.08	64.5	0.01	0.47	0.02	September 2017

NA = Total recoverable metals not measured in sediment toxicity test overlying water; therefore, chemistry results were not available.

[a] Identifies which tests had a statistically significant reduction in survival or biomass than respective control test

[b] Minimum pH was less then 7.0; aluminum HQ derived using the default 87µg/L water quality criteria

Color code definitions:

Lightest	Test survival > 80% or HQ <1.0 or pH >6.5
	Test survival <80% but >50% or HQ >1.0 but <5.0 or pH <6.5 but >5.5
	Test survival <50% but >20% or HQ >5.0 but <10.0 or pH <5.5 but >4.4
Darkest	Test survival <20% or HQ >10.0 or pH <4.4

Table 9.6 Summary of Benthic Macroinvertebrate Community Composition Metrics from Mountain Studies Institute (2016; 2017) September 2015 and 2016 Field Surveys.

Exposure unit	Location ID	Location	MMI-based impairment status	MMI score	Density (#/meter^2)	Total # of taxa	H'	HBI	EPT index[a]	Ephemeroptera abundance[b]	Percent EPT[c]	Habitat[c]
EU-01	M34	Lower Mineral Creek	Impaired - 4	42.8	157	11	1.23	2.31	55%	1%	90%	Suboptimal
EU-02	M27	Lower Mineral Creek	Impaired - 3	20.8	78	12	1.42	4.77	25%	0%	27%	Suboptimal
EU-03	M14B	Middle Mineral Creek	Impaired - 3	45.0	104	15	1.60	2.38	47%	1%	88%	Optimal
	M13B[d]	Middle Mineral Creek	Not impaired - 1	54.9	2671	22	1.43	2.09	55%	7%	92%	
EU-04	M10A	Upper Mineral Creek	Not impaired - 1	56.2	345	24	2.39	2.97	46%	2%	61%	Suboptimal
EU-05	M26B[d]	South Fork Mineral Creek	Not impaired - 2	77.1	248	28	2.22	2.31	64%	4%	89%	Optimal
	M28	South Fork Mineral Creek	Not impaired - 2	51.6	444	21	1.90	3.65	71%	2%	68%	
EU-06	M20	Middle Fork Mineral Creek	Impaired - 3	26.6	41	14	2.00	4.47	43%	0%	30%	Optimal
EU-07	A56	Mainstem Animas River	Impaired - 4	47.3	1763	23	2.25	3.90	57%	19%	48%	Optimal
EU-08	A48	Cunningham Creek	Not impaired - 2	79.0	4188	29	2.08	1.58	66%	23%	91%	Suboptimal
EU-09	A45	Mainstem Animas River	Not impaired - 2	63.1	2361	26	2.01	2.66	58%	29%	76%	Suboptimal
EU-10	A40	Mainstem Animas River	Not impaired - 1	52.2	500	21	2.02	3.31	52%	2%	68%	Suboptimal
EU-11	A36	Upper South Fork Animas River	Impaired - 3	48.0	581	17	1.00	2.46	47%	1%	88%	Optimal
	A36A[d]	Upper South Fork Animas River	Not impaired - 1	73.7	4682	30	2.23	1.91	57%	36%	87%	
EU-12	A37	Eureka Gulch	Not impaired - 1	57.8	541	27	2.48	2.93	48%	7%	66%	Suboptimal
EU-13	A34	Lower South Fork Animas River	Not impaired - 1	63.0	1250	20	1.68	2.13	55%	8%	91%	Optimal
EU-14	A33	Mainstem Animas River	Impaired - 3	43.4	226	9	1.32	1.56	89%	0%	99%	Optimal
EU-15	A10	Lower West Fork Animas River	Impaired - 3	21.8	10	5	1.52	3.25	40%	0%	58%	Optimal
EU-16	A20	Placer Gulch	Impaired - 3	30.0	30	2	0.13	1.97	100%	0%	100%	Optimal
EU-17	A15	Upper West Fork Animas River	Impaired - 3	29.3	35	14	2.24	3.90	36%	0%	50%	Optimal
EU-18	A09	North Fork Animas River	Impaired - 3	34.2	10	8	1.81	3.00	50%	0%	67%	Suboptimal
EU-19	A07	Burrows Creek	Impaired - 3	20.7	1012	12	1.16	7.37	25%	0%	5%	Optimal
EU-DR01	James Ranch	James Ranch - Fall 2015	Not impaired - 2	52.6	563	18	1.56	3.90	44%	66%	84%	NA
		James Ranch - Fall 2016	Not impaired - 2	63.5	2400	22	2.00	6.00	NA	NA	NA	NA
	Oxbow Park	Oxbow Park - Fall 2015	Impaired - 2	33.6	13118	20	2.00	6.50	5%	0%	1%	NA
	32nd St. Bridge	32nd St. Bridge - Fall 2015	Impaired - 2	41.8	23978	15	1.85	6.00	33%	3%	28%	NA
		32nd St. Bridge - Fall 2016	Impaired - 2	48.3	4000	20	2.20	5.00	NA	NA	NA	NA
EU-DR02	Rotary Park	Rotary Park - Fall 2015	Impaired - 1	44.8	8574	15	2.19	5.90	33%	15%	38%	NA
	Lightner Creek	Lightner Creek - Fall 2015	Impaired - 2	46.1	11538	24	2.26	5.40	33%	25%	67%	NA
		Lightner Creek - Fall 2016	Impaired - 2	46.0	4000	18	2.00	5.40	NA	NA	NA	NA
	Purple Cliffs	Purple Cliffs - Fall 2015	Not impaired - 2	53.4	16259	18	1.85	4.80	33%	26%	70%	NA
		Purple Cliffs - Fall 2016	Impaired - 2	45.7	24700	18	1.90	5.00	NA	NA	NA	NA
EU-R1	M30	Mineral Creek trib. - Bear Creek	Not impaired - 2	71.8	2463	30	2.58	3.07	57%	19%	69%	Optimal
EU-R2	M08	Mineral Creek trib. - Mill Creek	Not impaired - 2	61.9	10991	25	2.10	1.84	56%	39%	91%	Optimal
EU-R3	A43	Animas River trib - Maggie Gulch	Not impaired - 2	63.8	10393	28	1.91	2.06	54%	10%	84%	Optimal
EU-R4	A26	Animas River trib - Picayne Gulch	Not impaired - 2	68.5	6198	27	1.80	2.24	63%	15%	94%	Optimal
EU-R5	A05	Animas River trib - upper N. Fork Animas R.	Not impaired - 1	76.3	1234	33	2.40	2.47	48%	18%	86%	Optimal
EU-R6	HC01	Durango Reach trib. - Hermosa Creek	Not impaired - 2	66.0	1538	33	2.13	4.16	48%	46%	80%	Suboptimal

MMI = Multi-Metric Index (Colorado)

H' = Shannon-Weaver Diversity Index

HBI = Hilsenhoff Biotic Index

EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), and Tricoptera (caddisflies)

[a] EPT Index = Number of EPT taxa / total number of taxa

[b] Ephemeroptera Abundance = Number of Ephemeroptera individuals / total number of individuals (all taxa)

[c] Percent EPT = Number of EPT individuals / total number of individuals (all taxa)

[d] Note that this was not a representative site for respective EUs, but included here for completeness.

[e] Habitat ratings based on average Barbour et al. (1999) habitat evaluation parameter scores obtained from respective Mountain Studies Institute benthic macroinvertebrate assessment reports

Impairment status reasoning definitions:

1 = No aquatic life use designation for this reach, but theoretically MMI score would indicate attainment of aquatic life use designation attainment classes 1 and 2

2 = MMI score indicates attainment of site aquatic life use designation

3 = No aquatic life use designation for this reach, but theoretically MMI score would indicate impairment for aquatic life use designation attainment classes 1 or 2

4 = MMI score indicates nonattainment of site aquatic life use designation

Color code definitions:

GREEN	MMI score above attainment threshold
GREY	MMI score below attainment threshold, but above impairment threshold (grey zone)
BLUE	MMI below impairment threshold
ORANGE	MMI score between attainment and impairment thresholds, but Shannon Diversity (H') was lower or Hilsenhoff Biotic (HBI) Indices was greater than respective aquatic life use Class 1 impairment thresholds identified in the EPA (2016d) aquatic BERA work plan.

Table 9.7 Summary of Surface Water Central Tendency Exposure (CTE) Minimum Hardness Acute Ecological Screening Value Hazard Quotients (HQs) for Aquatic Community-Level Receptors. Note that only contaminants that had at least one CTE low-effect HQ>1 (acute or chronic) in at least one exposure unit are summarized.

Exposure unit	Location	pH[a]	Aluminum	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Zinc
EU-01	Lower Mineral Creek	5.42	0.95		0.42				0.01	1.19
EU-02	Lower Mineral Creek	4.66	1.60		0.74	1.08	0.10			1.98
EU-03	Middle Mineral Creek	6.53	0.75		0.71	2.05	0.25			2.14
EU-04	Upper Mineral Creek		0.37	0.05	1.22	3.26	0.46			4.85
EU-05	South Fork Mineral Creek		0.34							
EU-06	Middle Fork Mineral Creek	4.34	1.27		0.26					
EU-07	Mainstem Animas River		0.12		0.60	0.66				2.19
EU-08	Cunningham Creek		0.13							
EU-09	Mainstem Animas River	6.43	0.30		1.22	1.42				4.30
EU-10	Mainstem Animas River		0.45		1.89	2.28	0.04	0.39		6.17
EU-11	Upper South Fork Animas River		0.22							-
EU-12	Eureka Gulch		0.19		2.55	1.77				9.72
EU-13	Lower South Fork Animas River		0.40		1.32	1.36	0.04	-		4.84
EU-14	Mainstem Animas River	4.31	1.42	0.06	3.70	3.41	0.09	2.05		11.1
EU-15	Lower West Fork Animas River	5.37	1.85	0.06	4.57	3.19	0.17	4.79		17.4
EU-16	Placer Gulch	6.04	0.90		3.53	3.84	0.29	0.76		15.4
EU-17	Upper West Fork Animas River	5.29	3.47	0.16	6.57	1.87	0.07	7.57		22.0
EU-18	North Fork Animas River	5.02	2.57	0.11	6.46	2.22	0.20	0.59		12.9
EU-19	Burrows Gulch	4.57	13.6	0.21	25.9	12.4	0.40	2.21		46.4
EU-DR01	Animas River - upper Durango reach		0.34						0.01	
EU-DR02	Animas River - lower Durango reach	6.79	0.77		0.11				0.01	
EU-R1	Mineral Creek trib. - Bear Creek									
EU-R2	Mineral Creek trib. - Mill Creek		0.23	0.09			0.06			
EU-R3	Animas River trib - Maggie Gulch		0.28							
EU-R4	Animas River trib - Picayne Gulch		0.21	-			-			
EU-R5	Animas River trib - upper N. Fork Animas R.		0.91	0.10	3.30		0.05			5.48
EU-R6	Durango Reach trib. - Hermosa Creek									

[a] Reported pH values are lowest CTEs of all pH measurements collected from each EU and hydroperiod; not HQs

Color code definitions:

WHITE (no value)	Not a contaminant of potential ecological concern
Lightest	HQ <1.0 or pH >6.5
	HQ >1.0 but <5.0 or pH <6.5 but >5.5
	HQ >5.0 but <10.0 or pH <5.5 but >4.4
Darkest	HQ >10.0 or pH <4.4

Table 9.8 Summary of Surface Water Central Tendency Exposure (CTE) Minimum Hardness Chronic Ecological Screening Value Hazard Quotients (HQs) for Aquatic Community-Level Receptors. Note that only contaminants that had at least one CTE low-effect HQ>1 (acute or chronic) in at least one exposure unit are summarized.

Exposure unit	Location	pH[a]	Aluminum[b]	Beryllium	Cadmium	Copper	Iron	Lead	Manganese	Mercury	Zinc
EU-01	Lower Mineral Creek	5.42	40.4/6.65		1.79		4.81			4.00	1.58
EU-02	Lower Mineral Creek	4.66	61.8/11.2		2.87	1.62	6.90	2.54			2.61
EU-03	Middle Mineral Creek	6.53	8.22/5.23		2.53	2.80	1.03	6.31			2.83
EU-04	Upper Mineral Creek		3.24/2.62	0.96	4.88	4.45		11.8			6.40
EU-05	South Fork Mineral Creek		7.05/2.36				0.86				
EU-06	Middle Fork Mineral Creek	4.34	147/8.9		1.10		18.8				
EU-07	Mainstem Animas River		3.87/0.85		2.35	0.98	0.33				2.90
EU-08	Cunningham Creek		1.63/0.90		-	-					
EU-09	Mainstem Animas River	6.43	4.10/2.10		4.48	2.00					5.68
EU-10	Mainstem Animas River		5.81/3.16		6.92	3.18		0.99	0.70		8.15
EU-11	Upper South Fork Animas River		5.88/1.55								
EU-12	Eureka Gulch		2.92/1.32		9.46	2.51					12.8
EU-13	Lower South Fork Animas River		10.9/2.77		4.88	1.92	0.58	1.01			6.39
EU-14	Mainstem Animas River	4.31	28.8/9.95	1.11	12.9	4.61		2.25	3.70		14.6
EU-15	Lower West Fork Animas River	5.37	75.6/12.9	1.10	18.7	4.32		4.48	8.67		23.0
EU-16	Placer Gulch	6.04	10.6/6.31		12.5	5.24		7.43	1.38		20.4
EU-17	Upper West Fork Animas River	5.29	114/24.3	2.79	26.5	2.81		1.84	13.7		29.0
EU-18	North Fork Animas River	5.02	40.4/18.0	1.92	23.5	3.18		5.02	1.08		17.1
EU-19	Burrows Gulch	4.57	110/94.9	3.82	91.0	16.8		10.2	3.99		61.3
EU-DR01	Animas River - upper Durango Reach		31.0/11.1				4.70			4.00	
EU-DR02	Animas River - lower Durango Reach	6.79	16.9/5.40		0.44		6.92			4.00	
EU-R1	Mineral Creek trib. - Bear Creek										
EU-R2	Mineral Creek trib. - Mill Creek		3.05/1.62	1.57				1.55			
EU-R3	Animas River trib - Maggie Gulch		3.44/1.98								
EU-R4	Animas River trib - Picayne Gulch		2.30/1.45								
EU-R5	Animas River trib - upper N. Fork Animas R.		4.77/6.35	1.78	11.2			1.26			7.24
EU-R6	Durango Reach trib. - Hermosa Creek										

[a] Reported pH values are lowest CTEs of all pH measurements collected from each EU and hydroperiod; not HQs

[b] Two aluminum HQs were derived; one using the 87 µg/L default criteria and the other using the hardness-dependent criteria, respectively. Color coding refers to the hardness-dependent criteria

Color code definitions:

WHITE (no value)	Not a contaminant of potential ecological concern
Lightest	HQ <1.0 or pH >6.5
	HQ >1.0 but <5.0 or pH <6.5 but >5.5
	HQ >5.0 but <10.0 or pH <5.5 but >4.4
Darkest	HQ >10.0 or pH <4.4

Table 9.9 Summary of Rainbow Trout Acute Surface Water Toxicity Test Performance and Maximum Acute Ecological Screening Value (ESV) Exposure Water Hazard Quotients (HQs). Note that only metals that had at least one acute ESV HQ>1 and minimum overlying water pH values were presented.

Exposure unit	Location ID	Percent survival	Sig. reduced survival[a]	Minimum pH	Aluminum	Cadmium	Copper	Manganese	Zinc	Test water collection
EU-01	M34	0%	Yes	5.45	0.45	0.19	0.20	0.14	0.56	November 2012
		15%	Yes	4.98	0.33	0.35	0.25	0.11	1.01	April 2013
		73%	No	6.82	0.33	0.17	0.09	0.08	0.48	October 2016
EU-02	M27	0%	Yes	5.25	0.61	0.27	0.30	0.17	0.68	October 2016
EU-03	M14B	98%	No	6.88	0.16	0.37	0.37	0.06	1.13	October 2016
EU-04	M10A	95%	No	7.25	0.08	0.99	0.73	0.08	3.90	October 2016
EU-05	M28	100%	No	7.19	0.14	0.07	0.07	0.02	0.12	October 2016
EU-06	M20	0%	Yes	5.00	1.31	0.27	0.15	0.23	0.34	October 2016
EU-07	A56	100%	No	7.00	0.01	0.16	0.03	0.03	0.64	October 2012
		100%	No	7.50	0.02	0.29	0.13	0.10	1.12	October 2016
EU-08	A48	100%	No	7.29	0.01	0.11	0.12	<0.01	0.16	October 2016
EU-09	A45	100%	No	7.24	0.01	0.25	0.12	0.04	1.24	October 2016
EU-10	A40	100%	No	7.16	0.07	0.74	0.25	0.34	2.61	October 2016
EU-11	A36	100%	No	7.12	0.06	0.10	0.15	0.04	0.24	October 2016
EU-12	A37	100%	No	7.60	0.01	0.33	0.27	0.03	1.64	October 2016
EU-13	A34	98%	No	7.28	0.03	0.26	0.30	0.04	0.99	October 2016
EU-14	A33	98%	No	7.22	0.15	1.70	0.34	0.80	4.99	October 2016
EU-15	A10	0%	Yes	5.71	1.21	3.58	1.38	3.39	13.02	October 2016
EU-16	A20	70%	No	6.81	0.24	1.67	0.84	0.27	8.12	October 2016
EU-17	A15	0%	Yes	5.50	1.60	4.13	1.17	5.42	13.77	October 2016
EU-18	A08	0%	Yes	5.17	2.03	5.38	1.77	0.73	9.80	October 2016
EU-19	A07	0%	Yes	5.08	5.71	14.1	4.99	1.76	25.56	October 2016
EU-R1	M30	100%	No	7.31	0.02	0.04	0.08	<0.01	0.04	October 2016
EU-R2	M08	98%	No	7.13	0.13	0.24	0.17	0.05	0.51	October 2016
EU-R3	A43	100%	No	7.83	0.02	0.03	0.09	0.01	0.03	October 2016
EU-R4	A26	98%	No	7.09	0.01	0.02	0.05	0.05	0.06	October 2016
EU-R5	A05	100%	No	6.81	<0.01	0.48	0.10	<0.01	0.99	October 2016
EU-R6	HC01	100%	No	NA	<0.01	0.01	0.03	<0.01	0.01	October 2016

NA = Not available

Color code definitions:

Lightest	Test survival > 80% or HQ <1.0 or pH >6.5
	Test survival <80% but >50% or HQ >1.0 but <5.0 or pH <6.5 but >5.5
	Test survival <50% but >20% or HQ >5.0 but <10.0 or pH <5.5 but >4.4
Darkest	Test survival <20% or HQ >10.0 or pH <4.4

Table 9.10 Summary of Trout Species Observed During Historic and Fall 2016 United State Geological Survey ([USGS] 2018) Fish Community Surveys. Superscript numbers next to each fish species code or survey result correspond to the list of numbered references provided below this table.

Exposure unit	Location	Trout spp. obs. (historic surveys)	USGS 2016[12]
EU-01	Lower Mineral Creek	No fish[3]	RBT, BRK
EU-02	Lower Mineral Creek	No fish[3]	No fish[b]
EU-03	Middle Mineral Creek	No fish[3]	BRK
EU-04	Upper Mineral Creek	No fish[3]	Unknown[c]
EU-05	South Fork Mineral Creek	RBT[3]; BRK[3,5]	RBT; BRK
EU-06	Middle Fork Mineral Creek	No fish[3]	Unknown[c]
EU-07	Mainstem Animas River	RBT[1]; BRK[3]	Not surveyed
EU-08	Cunningham Creek	CTT[7]; RBT[1]; BRK[1,4,7]	CTT; BRK
EU-09	Mainstem Animas River	RBT[7]; BRK[3-5,7-10]	BRK
EU-10	Mainstem Animas River	No fish[1,5]	Not surveyed
EU-11	Upper South Fork Animas River[a]	Not surveyed	No fish
EU-12	Eureka Gulch	No fish[1]	No fish
EU-13	Lower South Fork Animas River[a]	No fish[1,5]	No fish
EU-14	Mainstem Animas River	No fish[1,3]	No fish
EU-15	Lower West Fork Animas River	No fish[3]	No fish
EU-16	Placer Gulch	Not surveyed	No fish
EU-17	Upper West Fork Animas River	No fish[3]	No fish
EU-18	North Fork Animas River	No fish[3]	No fish
EU-19	Burrows Gulch	No fish[1]	No fish
EU-DR01	Animas River - upper Durango Reach	RBT; BRK; LOC[1,6]	Not surveyed
EU-DR02	Animas River - lower Durango Reach	RBT; LOC[1,7-10]	Not surveyed
EU-R1	Mineral Creek trib. - Bear Creek	No fish[2]	No fish
EU-R2	Mineral Creek trib. - Mill Creek	No fish[3]	BRK
EU-R3	Animas River trib - Maggie Gulch	CTT; BRK[7]	CTT; BRK
EU-R4	Animas River trib - Picayne Gulch	No fish[1]	Unknown[c]
EU-R5	Animas River trib - upper N. Fork Animas R.	RBT (stocked)[1]	BRK
EU-R6	Durango Reach trib. - Hermosa Creek	CTT[11]	Not surveyed

RBT = Rainbow trout; BRK = Brook trout; LOC = Brown trout; CTT = Cutthroat trout

[a] Historic fish survey sources report that South Fork Animas River was surveyed; it was assumed that surveys were conducted in the lower section of this tributary

[b] A brook trout was observed in this reach during runoff (7/6/16), but no fish were captured during electrofishing in the fall (10/9/16)

[c] Qualitative observations occurred within in these reaches, but the reaches were not electroshocked

References:

[1] Smith, N.F. 1976. Aquatic inventory: Animas La Plata project. Colorado Division of Wildlife, Durango, CO

[2] Horn, B. 1988. Biological assessment of Maggie Gulch. Colorado Division of Wildlife, Denver, CO.

[3] Colorado Department of Health. 1992. Animas River Basin Fish Sampling Summary. Water Quality Control Division

[4] Colorado Division of Wildlife. 1994. Fish distribution ticket tabulation. Durango Area Office, CO.

[5] Brantlinger, B. 1998. Brook trout fry sampling in the upper Animas River. U.S. Forest Service, Durango, CO

[6] Japhet, M. 1998. Results of the 1997 small fishes sampling in the Animas River. Colorado Division of Wildlife. Durango Area Office, CO.

[7] Colorado Parks and Wildlife. 2010. 2010 Animas River Report. San Juan Basin. Colorado Division of Wildlife, Durango, CO.

[8] Colorado Parks and Wildlife. 2014. 2014 Animas River #1 & #2 (Gold Medal and Standard Reaches) Report. San Juan Basin. Colorado Division of Wildlife, Durango, CO.

[9] Colorado Parks and Wildlife. 2015. 2015 Animas River #1 & #2 (Gold Medal and Standard Reaches) Report. San Juan Basin. Colorado Division of Wildlife, Durango, CO.

[10] Colorado Parks and Wildlife. 2016a. 2016 Animas River #1 & #2 (Gold Medal and Standard Reaches) Report. San Juan Basin. Colorado Division of Wildlife, Durango, CO.

[11] Colorado Parks and Wildlife. 2017b. Native cutthroat trout reintroduction program continues in Southwest Colorado. CPW News Release.

[12] United State Geological Survey (USGS). 2018. Bonita Peak Mining District Fall 2016 Fish Habitat and Community Survey Data Report.

Table 9.11 Summary of United State Geological Survey ([USGS] 2018) Fish Thermal Suitability and Habitat Assessment Results. Shaded rows designate EUs where fish were observed during USGS (2018) and/or historic fish surveys.

Exposure unit	Location	Intermittency or freezing?	Thermal suitability	Physical habitat potential[3]
EU-01	Lower Mineral Creek	No	CTT[2]	NA
EU-02	Lower Mineral Creek	No	CTT[2]	NA
EU-03	Middle Mineral Creek	No	NA	NA
EU-04	Upper Mineral Creek	No	CTT[2]	NA
EU-05	South Fork Mineral Creek	No	Below CTT temp. range[2]	NA
EU-06	Middle Fork Mineral Creek	No	Below CTT temp. range[2]	NA
EU-07	Mainstem Animas River	No	NA	NA
EU-08	Cunningham Creek	No	BRK[1]; CTT[1,2]	Good
EU-09	Mainstem Animas River	No	BRK[1]; CTT[1,2]	Good
EU-10	Mainstem Animas River	No	NA	NA
EU-11	Upper South Fork Animas River	No	Below CTT temp. range[2]	NA
EU-12	Eureka Gulch	No	BRK[1]; Below CTT temp. range[2]	Fair
EU-13	Lower South Fork Animas River	No	BRK[1]; Below CTT temp. range[2]	Poor
EU-14	Mainstem Animas River	No	BRK[1]; CTT[1]	Good
EU-15	Lower West Fork Animas River	No	BRK[1]; Below CTT temp. range[2]	Good
EU-16	Placer Gulch	No	BRK[1]; Below CTT temp. range[2]	Fair
EU-17	Upper West Fork Animas River	No	BRK[1]; Below CTT temp. range[2]	Fair
EU-18	North Fork Animas River	NA	BRK[1]	Fair
EU-19	Burrows Gulch	No	BRK[1]; Below CTT temp. range[2]	Poor
EU-DR01	Animas River - upper Durango Reach	No	NA	NA
EU-DR02	Animas River - lower Durango Reach	No	NA	NA
EU-R1	Mineral Creek trib. - Bear Creek	No	NA	NA
EU-R2	Mineral Creek trib. - Mill Creek	No	Below CTT temp. range[2]	NA
EU-R3	Animas River trib - Maggie Gulch	No	BRK[1]; CTT[1]	Good
EU-R4	Animas River trib - Picayne Gulch	NA	NA	NA
EU-R5	Animas River trib - upper N. Fork Animas I	No	BRK[1]; Below CTT temp. range[2]	Fair
EU-R6	Durango Reach trib. - Hermosa Creek	No	NA	NA

BRK = Brook trout

CTT = Cutthroat trout

NA = Not assessed or stream temperature, intermittency, relative conductivity logger was lost

[1] Thermal suitability determined using Harig and Fausch (2002) realized thermal niche rankings

[2] Thermal suitability determined by USGS (2018) using temperature data obtained from Rocky Mountain rivers and steams

[3] Fish habitat ratings were obtained from Table 15 in the USGS (2018) Fish Habitat and Community Survey Data Report; fish habitat ratings were based on physical habitat parameters (gradient/slope, depth, substrate composition, bank stability, riparian composition, and presence of pools and large woody debris) measured and observed in each survey reach.

Table 9.12 Summary of Central Tendency Exposure Low-Effect Toxicity Reference Value Hazard Quotients (HQs) for American Dipper. Note that only contaminants that had at least one HQ>1 in at least one Exposure Unit (EU) among all wildlife receptors are summarized.

Exposure unit	Location	Copper	Lead	Selenium
EU-01	Lower Mineral Creek	0.84	3.31	0.44
EU-02	Lower Mineral Creek	0.19	2.24	0.24
EU-03	Middle Mineral Creek	0.41	3.45	0.12
EU-04	Upper Mineral Creek	1.30	16.1	0.08
EU-05	South Fork Mineral Creek	0.11	0.53	0.20
EU-06	Middle Fork Mineral Creek	0.27	0.75	0.45
EU-07	Mainstem Animas River	1.07	11.5	0.38
EU-08	Cunningham Creek	0.52	2.84	0.26
EU-09	Mainstem Animas River	1.09	9.16	0.14
EU-10	Mainstem Animas River	1.17	8.30	0.14
EU-11	Upper South Fork Animas River	0.16	1.14	0.20
EU-12	Eureka Gulch	1.18	4.78	0.12
EU-13	Lower South Fork Animas River	0.78	3.89	0.16
EU-14	Mainstem Animas River	0.86	5.54	0.07
EU-15	Lower West Fork Animas River	4.09	10.3	0.18
EU-16	Placer Gulch	1.84	35.8	0.35
EU-17	Upper West Fork Animas River	2.59	1.90	0.30
EU-18	North Fork Animas River	1.14	2.79	0.30
EU-19	Burrows Gulch	0.53	3.13	0.11
EU-DR01	Animas River - upper Durango Reach	0.77	2.04	1.05
EU-DR02	Animas River - lower Durango Reach	0.51	1.27	0.31
EU-R1	Mineral Creek trib. - Bear Creek	0.11	0.30	0.38
EU-R2	Mineral Creek trib. - Mill Creek	0.10	2.01	0.14
EU-R3	Animas River trib - Maggie Gulch	0.10	0.21	0.30
EU-R4	Animas River trib - Picayne Gulch	0.10	0.51	0.19
EU-R5	Animas River trib - upper N. Fork Animas R.	0.13	1.44	0.15
EU-R6	Durango Reach trib. - Hermosa Creek	0.07	0.07	0.33

Color code definitions:

Lightest	HQ <1.0
	HQ >1.0 but <5.0
	HQ >5.0 but <10.0
Darkest	HQ >10.0

Table 9.13 Summary of Central Tendency Exposure Low-Effect Toxicity Reference Value Hazard Quotients (HQs) for Mallard. Note that only contaminants that had at least one HQ>1 in at least one Exposure Unit (EU) among all wildlife receptors are summarized.

Exposure unit	Location	Copper	Lead	Selenium
EU-01	Lower Mineral Creek	0.14	0.42	0.16
EU-02	Lower Mineral Creek	0.04	0.23	0.07
EU-03	Middle Mineral Creek	0.07	0.36	0.04
EU-04	Upper Mineral Creek	0.19	1.86	0.02
EU-05	South Fork Mineral Creek	0.03	0.06	0.06
EU-06	Middle Fork Mineral Creek	0.05	0.10	0.09
EU-07	Mainstem Animas River	0.16	1.22	0.07
EU-08	Cunningham Creek	0.09	0.27	0.07
EU-09	Mainstem Animas River	0.16	0.75	0.04
EU-10	Mainstem Animas River	0.16	0.67	0.07
EU-11	Upper South Fork Animas River	0.04	0.11	0.06
EU-12	Eureka Gulch	0.18	0.52	0.05
EU-13	Lower South Fork Animas River	0.12	0.35	0.07
EU-14	Mainstem Animas River	0.13	0.44	0.03
EU-15	Lower West Fork Animas River	0.60	0.92	0.04
EU-16	Placer Gulch	0.20	2.48	0.09
EU-17	Upper West Fork Animas River	0.39	0.21	0.06
EU-18	North Fork Animas River	0.18	0.29	0.06
EU-19	Burrows Gulch	0.09	0.31	0.03
EU-DR01	Animas River - upper Durango Reach	0.13	0.25	0.20
EU-DR02	Animas River - lower Durango Reach	0.09	0.14	0.07
EU-R1	Mineral Creek trib. - Bear Creek	0.03	0.04	0.08
EU-R2	Mineral Creek trib. - Mill Creek	0.02	0.19	0.05
EU-R3	Animas River trib - Maggie Gulch	0.03	0.03	0.07
EU-R4	Animas River trib - Picayne Gulch	0.03	0.06	0.05
EU-R5	Animas River trib - upper N. Fork Animas R	0.03	0.16	0.03
EU-R6	Durango Reach trib. - Hermosa Creek	0.02	0.01	0.10

Color code definitions:

Lightest	HQ <1.0
	HQ >1.0 but <5.0
	HQ >5.0 but <10.0
Darkest	HQ >10.0

Table 9.14 Summary of Central Tendency Exposure Low-Effect Toxicity Reference Value Hazard Quotients (HQs) for Belted Kingfisher. Note that only contaminants that had at least one HQ>1 in at least one Exposure Unit (EU) among all wildlife receptors are summarized.

Exposure unit	Location	Copper	Lead	Selenium
EU-01	Lower Mineral Creek	0.12	0.87	2.10
EU-02	Lower Mineral Creek	0.10	1.27	0.96
EU-03	Middle Mineral Creek	0.15	0.69	0.88
EU-04	Upper Mineral Creek	0.21	5.07	0.55
EU-05	South Fork Mineral Creek	0.05	0.11	1.26
EU-06	Middle Fork Mineral Creek	0.05	0.32	0.87
EU-07	Mainstem Animas River	0.20	4.71	0.65
EU-08	Cunningham Creek	0.09	1.68	1.04
EU-09	Mainstem Animas River	0.19	0.85	0.64
EU-10	Mainstem Animas River	0.28	5.48	1.27
EU-11	Upper South Fork Animas River	0.11	0.79	1.01
EU-12	Eureka Gulch	0.18	2.07	1.03
EU-13	Lower South Fork Animas River	0.18	2.46	1.26
EU-14	Mainstem Animas River	0.22	3.81	0.65
EU-15	Lower West Fork Animas River	0.21	5.91	0.48
EU-16	Placer Gulch	0.45	24.8	1.13
EU-17	Upper West Fork Animas River	0.16	0.92	0.65
EU-18	North Fork Animas River	0.10	1.42	0.65
EU-19	Burrows Gulch	0.17	1.71	0.51
EU-DR01	Animas River - upper Durango Reach	0.10	0.77	1.17
EU-DR02	Animas River - lower Durango Reach	0.09	0.64	0.77
EU-R1	Mineral Creek trib. - Bear Creek	0.05	0.20	0.86
EU-R2	Mineral Creek trib. - Mill Creek	0.04	0.38	0.93
EU-R3	Animas River trib - Maggie Gulch	0.06	0.13	0.71
EU-R4	Animas River trib - Picayne Gulch	0.07	0.33	0.63
EU-R5	Animas River trib - upper N. Fork Animas R	0.07	0.79	0.52
EU-R6	Durango Reach trib. - Hermosa Creek	0.04	0.04	1.39

Color code definitions:

Lightest	HQ <1.0
	HQ >1.0 but <5.0
	HQ >5.0 but <10.0
Darkest	HQ >10.0

Table 9.15 Summary of Central Tendency Exposure Low-Effect Toxicity Reference Value Hazard Quotients (HQs) for Muskrat. Note that only contaminants that had at least one HQ>1 in at least one Exposure Unit (EU) among all wildlife receptors are summarized.

Exposure unit	Location	Copper	Lead	Selenium
EU-01	Lower Mineral Creek	0.22	0.27	1.03
EU-02	Lower Mineral Creek	0.17	0.38	0.38
EU-03	Middle Mineral Creek	0.22	0.51	0.23
EU-04	Upper Mineral Creek	0.44	1.39	0.16
EU-05	South Fork Mineral Creek	0.07	0.11	0.32
EU-06	Middle Fork Mineral Creek	0.07	0.11	0.33
EU-07	Mainstem Animas River	0.40	1.30	0.21
EU-08	Cunningham Creek	0.16	0.49	0.42
EU-09	Mainstem Animas River	0.49	1.60	0.21
EU-10	Mainstem Animas River	0.65	1.50	0.55
EU-11	Upper South Fork Animas River	0.19	0.24	0.41
EU-12	Eureka Gulch	0.37	0.60	0.42
EU-13	Lower South Fork Animas River	0.35	0.70	0.55
EU-14	Mainstem Animas River	0.46	1.06	0.21
EU-15	Lower West Fork Animas River	0.44	1.61	0.13
EU-16	Placer Gulch	1.24	6.46	0.47
EU-17	Upper West Fork Animas River	0.31	0.28	0.21
EU-18	North Fork Animas River	0.18	0.42	0.21
EU-19	Burrows Gulch	0.33	0.50	0.14
EU-DR01	Animas River - upper Durango Reach	0.17	0.24	0.49
EU-DR02	Animas River - lower Durango Reach	0.16	0.20	0.27
EU-R1	Mineral Creek trib. - Bear Creek	0.08	0.07	0.32
EU-R2	Mineral Creek trib. - Mill Creek	0.07	0.37	0.29
EU-R3	Animas River trib - Maggie Gulch	0.09	0.05	0.24
EU-R4	Animas River trib - Picayne Gulch	0.10	0.11	0.20
EU-R5	Animas River trib - upper N. Fork Animas R	0.10	0.25	0.14
EU-R6	Durango Reach trib. - Hermosa Creek	0.06	0.02	0.62

Color code definitions:

Lightest	HQ <1.0
	HQ >1.0 but <5.0
	HQ >5.0 but <10.0
Darkest	HQ >10.0

Table 9.16 Summary of Central Tendency Exposure Low-Effect Toxicity Reference Value Hazard Quotients (HQs) for Raccoon. Note that only contaminants that had at least one HQ>1 in at least one Exposure Unit (EU) among all wildlife receptors are summarized.

Exposure unit	Location	Copper	Lead	Selenium
EU-01	Lower Mineral Creek	0.08	0.15	1.35
EU-02	Lower Mineral Creek	0.05	0.22	0.61
EU-03	Middle Mineral Creek	0.08	0.21	0.56
EU-04	Upper Mineral Creek	0.16	0.87	0.35
EU-05	South Fork Mineral Creek	0.02	0.04	0.79
EU-06	Middle Fork Mineral Creek	0.02	0.06	0.55
EU-07	Mainstem Animas River	0.15	0.81	0.42
EU-08	Cunningham Creek	0.05	0.29	0.67
EU-09	Mainstem Animas River	0.17	0.60	0.41
EU-10	Mainstem Animas River	0.25	0.94	0.82
EU-11	Upper South Fork Animas River	0.06	0.14	0.65
EU-12	Eureka Gulch	0.13	0.36	0.66
EU-13	Lower South Fork Animas River	0.13	0.42	0.81
EU-14	Mainstem Animas River	0.17	0.66	0.42
EU-15	Lower West Fork Animas River	0.16	1.02	0.30
EU-16	Placer Gulch	0.49	4.28	0.73
EU-17	Upper West Fork Animas River	0.11	0.16	0.42
EU-18	North Fork Animas River	0.06	0.25	0.42
EU-19	Burrows Gulch	0.12	0.30	0.32
EU-DR01	Animas River - upper Durango Reach	0.06	0.13	0.75
EU-DR02	Animas River - lower Durango Reach	0.05	0.11	0.49
EU-R1	Mineral Creek trib. - Bear Creek	0.02	0.04	0.55
EU-R2	Mineral Creek trib. - Mill Creek	0.02	0.14	0.59
EU-R3	Animas River trib - Maggie Gulch	0.03	0.02	0.45
EU-R4	Animas River trib - Picayne Gulch	0.03	0.06	0.40
EU-R5	Animas River trib - upper N. Fork Animas R	0.03	0.14	0.33
EU-R6	Durango Reach trib. - Hermosa Creek	0.01	0.01	0.89

Color code definitions:

Lightest	HQ <1.0
	HQ >1.0 but <5.0
	HQ >5.0 but <10.0
Darkest	HQ >10.0

Table 10-1 Final Risk Characterization Summary for Each Assessment Endpoint and Exposure Unit (EU). Hazard quotient (HQ)-based risk characterization focused on Central Tendency Exposure (CTE) low-effect or chronic results since these HQs represent the highest levels of risk.

			BENTHIC MACROINVERTEBRATES				HABITAT[7]	WATER-COLUMN INVERTEBRATES AND FISH			WILDLIFE SPECIES[5]				
Exposure unit	**Exposure unit description**	**Sample locations**	**Low-effect sediment HQs[1]**	**Chronic pore water HQs[2]**	**Sed. tox. test**	**BMI comm. survey[3]**	**BMI/Fish**	**Chronic surface water HQs[2]**	**Acute tox. test**	**Fish pres./abs.[4]**	**Am. Dipper**	**Mallard**	**Kingfisher**	**Muskrat**	**Raccoon**
MINERAL CREEK WATERSHED															
EU-01	Lower mainstem Mineral Creek	M29A, M34	Low risk (Fe, Pb, Mn, Zn, As)	Low risk (pH, Al) Mod. risk (Fe)	<10% survival (sig. reduced) Sig. reduced biomass	Impaired	Suboptimal / NA	Low risk (Fe, Hg, Cd, Zn) Mod. risk (pH) High risk (Al)	0% to 73% survival (variable sig. diff.)	RBT and BRK present; trout historically absent	Low risk (Pb)	All CTE low-effect HQs <1.0	Low risk (Se) (est. fish tissue)	Low risk (Se) (est. plant tissue)	Low risk (Se) (est. fish tissue)
EU-02	Lower mainstem Mineral Creek	M27, M27A	Low risk (Pb, Zn, Fe, As)	Low risk (Zn, Cu, Cd) High risk (pH, Fe, Al, Pb)	0% survival (sig. reduced) Sig. reduced biomass	Impaired	Suboptimal / NA	Low risk (Cd, Zn, Pb, Cu) Mod. risk (pH, Fe) High risk (Al)	0% survival (sig. reduced)	Not surveyed; trout historically absent	Low risk (Pb)	All CTE low-effect HQs <1.0	Low risk (Pb) (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-03	Mid. mainstem Mineral Creek	M11, M14B	Low risk (Zn, Pb, Mn, As, Cd)	Low risk (pH, Zn, Cd) Mod. risk (Fe, Al)	25% survival (sig. reduced) Sig. reduced biomass	Impaired	Optimal / NA	Low risk (Zn, Cu, Cd, Fe) Mod. risk (Pb, Al)	98% survival (not sig. reduced)	BRK present; trout historically absent	Low risk (Pb)	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-04	Upper mainstem Mineral Creek	M10A	Low risk (As, Cu, Cd, Mn) High risk (Zn, Pb)	Low risk (Zn, Cd, Cu)	39% survival (sig. reduced) Sig. reduced biomass	Not impaired	Suboptimal / NA	Low risk (Al, Cd, Cu) Mod. risk (Zn) High risk (Pb)	95% survival (not sig. reduced)	Not surveyed; trout historically absent	Low risk (Cu) High risk (Pb)	Low risk (Pb)	Mod. risk (Pb) (est. fish tissue)	Low risk (Pb) (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-05	South Fork Mineral Creek	M28	All CTE low-effect HQs <1.0	Low risk (Cd) Mod. risk (Al) High risk (pH, Fe)	70% survival (sig. reduced) Sig. reduced biomass	Not impaired	Optimal / NA	Low risk (Al)	100% survival (not sig. reduced)	RBT and BRK present; RBT and BRK historically present	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0	Low risk (Se)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-06	Middle Fork Mineral Creek	M20	Low risk (Fe)	Low risk (Cd) Mod. risk (Al) High risk (pH, Fe)	0% survival (sig. reduced) Sig. reduced biomass	Impaired	Optimal / NA	Low risk (Cd) High risk (pH, Fe, Al)	0% survival (sig. reduced)	Not surveyed; trout historically absent	All CTE low-effect HQs <1.0 (est. invert. tissue)	All CTE low-effect HQs <1.0 (est. invert. tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
UPPER ANIMAS BERA EUs															
NA	Cement Creek	CC48, CC49	Low risk (Fe, Pb, As)	NA	0% survival (sig. reduced) Sig. reduced biomass	Impaired	NA / NA	Low risk (Pb, Mn, Be) Mod. risk (Zn, Cu, Cd) High risk (pH, Al, Fe)	0% survival (sig. reduced)	Not surveyed; trout historically absent	Low risk (Pb) (est. invert. tissue)	All CTE low-effect HQs <1.0 (est. invert. tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
NA	Animas R. above Cement Cr. to Arrastra Cr.	A60, A61, A64, A65, A66, A68	Low risk (Cu, Cd, Ag) Mod. risk (Mn, Zn) High risk (Pb)	Low risk (Pb, Ag) Mod. risk (Mn, Cu) High risk (Cd, Zn)	56% to 78% (variable sig.) Sig. reduced biomass	Impaired	NA / NA	Low risk (Zn, Cd, Mn, Cu) Mod. risk (Al)	68% to 100% survival (variable sig. diff.)	Not surveyed; trout historically present	Low risk (Cu) High risk (Pb)	All CTE low-effect HQs <1.0	Low risk (Pb) (est. fish tissue)	Low risk (Pb) (est. plant tissue)	Low risk (Pb) (est. fish tissue)
NA	Animas R. between Cement Cr. and Mineral Cr.	A69A, A70B	NA	NA	NA	NA	NA / NA	Low risk (pH, Zn, Cd, Mn, Fe) High risk (Al)	NA	Not surveyed; no historic surveys	NA	NA	NA	NA	NA
NA	Animas R. 300 ft. below Mineral Cr.	A71B	NA	NA	NA	NA	NA / NA	Low risk (pH, Fe, Cd, Zn) High risk (Al)	NA	Not surveyed; no historic surveys	NA	NA	NA	NA	NA
NA	Animas R. 3,500 feet below Mineral Cr.	A72	Low risk (Pb, Mn, Zn, Fe, As)	Low risk (Cd, Ag) Mod. risk (Zn)	36% to 70% (variable sig.) Sig. reduced biomass	Impaired	NA / NA	Low risk (Zn, Cd, Cu, Mn) Mod. risk (pH, Fe) High risk (Al)	0% to 2.5% survival (sig. reduced)	Not surveyed; trout historically present (only during one event)	Low risk (Pb)	All CTE low-effect HQs <1.0	Low risk (Pb) (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
NA	Animas R. at Elk Cr. confluence	A73, A73B	Low risk (Pb, Mn, Zn, Fe, Cu)	Low risk (Zn, Cd, Be) High risk (Ag)	5% to 74% (variable sig.) Sig. reduced biomass	Impaired	NA / NA	Low risk (Cd, Fe) Mod. risk (Zn) High risk (Al)	98 to 100% survival (not sig. reduced)	Not surveyed; trout historically present	Low risk (Pb, Cu, Se) (est. invert. tissue)	All CTE low-effect HQs <1.0 (est. invert. tissue)	Low risk (Pb) (est. fish tissue)	All CTE low-effect HQs <1.1 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
NA	Animas R. at Cascade Cr. confluence	A75B, A75D	Low risk (Zn, Mn, Pb, Cu, Cd, Fe)	Low risk (Ag, Zn, Cd)	49% to 76% (variable sig.) Sig. reduced biomass	Not impaired	NA / NA	Low risk (Zn, Cd, Fe) High risk (Al)	100% survival (not sig. reduced)	Not surveyed; trout historically present	Low risk (Cu, Pb) (est. invert. tissue)	All CTE low-effect HQs <1.0 (est. invert. tissue)	All CTE low-effect HQs <1.1 (est. fish tissue)	All CTE low-effect HQs <1.2 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
NA	Animas R. at Bakers Bridge	Bakers Bridge	Low risk (Pb, Cd, Cu, Fe) Mod. risk (Mn) High risk (Zn)	Low risk (Ag, Mn)	76% to 86% (variable sig.) Sig. reduced biomass	Not impaired	NA / NA	Low risk (Zn, Fe, Cd) Mod. risk (Al)	100% survival (not sig. reduced)	Not surveyed; trout historically present	Low risk (Pb)	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.1 (est. fish tissue)	All CTE low-effect HQs <1.3 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
ANIMAS RIVER - UPPER REACHES AND TRIBUTARIES															
EU-07	Mainstem from Arrastra G. to Cunningham Cr.	A55, A56	Low risk (Cd, Cu, Ag) Mod. risk (Pb, Mn, Zn)	Low risk (Al, Pb, Cd, Zn, Cu, Mn, Fe)	44% to 63% survival Sig. reduced biomass	Impaired	Optimal / NA	Low risk (Zn, Cd)	100% survival (not sig. reduced)	Not surveyed; RBT and BRK historically present	Low risk (Cu) High risk (Pb)	Low risk (Pb)	Low risk (Pb) (est. fish tissue)	Low risk (Pb) (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-08	Cunningham Creek	A48	Low risk (Pb)	Low risk (Fe) Mod. risk (Al)	55% survival (sig. reduced) Sig. reduced biomass	Not impaired	Suboptimal / Good	All CTE chronic HQs <1.0	100% survival (not sig. reduced)	CTT and BRK present; CTT, RBT, and BRK historically present	Low risk (Pb)	All CTE low-effect HQs <1.0	Low risk (Pb, Se) (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-09	Mainstem from Cunningham Cr. to Mannie G.	A41A, A45	Low risk (Cu, Cd, Ag) Mod. risk (Mn, Zn) High risk (Pb)	Low risk (Zn, Al, Fe, Cd)	50% to 68% survival (sig. reduced) Sig. reduced biomass	Not impaired	Suboptimal / Good	Low risk (pH, Cu, Al, Cd) Mod. risk (Zn)	100% survival (not sig. reduced)	BRK present; RBT and BRK historically present	Low risk (Cu) Mod. risk (Pb)	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0	Low risk (Pb) (est. plant tissue)	All CTE low-effect HQs <1.0
EU-10	Mainstem from Minnie G. to South Fork Animas R.	A35, A40	Low risk (Cu, Cd, Ag, As) Mod. risk (Zn) High risk (Mn, Pb)	Low risk (pH, Cd, Zn)	64% survival (sig. reduced) Sig. reduced biomass	Not impaired	Suboptimal / NA	Low risk (Cu, Al) Mod. risk (Zn, Cd)	100% survival (not sig. reduced)	Trout absent; trout historically absent	Low risk (Cu) Mod. risk (Pb)	All CTE low-effect HQs <1.0	Low risk (Se) Mod. risk (Pb) (est. fish tissue)	Low risk (Pb) (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-11	Upper South Fork Animas River	A36	Low risk (Pb, Fe, Mn)	Low risk (Fe)	35% survival (sig. reduced) Sig. reduced biomass	Impaired	Optimal / NA	Low risk (Al)	100% survival (not sig. reduced)	Trout absent; no historic surveys	Low risk (Pb)	All CTE low-effect HQs <1.0	Low risk (Se) (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-12	Eureka Gulch	A37	Low risk (Pb, Cd, Cu) Mod. risk (Mn, Zn)	Low risk (Zn)	35% survival (sig. reduced) Sig. reduced biomass	Not impaired	Suboptimal / Fair	Low risk (Cu, Al) Mod. risk (Cd) High (Zn)	100% survival (not sig. reduced)	Trout absent; trout historically absent	Low risk (Pb, Cu)	All CTE low-effect HQs <1.0	Low risk (Pb, Se) (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-13	Lower South Fork Animas River	A34	Low risk (Zn, Mn, Cu, Cd, Fe) Mod risk (Pb)	All CTE chronic HQs <1.0	60% survival (sig. reduced) Sig. reduced biomass	Not impaired	Optimal / Poor	Low risk (Cd, Al, Cu, Pb) Mod. risk (Zn)	98% survival (not sig. reduced)	Trout absent; trout historically absent	Low risk (Pb)	All CTE low-effect HQs <1.0	Low risk (Pb, Se) (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-14	Mainstem from South Fork to West Fork Animas River	A14, A33	Low risk (Cu, Cd, Ag) Mod. risk (Pb, Mn, Zn)	Low risk (Mn, Fe, Be, Pb, Cu) Mod. risk (pH) High risk (Al, Cd, Zn)	56% survival (sig. reduced) Sig. reduced biomass	Impaired	Optimal / Good	Low risk (Cu, Mn, Pb, Be) Mod. risk (Al) High risk (pH, Zn, Cd)	98% survival (not sig. reduced)	Trout absent; trout historically absent	Mod. risk (Pb)	All CTE low-effect HQs <1.0	Low risk (Pb) (est. fish tissue)	Low risk (Pb) (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-15	Lower West Fork Animas River	A10	Low risk (Zn, Cu, Cd) Mod. risk (Mn) High risk (Pb)	Low risk (Cu, Be) Mod. risk (pH, Fe) High risk (Al, Zn, Cd)	16% survival (sig. reduced) Sig. reduced biomass	Impaired	Optimal / Good	Low risk (Pb, Cu, Be) Mod. risk (pH, Mn) High risk (Zn, Cd, Al)	0% survival (sig. reduced)	Trout absent; trout historically absent	Low risk (Cu) High risk (Pb) (est. invert. tissue)	All CTE low-effect HQs <1.0 (est. invert. tissue)	Mod. risk (Pb) (est. fish tissue)	Low risk (Pb) (est. plant tissue)	Low risk (Pb) (est. fish tissue)
EU-16	Placer Gulch	A20	Low risk (Ag, As) Mod. risk (Cd, Cu) High risk (Pb, Mn, Zn)	Low risk (pH, Al, Pb, Cu) Mod. risk (Cd) High risk (Zn)	54% survival (sig. reduced) Sig. reduced biomass	Impaired	Optimal / Fair	Low risk (pH, Mn) Mod. risk (Pb, Al, Cu) High risk (Zn, Cd)	70% survival (not sig. reduced)	Trout absent; no historic surveys	Low risk (Cu) High risk (Pb)	Low risk (Pb)	Low risk (Se) High risk (Pb) (est. fish tissue)	Low risk (Cu) Mod. risk (Pb) (est. plant tissue)	Low risk (Pb) (est. fish tissue)
EU-17	Upper West Fork Animas River	A15	Low risk (Pb, Zn, Cu) Mod. risk (Mn)	Low risk (Cu, Fe, Be) High risk (Zn, Cd, Al, Mn)	1% survival (sig. reduced) Sig. reduced biomass	Impaired	Optimal / Fair	Low risk (Cu, Be, Pb) Mod. risk (pH) High risk (Zn, Cd, Al, Mn)	0% survival (sig. reduced)	Trout absent; trout historically absent	Low risk (Cu, Pb) (est. invert. tissue)	All CTE low-effect HQs <1.0 (est. invert. tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-18	North Fork Animas River to Burrows Cr.	A08, A09	Low risk (Mn, Pb, Zn, As, Cd)	Low risk (Pb, Cu, Fe) Mod. risk (pH) High risk (Cd, Al, Zn)	29% survival (sig. reduced) Sig. reduced biomass	Impaired	Suboptimal / Fair	Low risk (Cu, Be, Mn) Mod. risk (pH, Pb) High risk (Cd, Al, Zn)	0% survival (sig. reduced)	Trout absent; trout historically absent	Low risk (Pb, Cu) (est. invert. tissue)	All CTE low-effect HQs <1.0 (est. invert. tissue)	Low risk (Pb) (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-19	Burrows Gulch	A07	Low risk (Pb, Zn, As, Cd, Cu) High risk (Mn)	Low risk (Pb, Mn, Fe, Be) Mod. risk (pH, Cu) High risk (Cd, Al, Zn)	36% survival (sig. reduced) Sig. reduced biomass	Impaired	Optimal / Poor	Low risk (Mn, Be) Mod. risk (pH) High risk (Al, Cd, Zn, Cu, Pb)	0% survival (sig. reduced)	Trout absent; trout historically absent	Low risk (Pb)	All CTE low-effect HQs <1.0	Low risk (Pb) (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
ANIMAS RIVER - DURANGO REACH															
EU-DR01	James Ranch to 32nd St. Bridge	James Ranch, 9426, Oxbow Park, 32nd St. Bridge	Low risk (Mn, Pb, Zn)	Low risk (Mn)	69% to 88% survival (not sig.)[6] Biomass not sig. reduced[6]	Impaired	NA / NA	Low risk (Fe, Hg) High risk (Al)	Not assessed	Not surveyed; RBT, BRK, BRN historically present	Low risk (Pb, Se)	All CTE low-effect HQs <1.0	Low risk (Se) (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-DR02	32nd St. Bridge to Purple Cliffs	Rotary Park, GKM05, Abv. Lightner Cr., AR19-3, Purple Cliffs	Low risk (Mn, Zn, Pb)	Low risk (Mn)	74% to 81% survival (not sig.)[6] Biomass not sig. reduced[6]	Historically variable; mostly impaired	NA / NA	Low risk (Hg) Mod. risk (Fe, Al)	Not assessed	Not surveyed; RBT, BRN historically present	Low risk (Pb)	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0 (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
REFERENCE EXPOSURE UNITS															
EU-R1	Mineral Creek trib. - Bear Creek	M30	Low risk (Mn)	Low risk (pH, Al)	76% survival (not sig.) Sig. reduced biomass	Not impaired	Optimal / NA	All CTE chronic HQs <1.0	100% survival (not sig. reduced)	Trout absent; trout historically absent	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0 (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-R2	Mineral Creek trib. - Mill Creek	M08	Low risk (Pb, Mn)	Low risk (pH)	58% survival (sig. reduced) Sig. reduced biomass	Not impaired	Optimal / NA	Low risk (Al, Be, Pb)	98% survival (not sig. reduced)	BRK present; trout historically absent	Low risk (Pb)	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0
EU-R3	Animas River trib - Maggie Gulch	A43	Low risk (Mn)	All CTE chronic HQs <1.0	78% survival (not sig.) Sig. reduced biomass	Not impaired	Optimal / Good	Low risk (Al)	100% survival (not sig. reduced)	CTT and BRK historically present	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0 (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-R4	Animas River trib - Picayne Gulch	A26	Low risk (Mn, Zn, Cd, As, Pb)	All CTE chronic HQs <1.0	63% survival (sig. reduced) Sig. reduced biomass	Not impaired	Optimal / NA	Low risk (Al)	98% survival (not sig. reduced)	Not surveyed; trout historically absent	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0 (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-R5	Animas River trib - upper N. Fork Animas River	A05	Low risk (Mn, As)	Low risk (pH, Fe, Cd)	69% survival (sig. reduced) Sig. reduced biomass	Not impaired	Optimal / Fair	Low risk (Be, Pb) Mod. risk (Zn, Al) High risk (Cd)	100% survival (not sig. reduced)	BRK present; RBT historically present	Low risk (Pb)	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0 (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)
EU-R6	Durango Reach trib. - Hermosa Creek	HC01, HC02	All CTE low-effect HQs <1.0	All CTE chronic HQs <1.0	3% to 65% survival Sig. reduced biomass	Not impaired	Suboptimal / NA	All CTE chronic HQs <1.0	100% survival (not sig. reduced)	Not surveyed; CTT historically present	All CTE low-effect HQs <1.0	All CTE low-effect HQs <1.0	Low risk (Se) (est. fish tissue)	All CTE low-effect HQs <1.0 (est. plant tissue)	All CTE low-effect HQs <1.0 (est. fish tissue)

BMI = Benthic Macroinvertebrate; RBT = Rainbow Trout; BRK = Brook Trout; CTT = Cutthroat Trout; BRN = Brown Trout; COPEC = Contaminant of Potential Ecological Concern; BERA = Baseline Ecological Risk Assessment

As = Arsenic; Al = Aluminum; Be = Beryllium; Cd = Cadmium; Cu = Copper; Fe = Iron; Pb = Lead; Mn = Manganese; Hg = Mercury; Se = Selenium; Zn = Zinc

1 Risk based on CTE low-effect, ecological screening value HQs for each COPEC; COPECs listed in order of highest to lowest HQs

2 Risk based on CTE chronic, ecological screening value HQs for each COPEC; COPECs listed in order of highest to lowest HQs

3 Impairment status based on Colorado Multi-Metric Index scores being above or below respective sampling location impairment threshold

4 Summarizes 2016 fish survey results followed by historic fish survey results

5 All wildlife risks based on CTE low-effect, toxicity reference value HQs; COPECs listed in order of highest to lowest HQs

6 Only summarizes the most recent, December 2017 sediment test results when more than one test was conducted

7 BMI habitat ratings were based on average Barbour et al. (1999) habitat evaluation parameter scores obtained from respective Mountain Studies Institute BMI assessment reports; Fish habitat ratings were obtained from Table 15 in the USGS (2018) Fish Habitat and Community Survey Data Report; fish habitat ratings were based on physical habitat parameters (gradient/slope, depth, substrate composition, bank stability, riparian composition, and presence of pools and large woody debris) measured and observed in each survey reach.

Relative risk categorization definitions*:

Low risk = Respective endpoint HQs >1.0 but <5.0 or pH <6.5 but >5.5

Moderate risk = Respective endpoint HQs >5.0 but <10.0 or pH <5.5 but >4.4

High risk = Respective endpoint HQs >10.0 or pH <4.4

* Note that it is understood that risk does not increase in a linear fashion with increasing HQs. As such, relative risk terminology was only used to qualitatively highlight differences in risk and should not be interpreted beyond this intended use.

Appendices

Appendix 1

List of Surface Water Samples Used in the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 1 Tables:

Table A1.1 Laboratory Sample IDs for Surface Water Samples Used to Identify Contaminants of Potential Ecological Concern and Estimate Exposure to Aquatic Community-level Receptors

Table A.1.1 Laboratory Sample IDs for Surface Water Samples Used to Identify Contaminants of Potential Ecological Concern and Estimate Exposure to Aquatic Community-level Receptors

Exposure unit	Loc. ID	Hydroperiod	Collection date	Lab_Samp_No
EU-01	M34	Pre-runoff	2/17/2010	1002004-03
EU-01	M34	Pre-runoff	3/17/2010	1003013-03
EU-01	M34	Pre-runoff	4/13/2010	1004007-03
EU-01	M34	Runoff	6/2/2010	1006002-03
EU-01	M34	Post-runoff	7/13/2010	1007017-03
EU-01	M34	Post-runoff	9/14/2010	1009024-03
EU-01	M34	Post-runoff	11/2/2010	1011008-03
EU-01	M34	Pre-runoff	3/15/2011	1103001-03
EU-01	M34	Runoff	6/14/2011	1106010-04
EU-01	M34	Post-runoff	7/19/2011	1107016-03
EU-01	M34	Post-runoff	8/16/2011	1108015-03
EU-01	M34	Post-runoff	8/16/2011	1108015-37
EU-01	M34	Post-runoff	9/13/2011	1109011-03
EU-01	M34	Post-runoff	10/18/2011	1110009-03
EU-01	M34	Runoff	5/15/2012	C120508-AU
EU-01	M34	Runoff	5/15/2012	C120508-AV
EU-01	M34	Post-runoff	10/2/2012	C121012-GZ
EU-01	M34	Post-runoff	10/2/2012	C121012-HA
EU-01	M34	Post-runoff	10/4/2012	C121012-HC
EU-01	M34	Post-runoff	10/4/2012	C121012-HD
EU-01	M34	Runoff	5/14/2013	C130504-DN
EU-01	M34	Runoff	5/14/2013	C130504-DO
EU-01	M34	Runoff	5/5/2014	C140508-BP
EU-01	M34	Runoff	5/5/2014	C140508-BQ
EU-01	M34	Post-runoff	9/24/2014	C140919-GB
EU-01	M34	Post-runoff	9/24/2014	C140919-GC
EU-01	M34	Runoff	6/9/2015	C150608-CG
EU-01	M34	Runoff	6/9/2015	C150608-CH
EU-01	M34	Post-runoff	9/29/2015	C151006-EI
EU-01	M34	Post-runoff	9/29/2015	C151006-EJ
EU-01	M34	Post-runoff	10/26/2015	M34_102615
EU-01	M34	Pre-runoff	3/22/2016	M34_032216L
EU-01	M34	Runoff	6/6/2016	M34_060616L
EU-01	M29A	Runoff	6/7/2016	C160609-FG
EU-01	M29A	Runoff	6/7/2016	C160609-FH
EU-01	M34	Runoff	6/7/2016	C160609-FV
EU-01	M34	Runoff	6/7/2016	C160609-FW
EU-01	M34	Post-runoff	9/27/2016	M34_092716
EU-01	M34	Post-runoff	9/27/2016	C161005-FL
EU-01	M34	Post-runoff	9/27/2016	C161005-FM
EU-01	M34	Pre-runoff	3/21/2017	C170306-42
EU-01	M34	Pre-runoff	3/21/2017	C170306-43
EU-01	M34	Pre-runoff	4/4/2017	C170401-40
EU-01	M34	Pre-runoff	4/4/2017	C170401-41
EU-01	M34	Pre-runoff	4/18/2017	C170405-40
EU-01	M34	Pre-runoff	4/18/2017	C170405-41
EU-01	M34	Runoff	5/2/2017	C170504-40
EU-01	M34	Runoff	5/2/2017	C170504-41
EU-01	M34	Runoff	5/15/2017	C170509-79
EU-01	M34	Runoff	5/15/2017	C170509-80
EU-01	M29A	Runoff	6/6/2017	C170606-CF
EU-01	M29A	Runoff	6/6/2017	C170606-CG
EU-01	M34	Runoff	6/6/2017	C170606-CX
EU-01	M34	Runoff	6/6/2017	C170606-CY
EU-01	M34	Post-runoff	9/26/2017	C171007-FX
EU-01	M34	Post-runoff	9/26/2017	C171007-FY
EU-01	M29A	Post-runoff	9/28/2017	C171007-ET
EU-01	M29A	Post-runoff	9/28/2017	C171007-EU
EU-02	M27	Runoff	6/7/2016	C160609-EU
EU-02	M27	Runoff	6/7/2016	C160609-EV
EU-02	M27A	Runoff	6/7/2016	C160609-EX
EU-02	M27A	Runoff	6/7/2016	C160609-EY
EU-02	M27	Post-runoff	9/27/2016	C161005-EE
EU-02	M27	Post-runoff	9/27/2016	C161005-EI
EU-02	M27A	Post-runoff	9/28/2016	C161005-EK
EU-02	M27A	Post-runoff	9/28/2016	C161005-EL
EU-02	M27	Pre-runoff	3/21/2017	C170306-39
EU-02	M27	Pre-runoff	3/21/2017	C170306-40
EU-02	M27	Pre-runoff	4/4/2017	C170401-37
EU-02	M27	Pre-runoff	4/4/2017	C170401-38
EU-02	M27	Pre-runoff	4/18/2017	C170405-37
EU-02	M27	Pre-runoff	4/18/2017	C170405-38
EU-02	M27	Runoff	5/2/2017	C170504-37
EU-02	M27	Runoff	5/2/2017	C170504-38
EU-02	M27	Runoff	5/16/2017	C170509-73
EU-02	M27	Runoff	5/16/2017	C170509-74
EU-02	M27	Runoff	6/6/2017	C170606-BQ
EU-02	M27	Runoff	6/6/2017	C170606-BR
EU-02	M27A	Runoff	6/6/2017	C170606-BT
EU-02	M27A	Runoff	6/6/2017	C170606-BU
EU-02	M27	Post-runoff	9/27/2017	C171007-DU
EU-02	M27	Post-runoff	9/27/2017	C171007-DV
EU-02	M27A	Post-runoff	9/28/2017	C171007-DZ
EU-02	M27A	Post-runoff	9/28/2017	C171007-EA
EU-03	M14B	Runoff	6/7/2016	C160609-CY
EU-03	M14B	Runoff	6/7/2016	C160609-CZ
EU-03	M11	Runoff	6/9/2016	C160609-CG
EU-03	M11	Runoff	6/9/2016	C160609-CH
EU-03	M14B	Post-runoff	9/28/2016	C161005-AW
EU-03	M14B	Post-runoff	9/28/2016	C161005-AX
EU-03	M11	Post-runoff	9/30/2016	C161005-89
EU-03	M11	Post-runoff	9/30/2016	C161005-90
EU-03	M11	Runoff	5/16/2017	C170509-67
EU-03	M11	Runoff	5/16/2017	C170509-68
EU-03	M14B	Runoff	6/6/2017	C170606-91
EU-03	M14B	Runoff	6/6/2017	C170606-92
EU-03	M11	Runoff	6/7/2017	C170606-70
EU-03	M11	Runoff	6/7/2017	C170606-71
EU-03	M14B	Post-runoff	9/27/2017	C171007-85
EU-03	M14B	Post-runoff	9/27/2017	C171007-86
EU-03	M11	Post-runoff	9/28/2017	C171007-50
EU-03	M11	Post-runoff	9/28/2017	C171007-51
EU-04	M10A	Runoff	6/9/2016	C160609-CD
EU-04	M10A	Runoff	6/9/2016	C160609-CE
EU-04	M10A	Post-runoff	9/30/2016	C161005-83
EU-04	M10A	Post-runoff	9/30/2016	C161005-84
EU-04	M10A	Runoff	5/16/2017	C170509-64
EU-04	M10A	Runoff	5/16/2017	C170509-65
EU-04	M10A	Post-runoff	9/28/2017	C171007-40
EU-04	M10A	Post-runoff	9/28/2017	C171007-41
EU-05	M28	Runoff	6/7/2016	C160609-FA
EU-05	M28	Runoff	6/7/2016	C160609-FB
EU-05	M28	Post-runoff	9/27/2016	C161005-EQ
EU-05	M28	Post-runoff	9/27/2016	C161005-ER
EU-05	M28	Runoff	5/16/2017	C170509-76
EU-05	M28	Runoff	5/16/2017	C170509-77
EU-05	M28	Runoff	6/6/2017	C170606-BZ
EU-05	M28	Runoff	6/6/2017	C170606-CA
EU-05	M28	Post-runoff	9/27/2017	C171007-EJ
EU-05	M28	Post-runoff	9/27/2017	C171007-EK

Table A.1.1 (cont) Laboratory Sample IDs for Surface Water Samples Used to Identify Contaminants of Potential Ecological Concern and Estimate Exposure to Aquatic Community-level Receptors

Exposure unit	Loc. ID	Hydroperiod	Collection date	Lab_Samp_No
EU-06	M20	Runoff	6/8/2016	C160609-EI
EU-06	M20	Runoff	6/8/2016	C160609-EJ
EU-06	M20	Post-runoff	9/29/2016	C161005-CS
EU-06	M20	Post-runoff	9/29/2016	C161005-CT
EU-06	M20	Runoff	6/6/2017	C170606-BE
EU-06	M20	Runoff	6/6/2017	C170606-BF
EU-06	M20	Post-runoff	9/26/2017	C171007-BU
EU-06	M20	Post-runoff	9/26/2017	C171007-BV
EU-07	A56	Post-runoff	10/3/2012	C121012-02
EU-07	A56	Post-runoff	10/3/2012	C121012-03
EU-07	A56	Runoff	5/13/2013	C130504-01
EU-07	A56	Runoff	5/13/2013	C130504-03
EU-07	A55	Pre-runoff	4/16/2014	C140406-03
EU-07	A55	Pre-runoff	4/16/2014	C140406-04
EU-07	A56	Pre-runoff	4/16/2014	C140406-07
EU-07	A56	Pre-runoff	4/16/2014	C140406-08
EU-07	A55	Runoff	5/6/2014	C140508-01
EU-07	A55	Runoff	5/6/2014	C140508-02
EU-07	A56	Runoff	5/6/2014	C140508-05
EU-07	A56	Runoff	5/6/2014	C140508-06
EU-07	A55	Post-runoff	9/23/2014	C140919-17
EU-07	A55	Post-runoff	9/23/2014	C140919-18
EU-07	A56	Post-runoff	9/23/2014	C140919-23
EU-07	A56	Post-runoff	9/23/2014	C140919-24
EU-07	A55	Post-runoff	11/20/2014	C150502-15
EU-07	A55	Post-runoff	11/20/2014	C150502-16
EU-07	A55	Post-runoff	12/5/2014	C150502-05
EU-07	A55	Post-runoff	12/5/2014	C150502-06
EU-07	A55	Post-runoff	12/15/2014	C150301-03
EU-07	A55	Post-runoff	12/15/2014	C150301-04
EU-07	A55	Pre-runoff	1/9/2015	C150301-01
EU-07	A55	Pre-runoff	1/9/2015	C150301-02
EU-07	A55	Pre-runoff	1/26/2015	C150502-11
EU-07	A55	Pre-runoff	1/26/2015	C150502-12
EU-07	A55	Pre-runoff	2/6/2015	C150301-05
EU-07	A55	Pre-runoff	2/6/2015	C150301-06
EU-07	A55	Pre-runoff	2/20/2015	C150502-09
EU-07	A55	Pre-runoff	2/20/2015	C150502-10
EU-07	A55	Pre-runoff	3/9/2015	C150301-07
EU-07	A55	Pre-runoff	3/9/2015	C150301-08
EU-07	A56	Pre-runoff	3/9/2015	C150301-09
EU-07	A56	Pre-runoff	3/9/2015	C150301-10
EU-07	A55	Pre-runoff	3/19/2015	C150502-03
EU-07	A55	Pre-runoff	3/19/2015	C150502-04
EU-07	A56	Pre-runoff	3/19/2015	C150502-21
EU-07	A56	Pre-runoff	3/19/2015	C150502-22
EU-07	A55	Pre-runoff	3/27/2015	C150502-07
EU-07	A55	Pre-runoff	3/27/2015	C150502-08
EU-07	A56	Pre-runoff	3/27/2015	C150502-23
EU-07	A56	Pre-runoff	3/27/2015	C150502-24
EU-07	A55	Pre-runoff	4/2/2015	C150502-19
EU-07	A55	Pre-runoff	4/2/2015	C150502-20
EU-07	A56	Pre-runoff	4/2/2015	C150502-27
EU-07	A56	Pre-runoff	4/2/2015	C150502-28
EU-07	A55	Pre-runoff	4/9/2015	C150502-17
EU-07	A55	Pre-runoff	4/9/2015	C150502-18
EU-07	A55	Pre-runoff	4/22/2015	C150502-01
EU-07	A55	Pre-runoff	4/22/2015	C150502-02
EU-07	A56	Pre-runoff	4/22/2015	C150502-25
EU-07	A56	Pre-runoff	4/22/2015	C150502-26
EU-07	A55	Pre-runoff	4/27/2015	C150502-13
EU-07	A55	Pre-runoff	4/27/2015	C150502-14
EU-07	A56	Pre-runoff	4/27/2015	C150502-29
EU-07	A56	Pre-runoff	4/27/2015	C150502-30
EU-07	A55	Runoff	5/14/2015	C150603-09
EU-07	A55	Runoff	5/14/2015	C150603-10
EU-07	A55	Runoff	6/9/2015	C150608-73
EU-07	A55	Runoff	6/9/2015	C150608-74
EU-07	A56	Runoff	6/9/2015	C150608-77
EU-07	A56	Runoff	6/9/2015	C150608-78
EU-07	A55	Post-runoff	9/29/2015	C151005-DS
EU-07	A55	Post-runoff	9/29/2015	C151005-DT
EU-07	A56	Post-runoff	9/29/2015	C151005-DW
EU-07	A56	Post-runoff	9/29/2015	C151005-DX
EU-07	A55	Pre-runoff	3/17/2016	C160404-05
EU-07	A55	Pre-runoff	3/17/2016	C160404-06
EU-07	A56	Pre-runoff	3/17/2016	C160404-11
EU-07	A56	Pre-runoff	3/17/2016	C160404-12
EU-07	A55	Pre-runoff	3/24/2016	C160404-07
EU-07	A55	Pre-runoff	3/24/2016	C160404-08
EU-07	A56	Pre-runoff	3/24/2016	C160404-13
EU-07	A56	Pre-runoff	3/24/2016	C160404-14
EU-07	A55	Pre-runoff	3/29/2016	C160404-09
EU-07	A55	Pre-runoff	3/29/2016	C160404-10
EU-07	A56	Pre-runoff	3/29/2016	C160404-15
EU-07	A56	Pre-runoff	3/29/2016	C160404-16
EU-07	A55	Pre-runoff	4/5/2016	C160405-15
EU-07	A55	Pre-runoff	4/5/2016	C160405-16
EU-07	A56	Pre-runoff	4/5/2016	C160405-17
EU-07	A56	Pre-runoff	4/5/2016	C160405-18
EU-07	A55	Pre-runoff	4/14/2016	C160510-03
EU-07	A55	Pre-runoff	4/14/2016	C160510-04
EU-07	A56	Pre-runoff	4/14/2016	C160510-05
EU-07	A56	Pre-runoff	4/14/2016	C160510-06
EU-07	A55	Pre-runoff	4/21/2016	C160511-03
EU-07	A55	Pre-runoff	4/21/2016	C160511-04
EU-07	A56	Pre-runoff	4/21/2016	C160511-05
EU-07	A56	Pre-runoff	4/21/2016	C160511-06
EU-07	A55	Pre-runoff	4/27/2016	C160513-04
EU-07	A56	Pre-runoff	4/27/2016	C160513-05
EU-07	A56	Pre-runoff	4/27/2016	C160513-06
EU-07	A55	Pre-runoff	4/27/2016	C160513-03
EU-07	A56	Runoff	5/4/2016	C160512-15
EU-07	A56	Runoff	5/4/2016	C160512-16
EU-07	A55	Runoff	5/4/2016	C160512-43
EU-07	A55	Runoff	5/4/2016	C160512-44
EU-07	A55	Runoff	5/19/2016	C160706-03
EU-07	A55	Runoff	5/19/2016	C160706-04
EU-07	A56	Runoff	5/19/2016	C160706-05
EU-07	A56	Runoff	5/19/2016	C160706-06
EU-07	A55	Runoff	6/6/2016	C160608-AC
EU-07	A55	Runoff	6/6/2016	C160608-AD

Table A.1.1 (cont) Laboratory Sample IDs for Surface Water Samples Used to Identify Contaminants of Potential Ecological Concern and Estimate Exposure to Aquatic Community-level Receptors

Exposure unit	Loc. ID	Hydroperiod	Collection date	Lab_Samp_No
EU-07	A56	Runoff	6/7/2016	C160608-AI
EU-07	A56	Runoff	6/7/2016	C160608-AJ
EU-07	A55	Post-runoff	9/27/2016	C161003-CP
EU-07	A55	Post-runoff	9/27/2016	C161003-CQ
EU-07	A56	Post-runoff	9/27/2016	C161003-CY
EU-07	A56	Post-runoff	9/27/2016	C161003-CZ
EU-07	A55	Pre-runoff	3/21/2017	C170306-01
EU-07	A55	Pre-runoff	3/21/2017	C170306-02
EU-07	A56	Pre-runoff	3/21/2017	C170306-04
EU-07	A56	Pre-runoff	3/21/2017	C170306-05
EU-07	A55	Pre-runoff	4/4/2017	C170401-01
EU-07	A55	Pre-runoff	4/4/2017	C170401-02
EU-07	A56	Pre-runoff	4/4/2017	C170401-04
EU-07	A56	Pre-runoff	4/4/2017	C170401-05
EU-07	A55	Pre-runoff	4/18/2017	C170405-01
EU-07	A55	Pre-runoff	4/18/2017	C170405-02
EU-07	A56	Pre-runoff	4/18/2017	C170405-04
EU-07	A56	Pre-runoff	4/18/2017	C170405-05
EU-07	A55	Runoff	5/2/2017	C170504-01
EU-07	A55	Runoff	5/2/2017	C170504-02
EU-07	A56	Runoff	5/2/2017	C170504-04
EU-07	A56	Runoff	5/2/2017	C170504-05
EU-07	A55	Runoff	5/16/2017	C170509-13
EU-07	A55	Runoff	5/16/2017	C170509-14
EU-07	A56	Runoff	5/16/2017	C170509-16
EU-07	A56	Runoff	5/16/2017	C170509-17
EU-07	A55	Runoff	6/6/2017	C170605-64
EU-07	A55	Runoff	6/6/2017	C170605-65
EU-07	A56	Runoff	6/6/2017	C170605-70
EU-07	A56	Runoff	6/6/2017	C170605-71
EU-07	A56	Post-runoff	9/26/2017	C171004-FY
EU-07	A56	Post-runoff	9/26/2017	C171004-FZ
EU-08	A48	Runoff	6/9/2015	C150608-69
EU-08	A48	Runoff	6/9/2015	C150608-70
EU-08	A48	Post-runoff	9/30/2015	C151005-DL
EU-08	A48	Post-runoff	9/30/2015	C151005-DM
EU-08	A48	Runoff	5/4/2016	C160512-13
EU-08	A48	Runoff	5/4/2016	C160512-14
EU-08	A48	Post-runoff	9/27/2016	C161003-CG
EU-08	A48	Post-runoff	9/27/2016	C161003-CH
EU-08	A48	Runoff	6/6/2017	C170605-58
EU-08	A48	Runoff	6/6/2017	C170605-59
EU-08	A48	Post-runoff	9/28/2017	C171004-FJ
EU-08	A48	Post-runoff	9/28/2017	C171004-FK
EU-09	A41A	Runoff	6/9/2015	C150608-57
EU-09	A41A	Runoff	6/9/2015	C150608-58
EU-09	A45	Runoff	6/9/2015	C150608-65
EU-09	A45	Runoff	6/9/2015	C150608-66
EU-09	A41A	Post-runoff	8/4/2015	G3538-11
EU-09	A41A	Post-runoff	8/4/2015	G3541-11
EU-09	A41A	Post-runoff	9/30/2015	C151005-CS
EU-09	A41A	Post-runoff	9/30/2015	C151005-CT
EU-09	A45	Post-runoff	9/30/2015	C151005-DE
EU-09	A45	Post-runoff	9/30/2015	C151005-DF
EU-09	A45	Pre-runoff	4/5/2016	C160405-11
EU-09	A45	Pre-runoff	4/5/2016	C160405-12
EU-09	A41A	Pre-runoff	4/6/2016	C160405-09
EU-09	A41A	Pre-runoff	4/6/2016	C160405-10
EU-09	A41A	Runoff	5/4/2016	C160512-09
EU-09	A41A	Runoff	5/4/2016	C160512-10
EU-09	A45	Runoff	5/4/2016	C160512-41
EU-09	A45	Runoff	5/4/2016	C160512-42
EU-09	A41A	Runoff	6/7/2016	C160608-78
EU-09	A41A	Runoff	6/7/2016	C160608-79
EU-09	A45	Runoff	6/7/2016	C160608-90
EU-09	A45	Runoff	6/7/2016	C160608-91
EU-09	A45	Post-runoff	9/28/2016	C161003-BX
EU-09	A45	Post-runoff	9/28/2016	C161003-BY
EU-09	A41A	Post-runoff	9/29/2016	C161003-BI
EU-09	A41A	Post-runoff	9/29/2016	C161003-BJ
EU-09	A41A	Runoff	6/7/2017	C170605-49
EU-09	A41A	Runoff	6/7/2017	C170605-50
EU-09	A45	Runoff	6/7/2017	C170605-52
EU-09	A45	Runoff	6/7/2017	C170605-53
EU-09	A41A	Post-runoff	9/28/2017	C171004-EV
EU-09	A41A	Post-runoff	9/28/2017	C171004-EW
EU-09	A45	Post-runoff	9/28/2017	C171004-FA
EU-09	A45	Post-runoff	9/28/2017	C171004-FB
EU-10	A35	Runoff	6/9/2015	C150608-47
EU-10	A35	Runoff	6/9/2015	C150608-48
EU-10	A40	Runoff	6/9/2015	C150608-53
EU-10	A40	Runoff	6/9/2015	C150608-54
EU-10	A40	Post-runoff	8/4/2015	G3537-03
EU-10	A40	Post-runoff	8/4/2015	G3539-03
EU-10	A35	Post-runoff	9/30/2015	C151005-BS
EU-10	A35	Post-runoff	9/30/2015	C151005-BT
EU-10	A40	Post-runoff	9/30/2015	C151005-CH
EU-10	A40	Post-runoff	9/30/2015	C151005-CI
EU-10	A35	Pre-runoff	4/5/2016	C160405-05
EU-10	A35	Pre-runoff	4/5/2016	C160405-06
EU-10	A40	Pre-runoff	4/6/2016	C160405-07
EU-10	A40	Pre-runoff	4/6/2016	C160405-08
EU-10	A35	Runoff	5/4/2016	C160512-05
EU-10	A35	Runoff	5/4/2016	C160512-06
EU-10	A40	Runoff	5/4/2016	C160512-07
EU-10	A40	Runoff	5/4/2016	C160512-08
EU-10	A35	Runoff	6/7/2016	C160608-60
EU-10	A35	Runoff	6/7/2016	C160608-61
EU-10	A40	Runoff	6/7/2016	C160608-69
EU-10	A40	Runoff	6/7/2016	C160608-70
EU-10	A35	Post-runoff	9/29/2016	C161003-98
EU-10	A35	Post-runoff	9/29/2016	C161003-99
EU-10	A40	Post-runoff	9/29/2016	C161003-AW
EU-10	A40	Post-runoff	9/29/2016	C161003-AX
EU-10	A35	Runoff	5/17/2017	C170509-07
EU-10	A35	Runoff	5/17/2017	C170509-08
EU-10	A35	Runoff	6/7/2017	C170605-40
EU-10	A35	Runoff	6/7/2017	C170605-41
EU-10	A40	Runoff	6/7/2017	C170605-43
EU-10	A40	Runoff	6/7/2017	C170605-44
EU-10	A35	Post-runoff	9/26/2017	C171004-DC
EU-10	A35	Post-runoff	9/26/2017	C171004-DD

Table A.1.1 (cont) Laboratory Sample IDs for Surface Water Samples Used to Identify Contaminants of Potential Ecological Concern and Estimate Exposure to Aquatic Community-level Receptors

Exposure unit	Loc. ID	Hydroperiod	Collection date	Lab_Samp_No
EU-10	A40	Post-runoff	9/28/2017	C171004-EL
EU-10	A40	Post-runoff	9/28/2017	C171004-EM
EU-11	A36	Runoff	6/10/2015	C150608-49
EU-11	A36	Runoff	6/10/2015	C150608-50
EU-11	A36	Post-runoff	9/29/2015	C151005-BW
EU-11	A36	Post-runoff	9/29/2015	C151005-BX
EU-11	A36	Runoff	6/8/2016	C160608-63
EU-11	A36	Runoff	6/8/2016	C160608-64
EU-11	A36	Post-runoff	9/27/2016	C161003-AE
EU-11	A36	Post-runoff	9/27/2016	C161003-AF
EU-11	A36	Post-runoff	7/11/2017	C170703-73
EU-11	A36	Post-runoff	7/11/2017	C170703-74
EU-11	A36	Post-runoff	9/26/2017	C171004-DH
EU-11	A36	Post-runoff	9/26/2017	C171004-DI
EU-12	A37	Runoff	6/10/2015	C150608-51
EU-12	A37	Runoff	6/10/2015	C150608-52
EU-12	A37	Post-runoff	9/29/2015	C151005-CA
EU-12	A37	Post-runoff	9/29/2015	C151005-CB
EU-12	A37	Runoff	6/8/2016	C160608-66
EU-12	A37	Runoff	6/8/2016	C160608-67
EU-12	A37	Post-runoff	9/27/2016	C161003-AK
EU-12	A37	Post-runoff	9/27/2016	C161003-AL
EU-12	A37	Post-runoff	7/11/2017	C170703-79
EU-12	A37	Post-runoff	7/11/2017	C170703-80
EU-12	A37	Post-runoff	9/26/2017	C171004-DR
EU-12	A37	Post-runoff	9/26/2017	C171004-DS
EU-13	A34	Runoff	6/9/2015	C150608-45
EU-13	A34	Runoff	6/9/2015	C150608-46
EU-13	A34	Post-runoff	8/5/2015	G3537-02
EU-13	A34	Post-runoff	8/5/2015	G3539-02
EU-13	A34	Post-runoff	9/30/2015	C151005-BO
EU-13	A34	Post-runoff	9/30/2015	C151005-BP
EU-13	A34	Pre-runoff	4/5/2016	C160405-03
EU-13	A34	Pre-runoff	4/5/2016	C160405-04
EU-13	A34	Runoff	5/4/2016	C160512-03
EU-13	A34	Runoff	5/4/2016	C160512-04
EU-13	A34	Runoff	6/7/2016	C160608-57
EU-13	A34	Runoff	6/7/2016	C160608-58
EU-13	A34	Post-runoff	9/27/2016	C161003-92
EU-13	A34	Post-runoff	9/27/2016	C161003-93
EU-13	A34	Runoff	5/17/2017	C170509-04
EU-13	A34	Runoff	5/17/2017	C170509-05
EU-13	A34	Runoff	6/7/2017	C170605-37
EU-13	A34	Runoff	6/7/2017	C170605-38
EU-13	A34	Post-runoff	9/28/2017	C171004-CX
EU-13	A34	Post-runoff	9/28/2017	C171004-CY
EU-14	A14	Runoff	6/9/2015	C150608-19
EU-14	A14	Runoff	6/9/2015	C150608-20
EU-14	A33	Post-runoff	8/5/2015	G3537-01
EU-14	A33	Post-runoff	8/5/2015	G3539-01
EU-14	A14	Post-runoff	9/29/2015	C151005-68
EU-14	A14	Post-runoff	9/29/2015	C151005-69
EU-14	A33	Post-runoff	9/30/2015	C151005-BK
EU-14	A33	Post-runoff	9/30/2015	C151005-BL
EU-14	A33	Pre-runoff	4/5/2016	C160405-01
EU-14	A33	Pre-runoff	4/5/2016	C160405-02
EU-14	A33	Runoff	5/4/2016	C160512-01
EU-14	A33	Runoff	5/4/2016	C160512-02
EU-14	A14	Runoff	6/7/2016	C160608-27
EU-14	A14	Runoff	6/7/2016	C160608-28
EU-14	A33	Runoff	6/7/2016	C160608-54
EU-14	A33	Runoff	6/7/2016	C160608-55
EU-14	A33	Post-runoff	9/27/2016	C161003-86
EU-14	A33	Post-runoff	9/27/2016	C161003-87
EU-14	A14	Post-runoff	9/29/2016	C161003-47
EU-14	A14	Post-runoff	9/29/2016	C161003-48
EU-14	A33	Runoff	5/17/2017	C170509-01
EU-14	A33	Runoff	5/17/2017	C170509-02
EU-14	A14	Runoff	6/7/2017	C170605-16
EU-14	A14	Runoff	6/7/2017	C170605-17
EU-14	A33	Runoff	6/7/2017	C170605-34
EU-14	A33	Runoff	6/7/2017	C170605-35
EU-14	A14	Post-runoff	9/26/2017	C171004-98
EU-14	A14	Post-runoff	9/26/2017	C171004-99
EU-14	A33	Post-runoff	9/28/2017	C171004-CS
EU-14	A33	Post-runoff	9/28/2017	C171004-CT
EU-15	A10	Runoff	6/9/2015	C150608-09
EU-15	A10	Runoff	6/9/2015	C150608-10
EU-15	A10	Post-runoff	9/29/2015	C151005-50
EU-15	A10	Post-runoff	9/29/2015	C151005-51
EU-15	A10	Runoff	6/7/2016	C160608-13
EU-15	A10	Runoff	6/7/2016	C160608-14
EU-15	A10	Post-runoff	9/29/2016	C161003-31
EU-15	A10	Post-runoff	9/29/2016	C161003-32
EU-15	A10	Runoff	6/7/2017	C170605-07
EU-15	A10	Runoff	6/7/2017	C170605-08
EU-15	A10	Post-runoff	9/26/2017	C171004-83
EU-15	A10	Post-runoff	9/26/2017	C171004-84
EU-16	A20	Runoff	6/10/2015	C150608-23
EU-16	A20	Runoff	6/10/2015	C150608-24
EU-16	A20	Post-runoff	9/29/2015	C151005-85
EU-16	A20	Post-runoff	9/29/2015	C151005-86
EU-16	A20	Runoff	6/29/2016	C160701-49
EU-16	A20	Runoff	6/29/2016	C160701-50
EU-16	A20	Post-runoff	9/30/2016	C161003-63
EU-16	A20	Post-runoff	9/30/2016	C161003-64
EU-16	A20	Post-runoff	7/12/2017	C170703-58
EU-16	A20	Post-runoff	7/12/2017	C170703-59
EU-16	A20	Post-runoff	9/27/2017	C171004-AW
EU-16	A20	Post-runoff	9/27/2017	C171004-AX
EU-17	A15	Runoff	6/10/2015	C150608-21
EU-17	A15	Runoff	6/10/2015	C150608-22
EU-17	A15	Post-runoff	9/29/2015	C151005-72
EU-17	A15	Post-runoff	9/29/2015	C151005-73
EU-17	A15	Runoff	6/8/2016	C160608-30
EU-17	A15	Runoff	6/8/2016	C160608-31
EU-17	A15	Post-runoff	9/30/2016	C161003-53
EU-17	A15	Post-runoff	9/30/2016	C161003-54
EU-17	A15	Post-runoff	7/11/2017	C170703-46
EU-17	A15	Post-runoff	7/11/2017	C170703-47
EU-17	A15	Post-runoff	9/27/2017	C171004-AD
EU-17	A15	Post-runoff	9/27/2017	C171004-AE

Table A.1.1 (cont) Laboratory Sample IDs for Surface Water Samples Used to Identify Contaminants of Potential Ecological Concern and Estimate Exposure to Aquatic Community-level Receptors

Exposure unit	Loc. ID	Hydroperiod	Collection date	Lab_Samp_No
EU-18	A09	Runoff	6/9/2015	C150608-07
EU-18	A09	Runoff	6/9/2015	C150608-08
EU-18	A08	Runoff	6/10/2015	C150608-05
EU-18	A08	Runoff	6/10/2015	C150608-06
EU-18	A09	Post-runoff	9/29/2015	C151005-46
EU-18	A09	Post-runoff	9/29/2015	C151005-47
EU-18	A08	Post-runoff	9/30/2015	C151005-42
EU-18	A08	Post-runoff	9/30/2015	C151005-43
EU-18	A09	Runoff	6/7/2016	C160608-10
EU-18	A09	Runoff	6/7/2016	C160608-11
EU-18	A08	Runoff	6/8/2016	C160608-07
EU-18	A08	Runoff	6/8/2016	C160608-08
EU-18	A09	Post-runoff	9/29/2016	C161003-25
EU-18	A09	Post-runoff	9/29/2016	C161003-26
EU-18	A08	Post-runoff	9/30/2016	C161003-19
EU-18	A08	Post-runoff	9/30/2016	C161003-20
EU-18	A09	Runoff	6/7/2017	C170605-04
EU-18	A09	Runoff	6/7/2017	C170605-05
EU-18	A08	Post-runoff	7/11/2017	C170703-43
EU-18	A08	Post-runoff	7/11/2017	C170703-44
EU-18	A08	Post-runoff	9/26/2017	C171004-68
EU-18	A08	Post-runoff	9/26/2017	C171004-69
EU-18	A09	Post-runoff	9/26/2017	C171004-73
EU-18	A09	Post-runoff	9/26/2017	C171004-74
EU-19	A07	Post-runoff	9/30/2015	C151005-27
EU-19	A07	Post-runoff	9/30/2015	C151005-28
EU-19	A07	Runoff	6/8/2016	C160608-04
EU-19	A07	Runoff	6/8/2016	C160608-05
EU-19	A07	Post-runoff	9/30/2016	C161003-07
EU-19	A07	Post-runoff	9/30/2016	C161003-08
EU-19	A07	Post-runoff	7/11/2017	C170703-04
EU-19	A07	Post-runoff	7/11/2017	C170703-05
EU-19	A07	Post-runoff	9/26/2017	C171004-06
EU-19	A07	Post-runoff	9/26/2017	C171004-07
EU-DR01	ames Ranc	Post-runoff	9/24/2014	C140919-FU
EU-DR01	ames Ranc	Post-runoff	9/24/2014	C140919-FV
EU-DR01	nd St Brid	Post-runoff	9/25/2014	C140919-AP
EU-DR01	nd St Brid	Post-runoff	9/25/2014	C140919-AQ
EU-DR01	nd St Brid	Post-runoff	10/27/2015	GKMSW04_102715
EU-DR01	9426	Post-runoff	10/29/2015	9426SW_10292105
EU-DR01	9426	Pre-runoff	3/22/2016	9426_032216L
EU-DR01	nd St Brid	Pre-runoff	3/24/2016	32ndStreetBridge_032416L
EU-DR01	oxbow par	Pre-runoff	3/24/2016	OxbowPark_032416L
EU-DR01	9426	Runoff	6/6/2016	9426_060616L
EU-DR01	nd St Brid	Runoff	6/7/2016	32nd St Bridge_060716L
EU-DR01	nd St Brid	Post-runoff	8/22/2016	32nd St Bridge_082216
EU-DR01	9426	Post-runoff	8/22/2016	9426_082216
EU-DR01	nd St Brid	Post-runoff	9/28/2016	32nd St Bridge_092816
EU-DR01	9426	Post-runoff	9/29/2016	9426_092916
EU-DR02	Lightner C	Post-runoff	9/24/2014	C140919-AV
EU-DR02	Lightner C	Post-runoff	9/24/2014	C140919-AW
EU-DR02	Purple Cliff	Post-runoff	9/24/2014	C140919-BB
EU-DR02	Purple Cliff	Post-runoff	9/24/2014	C140919-BC
EU-DR02	Rotary Par	Post-runoff	10/27/2015	Animas Rotary Park_102715
EU-DR02	GKM05	Post-runoff	10/27/2015	GKMSW05_102715
EU-DR02	AR19-3	Post-runoff	10/28/2015	GKMSW01_10282015
EU-DR02	AR19-3	Pre-runoff	3/23/2016	AR19-3_032316L
EU-DR02	Rotary Par	Pre-runoff	3/24/2016	ANIMAS-ROTARY-PARK_032416L
EU-DR02	GKM05	Pre-runoff	3/24/2016	GKMSW05_032416L
EU-DR02	Rotary Park	Runoff	6/7/2016	Animas-RotaryPark_060716L
EU-DR02	AR19-3	Runoff	6/8/2016	AR19-3_060816L
EU-DR02	Rotary Park	Post-runoff	8/22/2016	Animas_RotaryPark_082216
EU-DR02	GKM05	Post-runoff	8/25/2016	GKM05_082516
EU-DR02	Rotary Park	Post-runoff	8/28/2016	Animas_RotaryPark_082816
EU-DR02	AR19-3	Post-runoff	8/28/2016	AR19-3_082816
EU-DR02	AR19-3	Post-runoff	9/2/2016	AR19-3_090216
EU-DR02	Rotary Park	Post-runoff	9/28/2016	Animas_RotaryPark_092816
EU-DR02	GKM05	Post-runoff	9/30/2016	GKM05_093016
EU-DR02	AR19-3	Post-runoff	10/4/2016	AR19-3_100416
EU-DR02	Rotary Park	Pre-runoff	4/4/2017	Rotary Park_040417
EU-DR02	Rotary Park	Pre-runoff	4/12/2017	Rotary Park_041217
EU-DR02	Rotary Park	Pre-runoff	4/25/2017	Rotary Park_042517
EU-DR02	Rotary Park	Runoff	5/11/2017	Rotary Park_051117
EU-DR02	Rotary Park	Runoff	5/18/2017	Rotary Park_051817
EU-DR02	Rotary Park	Runoff	5/31/2017	Rotary Park_053117
EU-DR02	Rotary Park	Runoff	6/7/2017	Rotary Park_060717
EU-DR02	Rotary Park	Runoff	6/14/2017	Rotary Park_061417
Bear Cr.	M30	Post-runoff	9/27/2016	C161005-EZ
Bear Cr.	M30	Post-runoff	9/27/2016	C161005-FA
Bear Cr.	M30	Post-runoff	9/28/2017	C171007-EY
Bear Cr.	M30	Post-runoff	9/28/2017	C171007-EZ
Hermosa Cr.	HC01	Post-runoff	10/4/2016	C161007-73
Hermosa Cr.	HC01	Post-runoff	10/4/2016	C161007-74
Maggie Gulch	A43	Runoff	6/9/2015	C150608-63
Maggie Gulch	A43	Runoff	6/9/2015	C150608-64
Maggie Gulch	A43	Post-runoff	9/30/2015	C151005-DA
Maggie Gulch	A43	Post-runoff	9/30/2015	C151005-DB
Maggie Gulch	A43	Runoff	6/7/2016	C160608-87
Maggie Gulch	A43	Runoff	6/7/2016	C160608-88
Maggie Gulch	A43	Post-runoff	9/28/2016	C161003-BR
Maggie Gulch	A43	Post-runoff	9/28/2016	C161003-BS
Mill Creek	M08	Runoff	6/9/2016	C160609-BX
Mill Creek	M08	Runoff	6/9/2016	C160609-BY
Mill Creek	M08	Post-runoff	9/30/2016	C161005-77
Mill Creek	M08	Post-runoff	9/30/2016	C161005-78
Picayne Gulch	A26	Runoff	6/9/2015	C150608-29
Picayne Gulch	A26	Runoff	6/9/2015	C150608-30
Picayne Gulch	A26	Post-runoff	9/30/2015	C151005-AK
Picayne Gulch	A26	Post-runoff	9/30/2015	C151005-AL
Picayne Gulch	A26	Post-runoff	9/29/2016	C161004-01
Picayne Gulch	A26	Post-runoff	9/29/2016	C161004-02
Upper Animas	A05	Runoff	6/10/2015	C150608-03
Upper Animas	A05	Runoff	6/10/2015	C150608-04
Upper Animas	A05	Post-runoff	9/30/2015	C151005-20
Upper Animas	A05	Post-runoff	9/30/2015	C151005-21
Upper Animas	A05	Runoff	6/8/2016	C160608-01
Upper Animas	A05	Runoff	6/8/2016	C160608-02
Upper Animas	A05	Post-runoff	9/30/2016	C161003-01
Upper Animas	A05	Post-runoff	9/30/2016	C161003-02
Upper Animas	A05	Runoff	6/7/2017	C170605-01
Upper Animas	A05	Runoff	6/7/2017	C170605-02
Upper Animas	A05	Post-runoff	7/11/2017	C170703-01
Upper Animas	A05	Post-runoff	7/11/2017	C170703-02
Upper Animas	A05	Post-runoff	9/26/2017	C171004-01
Upper Animas	A05	Post-runoff	9/26/2017	C171004-02

Appendix 2

List of Pore Water Samples Used in the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 2 Tables:

Table A2.1 Laboratory Sample IDs for Pore Water Samples Used to Identify Contaminants of Potential Ecological Concern and Estimate Exposure to Community-level Receptors

Table A2.1 Laboratory Sample IDs for Pore Water Samples Used to Identify Contaminants of Potential Ecological Concern and Estimate Exposure to Community-level Receptors

Exposure unit	Site ID	Collection date	Lab_Samp_No
EU-01	M34	9/25/2014	C140919-GG
EU-01	M34	9/29/2015	C151006-EM
EU-01	M34	9/29/2015	C151006-EN
EU-01	M34	9/27/2016	C161005-FO
EU-01	M34	9/27/2016	C161005-FP
EU-02	M27	9/27/2016	C161005-EF
EU-02	M27	9/27/2016	C161005-EH
EU-02	M27A	9/28/2016	C161005-EN
EU-02	M27A	9/28/2016	C161005-EO
EU-03	M14B	9/28/2016	C161005-AZ
EU-03	M14B	9/28/2016	C161005-BA
EU-03	M11	10/7/2016	C161007-AS
EU-03	M11	10/7/2016	C161007-AT
EU-04	M10A	10/7/2016	C161007-AP
EU-04	M10A	10/7/2016	C161007-AQ
EU-05	M28	9/27/2016	C161005-ET
EU-05	M28	9/27/2016	C161005-EU
EU-06	M20	9/29/2016	C161005-CV
EU-06	M20	9/29/2016	C161005-CW
EU-07	A55	4/16/2014	C140406-01
EU-07	A56	4/16/2014	C140406-05
EU-07	A55	9/23/2014	C140919-22
EU-07	A56	9/23/2014	C140919-28
EU-07	A55	11/19/2014	C141108-05
EU-07	A56	11/19/2014	C141108-10
EU-07	A56	9/29/2015	C151005-EA
EU-07	A56	9/29/2015	C151005-EB
EU-07	A55	9/27/2016	C161003-CS
EU-07	A55	9/27/2016	C161003-CT
EU-07	A56	9/27/2016	C161003-DB
EU-07	A56	9/27/2016	C161003-DC
EU-08	A48	9/27/2016	C161003-CJ
EU-08	A48	9/27/2016	C161003-CK
EU-09	A41A	8/4/2015	G3538-12
EU-09	A41A	8/4/2015	G3541-12
EU-09	A45	9/28/2016	C161003-CA
EU-09	A45	9/28/2016	C161003-CB
EU-09	A41A	9/29/2016	C161003-BL
EU-09	A41A	9/29/2016	C161003-BM
EU-10	A35	9/29/2016	C161003-AB
EU-10	A35	9/29/2016	C161003-AC
EU-10	A40	9/29/2016	C161003-AZ
EU-10	A40	9/29/2016	C161003-BA
EU-11	A36	9/28/2016	C161003-AH
EU-11	A36	9/28/2016	C161003-AI
EU-12	A37	9/28/2016	C161003-AN
EU-12	A37	9/28/2016	C161003-AO
EU-13	A34	9/29/2016	C161003-95
EU-13	A34	9/29/2016	C161003-96
EU-14	A14	9/29/2016	C161003-50
EU-14	A14	9/29/2016	C161003-51
EU-14	A33	9/29/2016	C161003-89
EU-14	A33	9/29/2016	C161003-90
EU-15	A10	9/29/2016	C161003-34
EU-15	A10	9/29/2016	C161003-35
EU-16	A20	9/30/2016	C161003-66
EU-16	A20	9/30/2016	C161003-67
EU-17	A15	9/30/2016	C161003-56
EU-17	A15	9/30/2016	C161003-57
EU-18	A09	9/29/2016	C161003-28
EU-18	A09	9/29/2016	C161003-29
EU-18	A08	9/30/2016	C161003-22
EU-18	A08	9/30/2016	C161003-23
EU-19	A07	9/30/2016	C161003-10
EU-19	A07	9/30/2016	C161003-11
EU-DR01	James Ranch	9/24/2014	C140919-FZ
EU-DR01	32nd St Bridge	9/25/2014	C140919-AU
EU-DR01	James Ranch	11/19/2014	C141108-75
EU-DR02	Lightner Creek	9/24/2014	C140919-BA
EU-DR02	Purple Cliffs	9/24/2014	C140919-BG
Bear Cr.	M30	9/27/2016	C161005-FC
Bear Cr.	M30	9/27/2016	C161005-FD
Hermosa Cr.	HC01	10/8/2016	C161007-76
Hermosa Cr.	HC01	10/8/2016	C161007-77
Maggie Gulch	A43	9/28/2016	C161003-BU
Maggie Gulch	A43	9/28/2016	C161003-BV
Mill Cr.	M08	10/7/2016	C161007-AM
Mill Cr.	M08	10/7/2016	C161007-AN
Picayne Gulch	A26	9/29/2016	C161004-04
Picayne Gulch	A26	9/29/2016	C161004-05
Upper Animas	A05	9/30/2016	C161003-04
Upper Animas	A05	9/30/2016	C161003-05

Appendix 3

List of Sediment Samples Used in the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 3 Tables:

Table A3.1 Laboratory Sample IDs for Sediment Samples Used to Identify Contaminants of Potential Ecological Concern and Estimate Exposure to Community-level and Wildlife Receptors

Table A3.1 Laboratory Sample IDs for Sediment Samples Used to Identify Contaminants of Potential Ecological Concern and Estimate Exposure to Community-level and Wildlife Receptors

Exposure unit	Site ID	Collection date	Lab_Samp_No
Bear Cr.	M30	9/27/2016	6100162-05
Bear Cr.	M30	9/28/2017	C171007-FC
EU-01	M34	10/4/2012	C121012-GY
EU-01	M34	9/24/2014	C140919-GF
EU-01	M34	9/29/2015	C151006-EL
EU-01	M34	10/26/2015	M34SE_102615
EU-01	M34	3/22/2016	M34_SED_032216L
EU-01	M34	6/6/2016	M34_SED_060616L
EU-01	M34	8/23/2016	M34_SED_082316
EU-01	M34	9/27/2016	6100162-11
EU-01	M34	9/26/2017	C171007-GB
EU-01	M29A	9/28/2017	C171007-EX
EU-02	M27	9/27/2016	6100159-16
EU-02	M27A	9/28/2016	6100159-18
EU-02	M27	9/27/2017	C171007-DY
EU-02	M27A	9/28/2017	C171007-ED
EU-03	M14B	9/28/2016	6100155-15
EU-03	M11	9/30/2016	6100154-11
EU-03	M14B	9/27/2017	C171007-89
EU-03	M11	9/28/2017	C171007-54
EU-04	M10A	9/30/2016	6100154-07
EU-04	M10A	9/28/2017	C171007-44
EU-05	M28	9/27/2016	6100159-14
EU-05	M28	9/27/2017	C171007-EN
EU-06	M20	9/29/2016	6100159-01
EU-06	M20	9/26/2017	C171007-BY
EU-07	A56	10/3/2012	C121012-01
EU-07	A56	5/13/2013	C130504-05
EU-07	A55	4/16/2014	C140406-02
EU-07	A56	4/16/2014	C140406-06
EU-07	A55	9/23/2014	C140919-21
EU-07	A56	9/23/2014	C140919-27
EU-07	A55	8/4/2015	G3551-01
EU-07	A55	9/29/2015	C151005-DV
EU-07	A56	9/29/2015	C151005-DZ
EU-07	A55	9/27/2016	6100176-06
EU-07	A56	9/27/2016	6100176-15
EU-07	A56	9/26/2017	C171004-GC
EU-08	A48	8/4/2015	G3550-20
EU-08	A48	9/30/2015	C151005-DO
EU-08	A48	9/27/2016	6100176-04
EU-08	A48	9/28/2017	C171004-FN
EU-09	A41A	8/4/2015	G3550-15
EU-09	A45	8/4/2015	G3550-19
EU-09	A41A	9/30/2015	C151005-CV
EU-09	A45	9/30/2015	C151005-DH
EU-09	A45	9/28/2016	6100175-14
EU-09	A41A	9/29/2016	6100175-12
EU-09	A41A	9/28/2017	C171004-EZ
EU-09	A45	9/28/2017	C171004-FE
EU-10	A40	8/4/2015	G3550-13
EU-10	A35	8/5/2015	G3550-10
EU-10	A35	9/30/2015	C151005-BV
EU-10	A40	9/30/2015	C151005-CK
EU-10	A35	9/29/2016	6100174-18
EU-10	A40	9/29/2016	6100175-04
EU-10	A35	9/26/2017	C171004-DG
EU-10	A40	9/28/2017	C171004-EP
EU-11	A36	8/5/2015	G3550-11
EU-11	A36	9/29/2015	C151005-BZ
EU-11	A36	9/27/2016	6100174-08
EU-11	A36	9/26/2017	C171004-DL
EU-12	A37	8/5/2015	G3550-12
EU-12	A37	9/29/2015	C151005-CD
EU-12	A37	9/27/2016	6100174-10
EU-12	A37	9/26/2017	C171004-DV
EU-13	A34	8/5/2015	G3550-09
EU-13	A34	9/30/2015	C151005-BR
EU-13	A34	9/27/2016	6100174-16
EU-13	A34	9/28/2017	C171004-DB
EU-14	A14	8/4/2015	G3549-13
EU-14	A33	8/5/2015	G3550-08
EU-14	A14	9/29/2015	C151005-71
EU-14	A33	9/30/2015	C151005-BN
EU-14	A33	9/27/2016	6100174-14
EU-14	A14	9/29/2016	6100172-16
EU-14	A14	9/26/2017	C171004-AC
EU-14	A33	9/28/2017	C171004-CW
EU-15	A10	8/4/2015	G3549-11
EU-15	A10	9/29/2015	C151005-53
EU-15	A10	9/29/2016	6100173-02
EU-15	A10	9/26/2017	C171004-87
EU-16	A20	8/6/2015	G3549-18
EU-16	A20	9/29/2015	C151005-88
EU-16	A20	9/30/2016	6100172-02
EU-16	A20	9/27/2017	C171004-BA
EU-17	A15	8/5/2015	G3549-14
EU-17	A15	9/29/2015	C151005-75
EU-17	A15	9/30/2016	6100172-04
EU-17	A15	9/27/2017	C171004-AH
EU-18	A09	8/4/2015	G3549-10
EU-18	A08	8/5/2015	G3549-09
EU-18	A09	9/29/2015	C151005-49
EU-18	A08	9/30/2015	C151005-45
EU-18	A09	9/29/2016	6100172-18
EU-18	A08	9/30/2016	6100171-14
EU-18	A08	9/26/2017	C171004-72
EU-18	A09	9/26/2017	C171004-77
EU-19	A07	8/5/2015	G3549-04
EU-19	A07	9/30/2015	C151005-30
EU-19	A07	9/30/2016	6100171-06
EU-19	A07	9/26/2017	C171004-10
EU-DR01	James Ranch	9/24/2014	C140919-FY
EU-DR01	32nd St Bridge	9/25/2014	C140919-AT
EU-DR01	32nd St Bridge	10/27/2015	GKMSE204_102715
EU-DR01	Oxbow Park	10/27/2015	Oxbow ParkSE_102715
EU-DR01	9426	10/29/2015	9426SEDIMENT_10292105
EU-DR01	9426	3/22/2016	9426_SED_032216L
EU-DR01	32nd St Bridge	3/24/2016	32ndStreetBridge_SED_032416L
EU-DR01	Oxbow Park	3/24/2016	OxbowPark_SED_032416L
EU-DR01	9426	6/6/2016	9426_SED_060616L
EU-DR01	32nd St Bridge	6/7/2016	32nd St Bridge_SED_060716L
EU-DR01	Oxbow Park	6/7/2016	Oxbow Park_SED_060716L
EU-DR01	32nd St Bridge	8/22/2016	32nd St Bridge_SED_082216
EU-DR01	9426	8/22/2016	9426_SED_082216
EU-DR01	Oxbow Park	8/22/2016	Oxbow Park_SED_082216
EU-DR01	9426	9/29/2016	9426_SED_092916
EU-DR02	Lightner Creek	9/24/2014	C140919-AZ
EU-DR02	Purple Cliffs	9/24/2014	C140919-BF
EU-DR02	GKM05	10/27/2015	GKMSE205_102715
EU-DR02	Rotary Park	10/27/2015	Animas Rotary ParkSE_102715
EU-DR02	AR19-3	10/28/2015	GKMSE201_10282015
EU-DR02	AR19-3	3/23/2016	AR19-3_SED_032316L
EU-DR02	GKM05	3/24/2016	GKM205_SED_032416L
EU-DR02	Rotary Park	3/24/2016	ANIMAS-ROTARY-PARK_SED_032416L
EU-DR02	Rotary Park	6/7/2016	Animas-RotaryPark_SED_060716L
EU-DR02	AR19-3	6/8/2016	AR19-3_SED_060816L
EU-DR02	Rotary Park	8/22/2016	Animas_RotaryPark_SED_082216
EU-DR02	GKM05	8/25/2016	GKM05_SED_082516
EU-DR02	AR19-3	8/28/2016	AR19-3_SED_082816
EU-DR02	Rotary Park	8/28/2016	Animas_RotaryPark_SED_082816
EU-DR02	AR19-3	9/2/2016	AR19-3_SED_090216
EU-DR02	GKM05	9/30/2016	GKM05_SED_093016
EU-DR02	AR19-3	10/4/2016	AR19-3_SED_100416
EU-DR02	Rotary Park	4/4/2017	Rotary Park_SED_040417
EU-DR02	Rotary Park	4/12/2017	Rotary Park_SED_041217
EU-DR02	Rotary Park	4/25/2017	Rotary Park_SED_042517
EU-DR02	Rotary Park	5/11/2017	Rotary Park_SED_051117
EU-DR02	Rotary Park	5/18/2017	Rotary Park_SED_051817
EU-DR02	Rotary Park	5/31/2017	Rotary Park_SED_053117
EU-DR02	Rotary Park	6/7/2017	Rotary Park_SED_060717
EU-DR02	Rotary Park	6/14/2017	Rotary Park_SED_061417
Hermosa Cr.	HC01	10/4/2016	6100180-13
Maggie Gulch	A43	8/6/2015	G3550-18
Maggie Gulch	A43	9/30/2015	C151005-DD
Maggie Gulch	A43	9/28/2016	6100175-08
Mill Cr.	M08	9/30/2016	6100154-03
Picayne Gulch	A26	8/4/2015	G3550-03
Picayne Gulch	A26	9/30/2015	C151005-AN
Picayne Gulch	A26	9/29/2016	6100177-07
Upper Animas	A05	8/5/2015	G3549-03
Upper Animas	A05	9/30/2015	C151005-23
Upper Animas	A05	9/30/2016	6100171-12
Upper Animas	A05	9/26/2017	C171004-05

Appendix 4

List of Dietary Item Samples Used in the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 4 Tables:

Table A4.1 Laboratory Sample IDs for Forage Fish Tissue Samples Used to Estimate Exposure to Wildlife Receptors

Table A4.2 Laboratory Sample IDs for Benthic Macroinvertebrate Tissue Samples Used to Estimate Exposure to Wildlife Receptors

Table A4.1 Laboratory Sample IDs for Forage Fish Tissue Samples Used to Estimate Exposure to Wildlife Receptors

Exposure unit	Location	Lab_Samp_No
EU-03	Mineral Below Mill	C170201-51
EU-03	Mineral Below Mill	C170201-53
EU-03	Mineral Below Mill	C170201-59
EU-03	Mineral Below Mill	C170201-61
EU-03	Mineral Below Mill	C170201-63
EU-05	South Fork Mineral	C170201-75
EU-05	South Fork Mineral	C170201-77
EU-05	South Fork Mineral	C170201-79
EU-05	South Fork Mineral	C170201-81
EU-05	South Fork Mineral	C170201-83
EU-09	A45	C141201-01
EU-09	A45	C141201-02
EU-09	A45	C141201-03
EU-09	A45	C141201-04
EU-09	A45	C141201-05
EU-09	A45	C141201-06
EU-09	A45	C141201-07
EU-09	A45	C141201-08
EU-09	A45	C141201-09
EU-09	A45	C141201-10
EU-09	A45	C141201-11
EU-09	A45	C141201-12
EU-09	A45	C141201-13
EU-09	A45	C141201-14
EU-09	A45	C141201-15
EU-09	A45	C141201-16
EU-09	A45	C141201-17
EU-09	A45	C141201-18
EU-09	A45	C141201-19
EU-09	A45	C141201-20
EU-09	Animas Above Cunningham	C170201-07
EU-09	Animas Above Cunningham	C170201-11
EU-09	Animas Above Cunningham	C170201-13
EU-09	Animas Above Cunningham	C170201-15
EU-09	Animas Above Cunningham	C170201-17
EU-09	Animas Above Cunningham	C170201-19
Mill Creek	Mill Creek	C170201-31
Mill Creek	Mill Creek	C170201-41
Mill Creek	Mill Creek	C170201-43
Mill Creek	Mill Creek	C170201-45
Mill Creek	Mill Creek	C170201-47
Mill Creek	Mill Creek	C170201-49

Table A4.2 Laboratory Sample IDs for Benthic Macroinvertebrate Tissue Samples Used to Estimate Exposure to Wildlife Receptors		
Exposure unit	**Location**	**Lab_Samp_No**
EU-01	M34	C121106-05
EU-01	M34	C161022-18
EU-02	M27	C161022-15
EU-03	M14B	C161022-14
EU-03	Mineral Cr.- Abv. Browns Gulch	C161022-19
EU-04	M10A	C161022-13
EU-05	M28	C161022-16
EU-05	SF Mineral - Below Cal. Gulch	C161022-23
EU-07	A55	C151101-02
EU-07	A60	C151101-03
EU-07	A56	C121106-01
EU-07	A55	C141107-02
EU-07	A56	C141107-03
EU-07	A60	C141107-04
EU-07	A56	C161022-08
EU-08	A48	C161022-07
EU-09	A45	C141107-01
EU-09	A45	C161022-06
EU-10	Animas - Above Minnie Gulch	C161022-10
EU-11	SF Animas River	C161022-22
EU-12	A37	C161022-04
EU-13	A34	C161022-03
EU-14	Animas - Above Eureka	C161022-09
EU-16	Placer Gulch	C161022-21
EU-19	A07	C161022-02
EU-DR01	32nd St Bridge	C151101-01
EU-DR01	James Ranch	C151101-11
EU-DR01	OxbowPark	C151101-12
EU-DR02	Purple Cliffs	C151101-13
Bear Cr.	M30	C161022-17
Hermosa Cr.	Hermosa Cr.	C161022-11
Maggie Gulch	A43	C161022-05
Mill Cr.	M08	C161022-12
Picayne Gulch	Picayne Gulch	C161022-20
Upper Animas	A05	C161022-01

Appendix 5

List of Total Recoverable Metals Surface Water Samples Used in the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 5 Tables:

Table A5.1 Laboratory Sample IDs for Surface Water Samples Used to Estimate Exposure to Wildlife Receptors

Table A5.1 Laboratory Sample IDs for Surface Water Samples Used to Estimate Exposure to Wildlife Receptors

Exposure unit	Loc. ID	Collection date	Lab_Samp_No
EU-01	M34	5/15/2012	C120508-AU
EU-01	M34	10/2/2012	C121012-HA
EU-01	M34	10/4/2012	C121012-HD
EU-01	M34	5/14/2013	C130504-DO
EU-01	M34	5/5/2014	C140508-BP
EU-01	M34	9/24/2014	C140919-GB
EU-01	M34	6/9/2015	C150608-CG
EU-01	M34	9/29/2015	C151006-EI
EU-01	M34	10/26/2015	M34_102615
EU-01	M34	3/22/2016	M34_032216L
EU-01	M34	6/6/2016	M34_060616L
EU-01	M29A	6/7/2016	C160609-FG
EU-01	M34	6/7/2016	C160609-FV
EU-01	M34	9/27/2016	C161005-FL
EU-01	M34	9/27/2016	M34_092716
EU-01	M34	3/21/2017	C170306-42
EU-01	M34	4/4/2017	C170401-40
EU-01	M34	4/18/2017	C170405-40
EU-01	M34	5/2/2017	C170504-40
EU-01	M34	5/15/2017	C170509-79
EU-01	M29A	6/6/2017	C170606-CF
EU-01	M34	6/6/2017	C170606-CX
EU-01	M34	9/26/2017	C171007-FX
EU-01	M29A	9/28/2017	C171007-ET
EU-02	M27	6/7/2016	C160609-EU
EU-02	M27A	6/7/2016	C160609-EX
EU-02	M27	9/27/2016	C161005-EE
EU-02	M27A	9/28/2016	C161005-EK
EU-02	M27	3/21/2017	C170306-39
EU-02	M27	4/4/2017	C170401-37
EU-02	M27	4/18/2017	C170405-37
EU-02	M27	5/2/2017	C170504-37
EU-02	M27	5/16/2017	C170509-73
EU-02	M27	6/6/2017	C170606-BQ
EU-02	M27A	6/6/2017	C170606-BT
EU-02	M27	9/27/2017	C171007-DU
EU-02	M27A	9/28/2017	C171007-DZ
EU-03	M14B	6/7/2016	C160609-CY
EU-03	M11	6/9/2016	C160609-CG
EU-03	M14B	9/28/2016	C161005-AW
EU-03	M11	9/30/2016	C161005-89
EU-03	M11	5/16/2017	C170509-67
EU-03	M14B	6/6/2017	C170606-91
EU-03	M11	6/7/2017	C170606-70
EU-03	M14B	9/27/2017	C171007-85
EU-03	M11	9/28/2017	C171007-50
EU-04	M10A	6/9/2016	C160609-CD
EU-04	M10A	9/30/2016	C161005-83
EU-04	M10A	5/16/2017	C170509-64
EU-04	M10A	9/28/2017	C171007-40
EU-05	M28	6/7/2016	C160609-FA
EU-05	M28	9/27/2016	C161005-EQ
EU-05	M28	5/16/2017	C170509-76
EU-05	M28	6/6/2017	C170606-BZ
EU-05	M28	9/27/2017	C171007-EJ
EU-06	M20	6/8/2016	C160609-EI
EU-06	M20	9/29/2016	C161005-CS
EU-06	M20	6/6/2017	C170606-BE
EU-06	M20	9/26/2017	C171007-BU
EU-07	A56	10/3/2012	C121012-03
EU-07	A56	5/13/2013	C130504-03
EU-07	A55	4/16/2014	C140406-04
EU-07	A56	4/16/2014	C140406-08
EU-07	A55	5/6/2014	C140508-01
EU-07	A56	5/6/2014	C140508-05
EU-07	A55	9/23/2014	C140919-17
EU-07	A56	9/23/2014	C140919-23
EU-07	A55	11/20/2014	C150502-15
EU-07	A55	12/5/2014	C150502-05
EU-07	A55	12/15/2014	C150301-03
EU-07	A55	1/9/2015	C150301-01
EU-07	A55	1/26/2015	C150502-11
EU-07	A55	2/6/2015	C150301-05
EU-07	A55	2/20/2015	C150502-09
EU-07	A55	3/9/2015	C150301-07
EU-07	A56	3/9/2015	C150301-09
EU-07	A55	3/19/2015	C150502-03
EU-07	A56	3/19/2015	C150502-21
EU-07	A55	3/27/2015	C150502-07
EU-07	A56	3/27/2015	C150502-23
EU-07	A55	4/2/2015	C150502-19
EU-07	A56	4/2/2015	C150502-27
EU-07	A55	4/9/2015	C150502-17
EU-07	A55	4/22/2015	C150502-01
EU-07	A56	4/22/2015	C150502-25
EU-07	A55	4/27/2015	C150502-13
EU-07	A56	4/27/2015	C150502-29
EU-07	A55	5/14/2015	C150603-10
EU-07	A55	6/9/2015	C150608-73
EU-07	A56	6/9/2015	C150608-77
EU-07	A55	9/29/2015	C151005-DS
EU-07	A56	9/29/2015	C151005-DW
EU-07	A55	3/17/2016	C160404-06
EU-07	A56	3/17/2016	C160404-12
EU-07	A55	3/24/2016	C160404-08
EU-07	A56	3/24/2016	C160404-14
EU-07	A55	3/29/2016	C160404-10
EU-07	A56	3/29/2016	C160404-16
EU-07	A55	4/5/2016	C160405-16
EU-07	A56	4/5/2016	C160405-18
EU-07	A55	4/14/2016	C160510-03
EU-07	A56	4/14/2016	C160510-05

Table A5.1 (cont.) Laboratory Sample IDs for Surface Water Samples Used to Estimate Exposure to Wildlife Receptors

Exposure unit	Loc. ID	Collection date	Lab_Samp_No
EU-07	A55	4/21/2016	C160511-03
EU-07	A56	4/21/2016	C160511-05
EU-07	A55	4/27/2016	C160513-03
EU-07	A56	4/27/2016	C160513-05
EU-07	A56	5/4/2016	C160512-15
EU-07	A55	5/4/2016	C160512-44
EU-07	A55	5/19/2016	C160706-03
EU-07	A56	5/19/2016	C160706-05
EU-07	A55	6/6/2016	C160608-AC
EU-07	A56	6/7/2016	C160608-AI
EU-07	A55	9/27/2016	C161003-CP
EU-07	A56	9/27/2016	C161003-CY
EU-07	A55	3/21/2017	C170306-01
EU-07	A56	3/21/2017	C170306-04
EU-07	A55	4/4/2017	C170401-01
EU-07	A56	4/4/2017	C170401-04
EU-07	A55	4/18/2017	C170405-01
EU-07	A56	4/18/2017	C170405-04
EU-07	A55	5/2/2017	C170504-01
EU-07	A56	5/2/2017	C170504-04
EU-07	A55	5/16/2017	C170509-13
EU-07	A56	5/16/2017	C170509-16
EU-07	A55	6/6/2017	C170605-64
EU-07	A56	6/6/2017	C170605-70
EU-07	A56	9/26/2017	C171004-FY
EU-08	A48	6/9/2015	C150608-69
EU-08	A48	9/30/2015	C151005-DL
EU-08	A48	5/4/2016	C160512-13
EU-08	A48	9/27/2016	C161003-CG
EU-08	A48	6/6/2017	C170605-58
EU-08	A48	9/28/2017	C171004-FJ
EU-09	A41A	6/9/2015	C150608-57
EU-09	A45	6/9/2015	C150608-65
EU-09	A41A	8/4/2015	G3538-11
EU-09	A41A	9/30/2015	C151005-CS
EU-09	A45	9/30/2015	C151005-DE
EU-09	A45	4/5/2016	C160405-12
EU-09	A41A	4/6/2016	C160405-10
EU-09	A41A	5/4/2016	C160512-09
EU-09	A45	5/4/2016	C160512-42
EU-09	A41A	6/7/2016	C160608-78
EU-09	A45	6/7/2016	C160608-90
EU-09	A45	9/28/2016	C161003-BX
EU-09	A41A	9/29/2016	C161003-BI
EU-09	A41A	6/7/2017	C170605-49
EU-09	A45	6/7/2017	C170605-52
EU-09	A41A	9/28/2017	C171004-EV
EU-09	A45	9/28/2017	C171004-FA
EU-10	A35	6/9/2015	C150608-47
EU-10	A40	6/9/2015	C150608-53
EU-10	A40	8/4/2015	G3537-03
EU-10	A35	9/30/2015	C151005-BS
EU-10	A40	9/30/2015	C151005-CH
EU-10	A35	4/5/2016	C160405-06
EU-10	A40	4/6/2016	C160405-08
EU-10	A35	5/4/2016	C160512-05
EU-10	A40	5/4/2016	C160512-07
EU-10	A35	6/7/2016	C160608-60
EU-10	A40	6/7/2016	C160608-69
EU-10	A35	9/29/2016	C161003-98
EU-10	A40	9/29/2016	C161003-AW
EU-10	A35	5/17/2017	C170509-07
EU-10	A35	6/7/2017	C170605-40
EU-10	A40	6/7/2017	C170605-43
EU-10	A35	9/26/2017	C171004-DC
EU-10	A40	9/28/2017	C171004-EL
EU-11	A36	6/10/2015	C150608-49
EU-11	A36	9/29/2015	C151005-BW
EU-11	A36	6/8/2016	C160608-63
EU-11	A36	9/27/2016	C161003-AE
EU-11	A36	7/11/2017	C170703-73
EU-11	A36	9/26/2017	C171004-DH
EU-12	A37	6/10/2015	C150608-51
EU-12	A37	9/29/2015	C151005-CA
EU-12	A37	6/8/2016	C160608-66
EU-12	A37	9/27/2016	C161003-AK
EU-12	A37	7/11/2017	C170703-79
EU-12	A37	9/26/2017	C171004-DR
EU-13	A34	6/9/2015	C150608-45
EU-13	A34	8/5/2015	G3537-02
EU-13	A34	9/30/2015	C151005-BO
EU-13	A34	4/5/2016	C160405-04
EU-13	A34	5/4/2016	C160512-03
EU-13	A34	6/7/2016	C160608-57
EU-13	A34	9/27/2016	C161003-92
EU-13	A34	5/17/2017	C170509-04
EU-13	A34	6/7/2017	C170605-37
EU-13	A34	9/28/2017	C171004-CX
EU-14	A14	6/9/2015	C150608-19
EU-14	A33	8/5/2015	G3537-01
EU-14	A14	9/29/2015	C151005-68
EU-14	A33	9/30/2015	C151005-BK
EU-14	A33	4/5/2016	C160405-02
EU-14	A33	5/4/2016	C160512-01
EU-14	A14	6/7/2016	C160608-27
EU-14	A33	6/7/2016	C160608-54
Hermosa Cr.	HC01	10/4/2016	C161007-73
Maggie Gulch	A43	6/9/2015	C150608-63
Maggie Gulch	A43	9/30/2015	C151005-DA
Maggie Gulch	A43	6/7/2016	C160608-87

Table A5.1 (cont.) Laboratory Sample IDs for Surface Water Samples Used to Estimate Exposure to Wildlife Receptors

Exposure unit	Loc. ID	Collection date	Lab_Samp_No
Maggie Gulch	A43	9/28/2016	C161003-BR
Mill Creek	M08	6/9/2016	C160609-BX
Mill Creek	M08	9/30/2016	C161005-77
Picayne Gulch	A26	6/9/2015	C150608-29
Picayne Gulch	A26	9/30/2015	C151005-AK
Picayne Gulch	A26	9/29/2016	C161004-01
Upper Animas	A05	6/10/2015	C150608-03
Upper Animas	A05	9/30/2015	C151005-20
Upper Animas	A05	6/8/2016	C160608-01
Upper Animas	A05	9/30/2016	C161003-01
Upper Animas	A05	6/7/2017	C170605-01
Upper Animas	A05	7/11/2017	C170703-01
Upper Animas	A05	9/26/2017	C171004-01
EU-14	A33	9/27/2016	C161003-86
EU-14	A14	9/29/2016	C161003-47
EU-14	A33	5/17/2017	C170509-01
EU-14	A14	6/7/2017	C170605-16
EU-14	A33	6/7/2017	C170605-34
EU-14	A14	9/26/2017	C171004-98
EU-14	A33	9/28/2017	C171004-CS
EU-15	A10	6/9/2015	C150608-09
EU-15	A10	9/29/2015	C151005-50
EU-15	A10	6/7/2016	C160608-13
EU-15	A10	9/29/2016	C161003-31
EU-15	A10	6/7/2017	C170605-07
EU-15	A10	9/26/2017	C171004-83
EU-16	A20	6/10/2015	C150608-23
EU-16	A20	9/29/2015	C151005-85
EU-16	A20	6/29/2016	C160701-49
EU-16	A20	9/30/2016	C161003-63
EU-16	A20	7/12/2017	C170703-58
EU-16	A20	9/27/2017	C171004-AW
EU-17	A15	6/10/2015	C150608-21
EU-17	A15	9/29/2015	C151005-72
EU-17	A15	6/8/2016	C160608-30
EU-17	A15	9/30/2016	C161003-53
EU-17	A15	7/11/2017	C170703-46
EU-17	A15	9/27/2017	C171004-AD
EU-18	A09	6/9/2015	C150608-07
EU-18	A08	6/10/2015	C150608-05
EU-18	A09	9/29/2015	C151005-46
EU-18	A08	9/30/2015	C151005-42
EU-18	A09	6/7/2016	C160608-10
EU-18	A08	6/8/2016	C160608-07
EU-18	A09	9/29/2016	C161003-25
EU-18	A08	9/30/2016	C161003-19
EU-18	A09	6/7/2017	C170605-04
EU-18	A08	7/11/2017	C170703-43
EU-18	A08	9/26/2017	C171004-68
EU-18	A09	9/26/2017	C171004-73
EU-19	A07	9/30/2015	C151005-27
EU-19	A07	6/8/2016	C160608-04
EU-19	A07	9/30/2016	C161003-07
EU-19	A07	7/11/2017	C170703-04
EU-19	A07	9/26/2017	C171004-06
EU-DR01	James Ranch	9/24/2014	C140919-FU
EU-DR01	32nd St Bridge	9/25/2014	C140919-AP
EU-DR01	32nd St Bridge	10/27/2015	GKMSW04_102715
EU-DR01	9426	10/29/2015	9426SW_10292105
EU-DR01	9426	3/22/2016	9426_032216L
EU-DR01	32nd St Bridge	3/24/2016	32ndStreetBridge_032416L
EU-DR01	oxbow park	3/24/2016	OxbowPark_032416L
EU-DR01	9426	6/6/2016	9426_060616L
EU-DR01	32nd St Bridge	6/7/2016	32nd St Bridge_060716L
EU-DR01	32nd St Bridge	8/22/2016	32nd St Bridge_082216
EU-DR01	9426	8/22/2016	9426_082216
EU-DR01	32nd St Bridge	9/28/2016	32nd St Bridge_092816
EU-DR01	9426	9/29/2016	9426_092916
EU-DR02	Lightner Creek	9/24/2014	C140919-AV
EU-DR02	Purple Cliffs	9/24/2014	C140919-BB
EU-DR02	GKM05	10/27/2015	GKMSW05_102715
EU-DR02	Rotary Park	10/27/2015	Animas Rotary Park_102715
EU-DR02	AR19-3	10/28/2015	GKMSW01_10282015
EU-DR02	AR19-3	3/23/2016	AR19-3_032316L
EU-DR02	GKM05	3/24/2016	GKMSW05_032416L
EU-DR02	Rotary Park	3/24/2016	ANIMAS-ROTARY-PARK_032416L
EU-DR02	Rotary Park	6/7/2016	Animas-RotaryPark_060716L
EU-DR02	AR19-3	6/8/2016	AR19-3_060816L
EU-DR02	Rotary Park	8/22/2016	Animas_RotaryPark_082216
EU-DR02	GKM05	8/25/2016	GKM05_082516
EU-DR02	AR19-3	8/28/2016	AR19-3_082816
EU-DR02	Rotary Park	8/28/2016	Animas_RotaryPark_082816
EU-DR02	AR19-3	9/2/2016	AR19-3_090216
EU-DR02	Rotary Park	9/28/2016	Animas_RotaryPark_092816
EU-DR02	GKM05	9/30/2016	GKM05_093016
EU-DR02	AR19-3	10/4/2016	AR19-3_100416
EU-DR02	Rotary Park	4/4/2017	Rotary Park_040417
EU-DR02	Rotary Park	4/12/2017	Rotary Park_041217
EU-DR02	Rotary Park	4/25/2017	Rotary Park_042517
EU-DR02	Rotary Park	5/11/2017	Rotary Park_051117
EU-DR02	Rotary Park	5/18/2017	Rotary Park_051817
EU-DR02	Rotary Park	5/31/2017	Rotary Park_053117
EU-DR02	Rotary Park	6/7/2017	Rotary Park_060717
EU-DR02	Rotary Park	6/14/2017	Rotary Park_061417
Bear Cr.	M30	9/27/2016	C161005-EZ
Bear Cr.	M30	9/28/2017	C171007-EY

Appendix 6

Invertebrate Tissue Models Used to Determine Sediment-to-Invertebrate Tissue Equations and Factors to Use in the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 6 Figures:

Figure A6-1 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Arsenic

Figure A6-2 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Cadmium

Figure A6-3 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Chromium

Figure A6-4 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Copper

Figure A6-5 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Lead

Figure A6-6 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Mercury

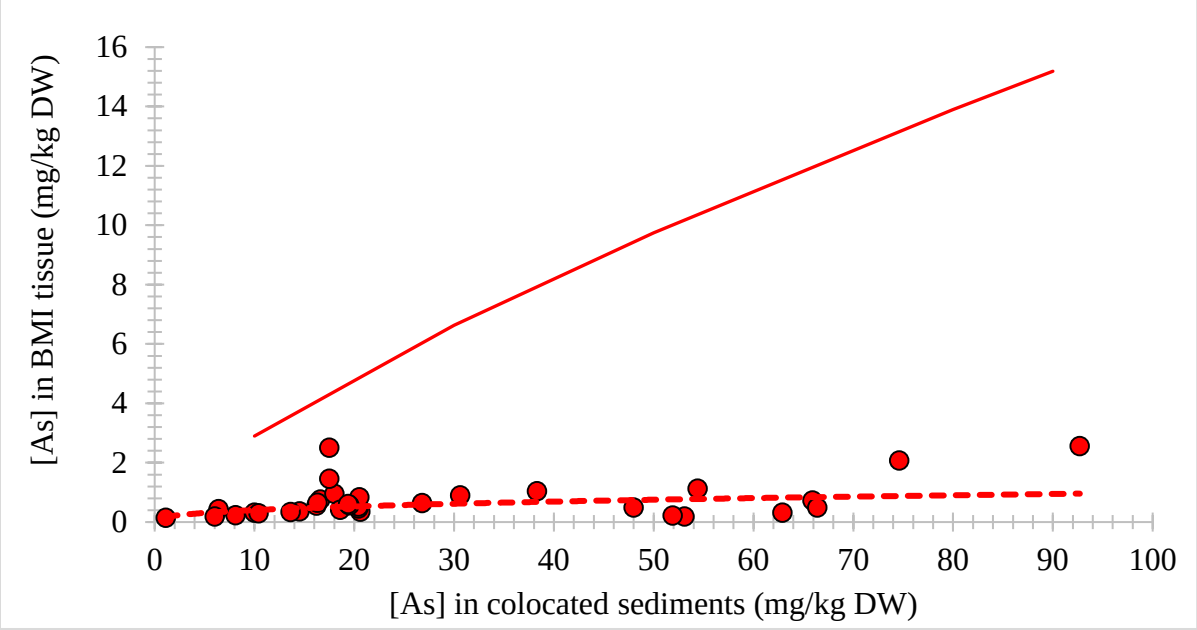
Figure A6-7 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Nickel

Figure A6-8 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Selenium

Figure A6-9 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Silver

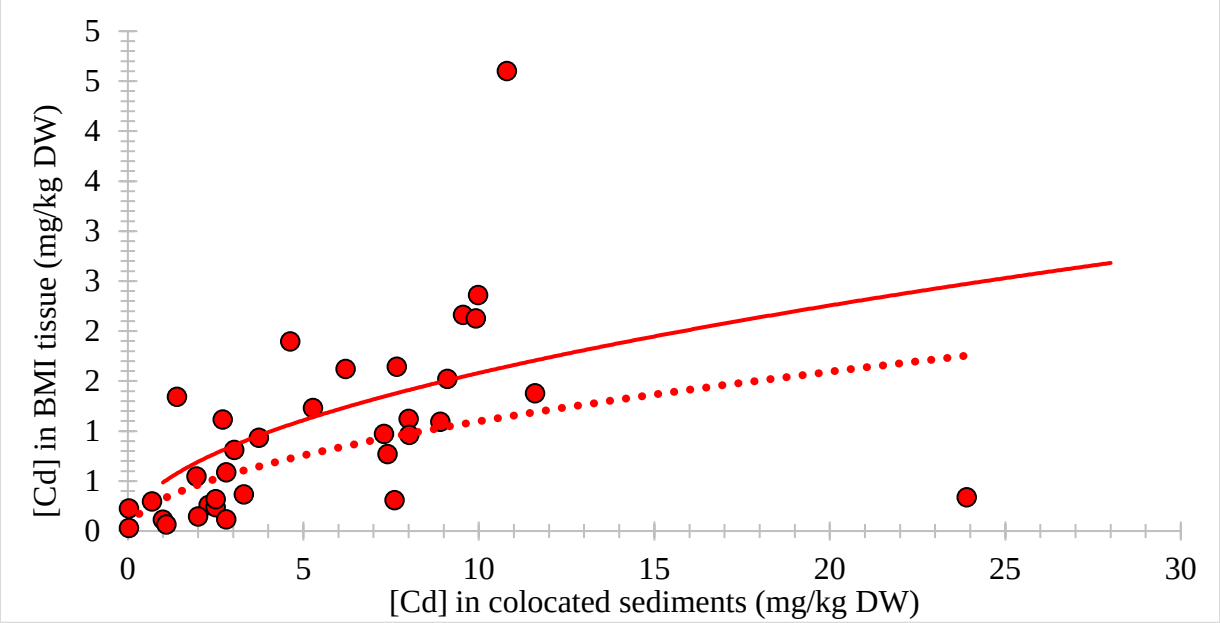
Figure A6-10 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Zinc

Figure A6-1 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Arsenic. Each point represents a paired sediment and tissue Arsenic (As) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; BMI tissue [As] (mg/kg) = 0.1643(sediment [As])$^{0.3889}$ (R^2 = 0.23). The solid line represents the sediment-to-invertebrate tissue equation that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); BMI tissue [As] (mg/kg) = $10^{(-0.292 + 0.754(\log \text{sediment [As]}))}$. The Upper Animas BERA sediment-to-invertebrate tissue equation was selected for use in the current BPMD Aquatic BERA.



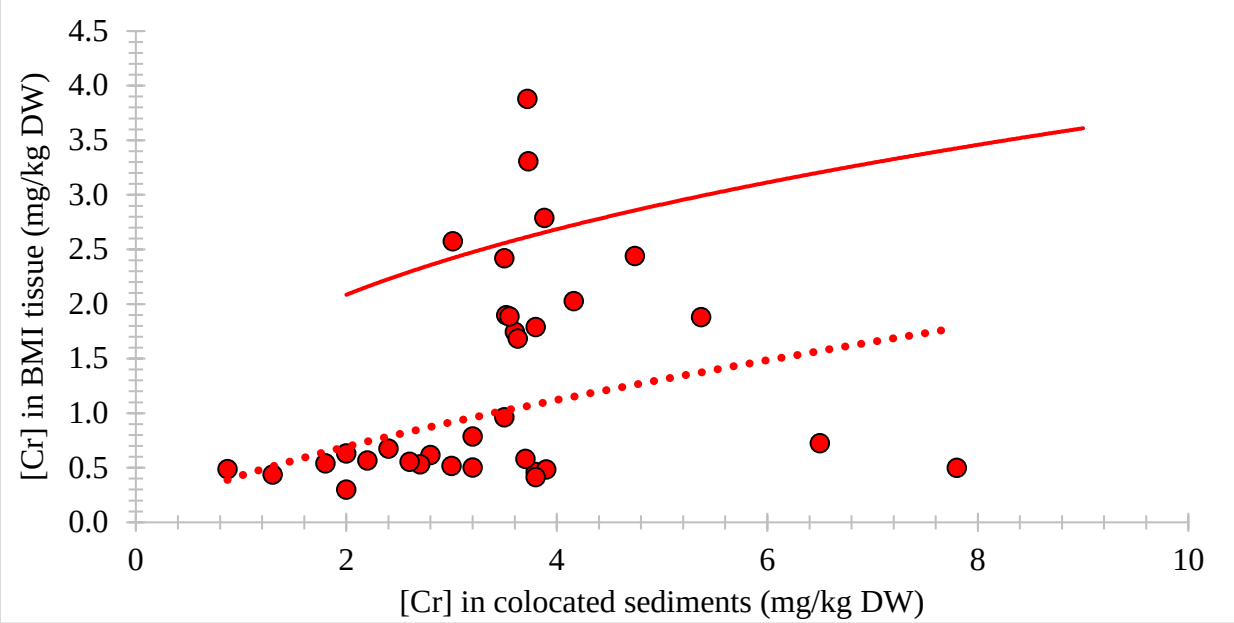
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A6-2 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Cadmium. Each point represents a paired sediment and tissue Cadmium (Cd) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; BMI tissue [Cd] (mg/kg) = 0.3186(sediment [Cd])$^{0.5373}$ (R^2 = 0.45). The solid line represents the sediment-to-invertebrate tissue equation that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); BMI tissue [Cd] (mg/kg) = $10^{(-0.314 + 0.513(\log \text{sediment [Cd]}))}$. The Upper Animas BERA sediment-to-invertebrate tissue equation was selected for use in the current BPMD Aquatic BERA.



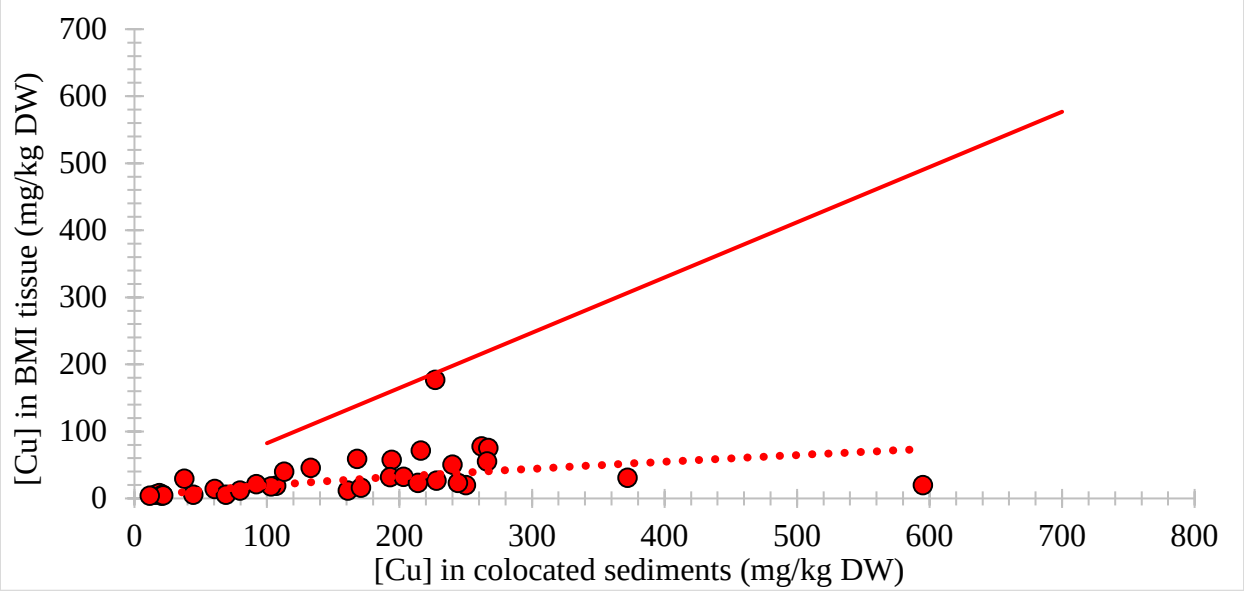
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A6-3 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Chromium. Each point represents a paired sediment and tissue Chromium (Cr) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; BMI tissue [Cr] (mg/kg) = $0.4283(\text{sediment [Cr]})^{0.6938}$ ($R^2 = 0.15$). The solid line represents the sediment-to-invertebrate tissue equation that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); BMI tissue [Cr] (mg/kg) = $10^{(0.2092 + 0.365(\log \text{sediment [Cr]})}$. The Upper Animas BERA sediment-to-invertebrate tissue equation was selected for use in the current BPMD Aquatic BERA.



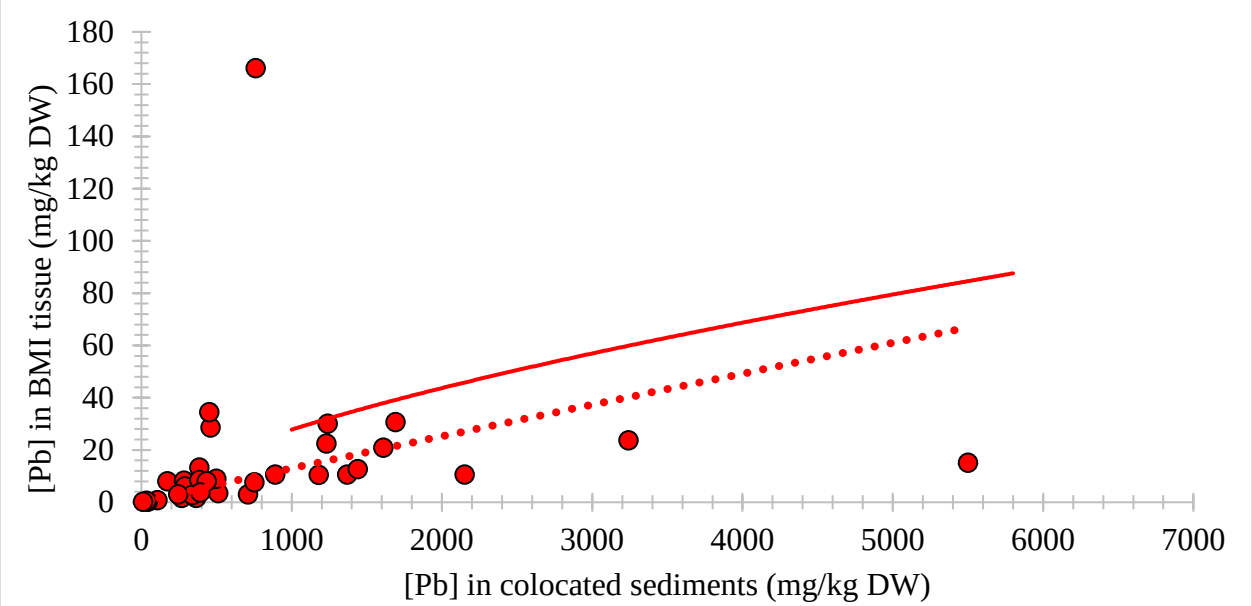
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A6-4 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Copper. Each point represents a paired sediment and tissue Copper (Cu) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; BMI tissue [Cu] (mg/kg) = 0.63(sediment [Cu])$^{0.7452}$ (R^2 = 0.60). The solid line represents the sediment-to-invertebrate tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); BMI tissue [Cu] (mg/kg) = 0.824*Sediment [Cu]. The Upper Animas BERA sediment-to-invertebrate tissue factor was selected for use in the current BPMD aquatic BERA.



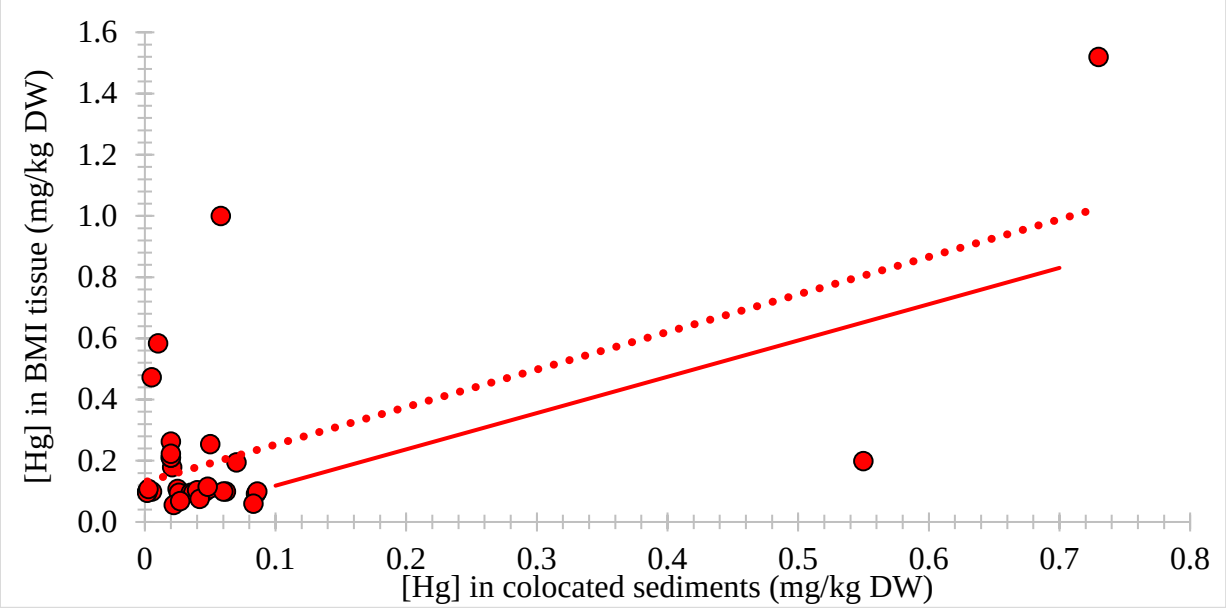
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A6-5 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Lead. Each point represents a paired sediment and tissue Lead (Pb) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; BMI tissue [Pb] (mg/kg) = $0.0168(\text{sediment [Pb]})^{0.9622}$ ($R^2 = 0.64$). The solid line represents the sediment-to-invertebrate tissue equation that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); BMI tissue [Pb] (mg/kg) = $10^{(-0.515 + 0.653(\log \text{sediment [Pb]}))}$. The Upper Animas BERA sediment-to-invertebrate tissue equation was selected for use in the current BPMD Aquatic BERA.



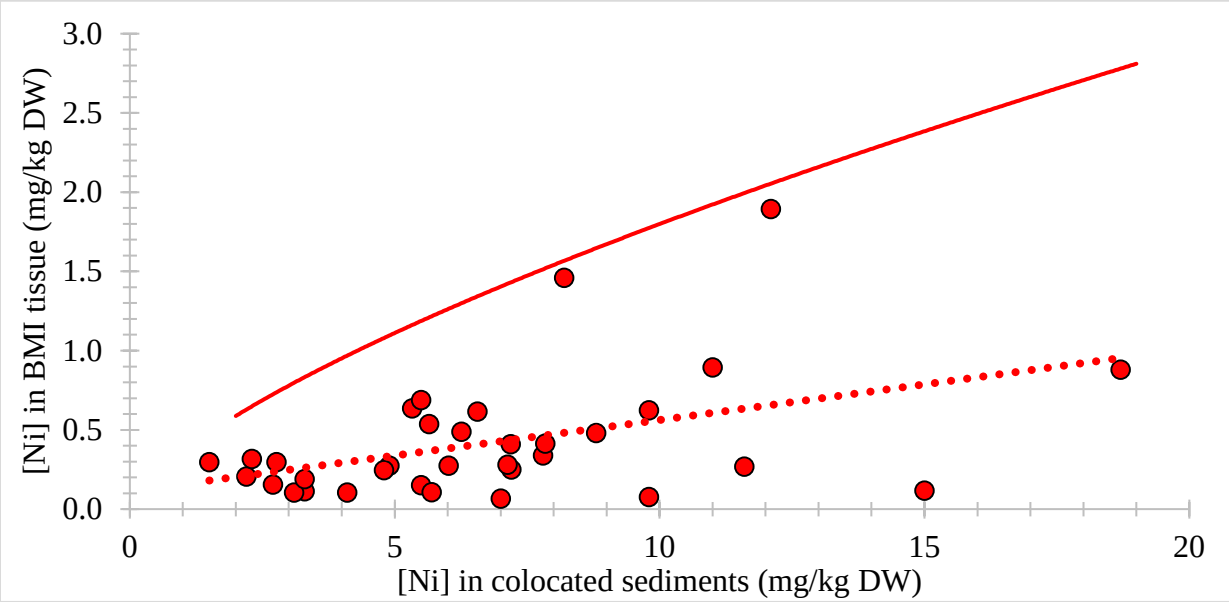
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A6-6 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Mercury. Each point represents a paired sediment and tissue Mercury (Hg) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; BMI tissue [Hg] (mg/kg) = 1.2268(sediment [Hg]) + 0.1301 (R^2 = 0.38). The solid line represents the sediment-to-invertebrate tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); BMI tissue [Hg] (mg/kg) = 1.186*Sediment [Hg]. The site-specific sediment-to-invertebrate tissue model was selected for use in the current BPMD Aquatic BERA.



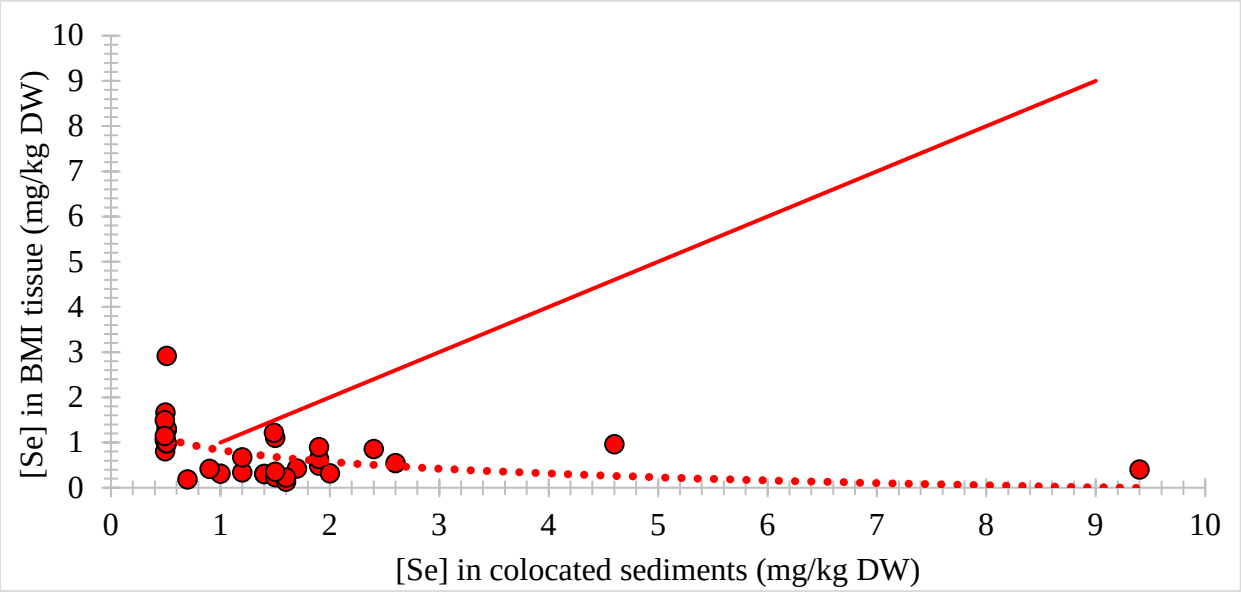
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A6-7 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Nickel. Each point represents a paired sediment and tissue Nickel (Ni) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; BMI tissue [Ni] (mg/kg) = 0.0449(sediment [Ni]) + 0.1131 (R^2 = 0.19). The solid line represents the sediment-to-invertebrate tissue equation that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); BMI tissue [Ni] (mg/kg) = $10^{(-0.440 + 0.695(\log \text{sediment [Ni]}))}$. The Upper Animas BERA sediment-to-invertebrate tissue equation was selected for use in the current BPMD Aquatic BERA.



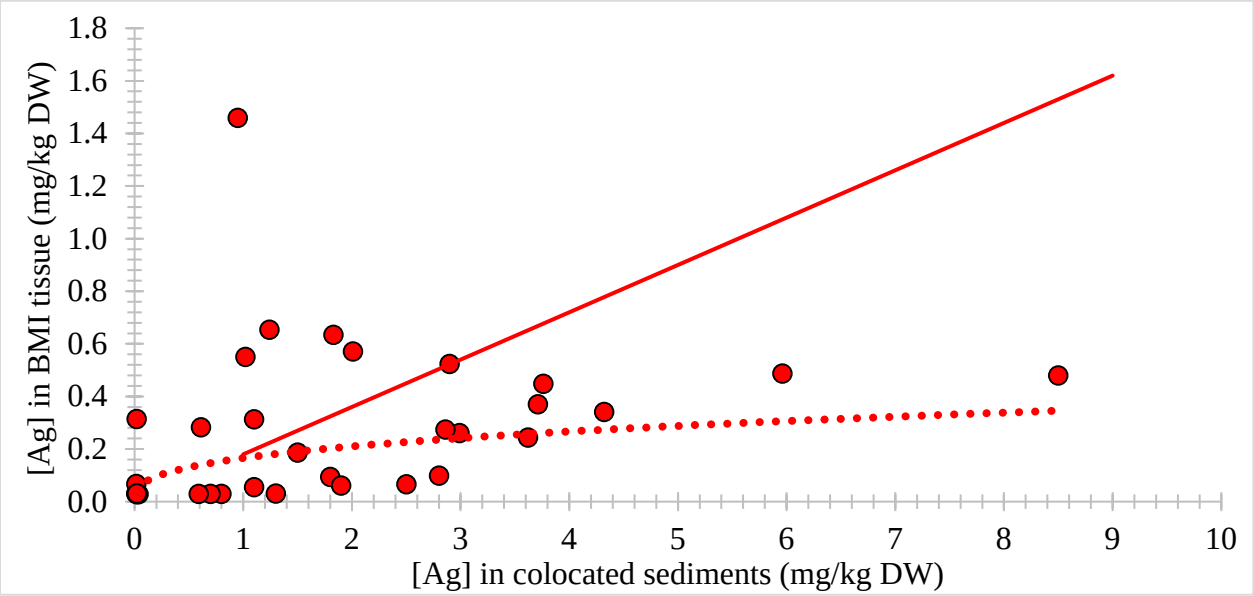
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A6-8 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Selenium. Each point represents a paired sediment and tissue Selenium (Se) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; BMI tissue [Se] (mg/kg) = 0.375Ln(sediment [Se]) + 0.8335 (R^2 = 0.24). The solid line represents the sediment-to-invertebrate tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); BMI tissue [Se] (mg/kg) = 1.00*Sediment [Se]. The Upper Animas BERA sediment-to-invertebrate tissue factor was selected for use in the current BPMD Aquatic BERA.



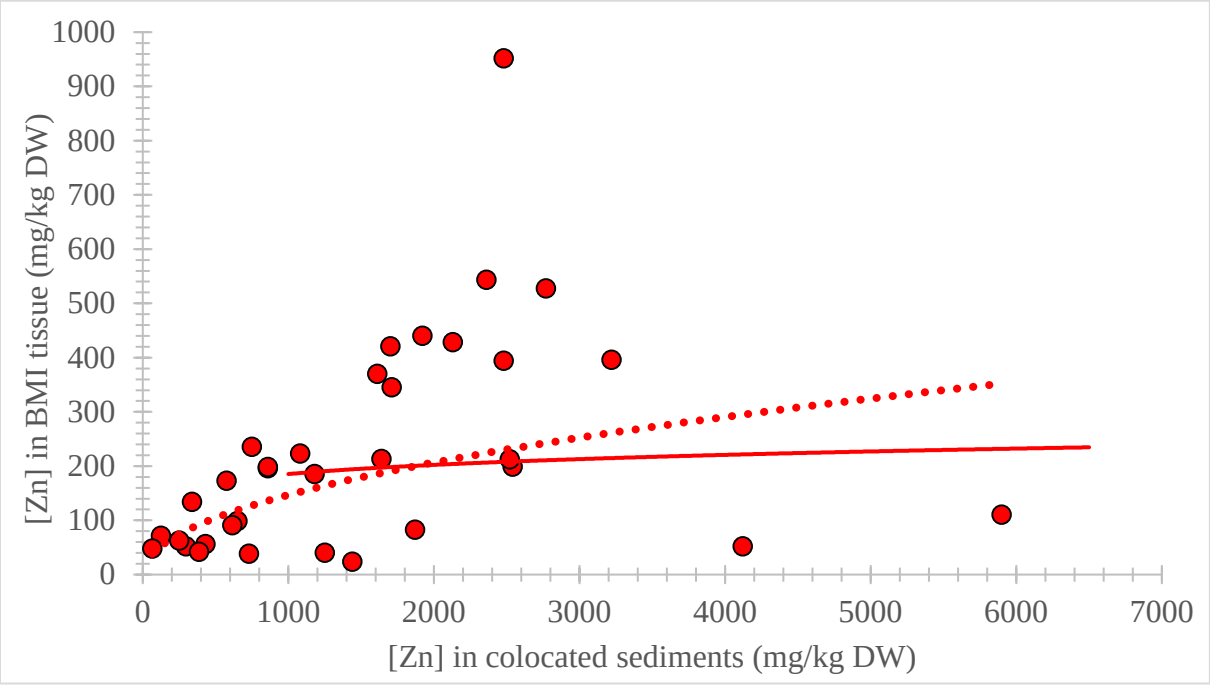
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A6-9 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Silver. Each point represents a paired sediment and tissue Silver (Ag) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; BMI tissue [Ag] (mg/kg) = 0.1656(sediment [Ag])$^{0.3437}$ (R^2 = 0.31). The solid line represents the sediment-to-invertebrate tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); BMI tissue [Ag] (mg/kg) = 0.18*Sediment [Ag]. The Upper Animas BERA sediment-to-invertebrate tissue factor was selected for use in the current BPMD Aquatic BERA.



DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A6-10 Benthic Macroinvertebrate (BMI) Tissue and Sediment Scatter Plot for Zinc. Each point represents a paired sediment and tissue Zinc (Zn) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; BMI tissue [Zn] (mg/kg) = 4.8814(sediment [Zn])$^{0.4927}$ (R^2 = 0.27). The solid line represents the sediment-to-invertebrate tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); BMI tissue [Zn] (mg/kg) = $10^{(1.89 + 0.126(\log \text{sediment [Zn]})}$. The site-specific sediment-to-invertebrate tissue model was selected for use in the current BPMD Aquatic BERA.



DW = Dry weight; mg = Milligrams; kg = Kilograms

Appendix 7

Fish Tissue Models Used to Determine Sediment-to-Fish Tissue Equations and Factors to Use in the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

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Figure A7-1 Whole Body Fish Tissue and Sediment Scatter Plot for Arsenic

Figure A7-2 Whole Body Fish Tissue and Sediment Scatter Plot for Cadmium

Figure A7-3 Whole Body Fish Tissue and Sediment Scatter Plot for Chromium

Figure A7-4 Whole Body Fish Tissue and Sediment Scatter Plot for Copper

Figure A7-5 Whole Body Fish Tissue and Sediment Scatter Plot for Lead

Figure A7-6 Whole Body Fish Tissue and Sediment Scatter Plot for Mercury

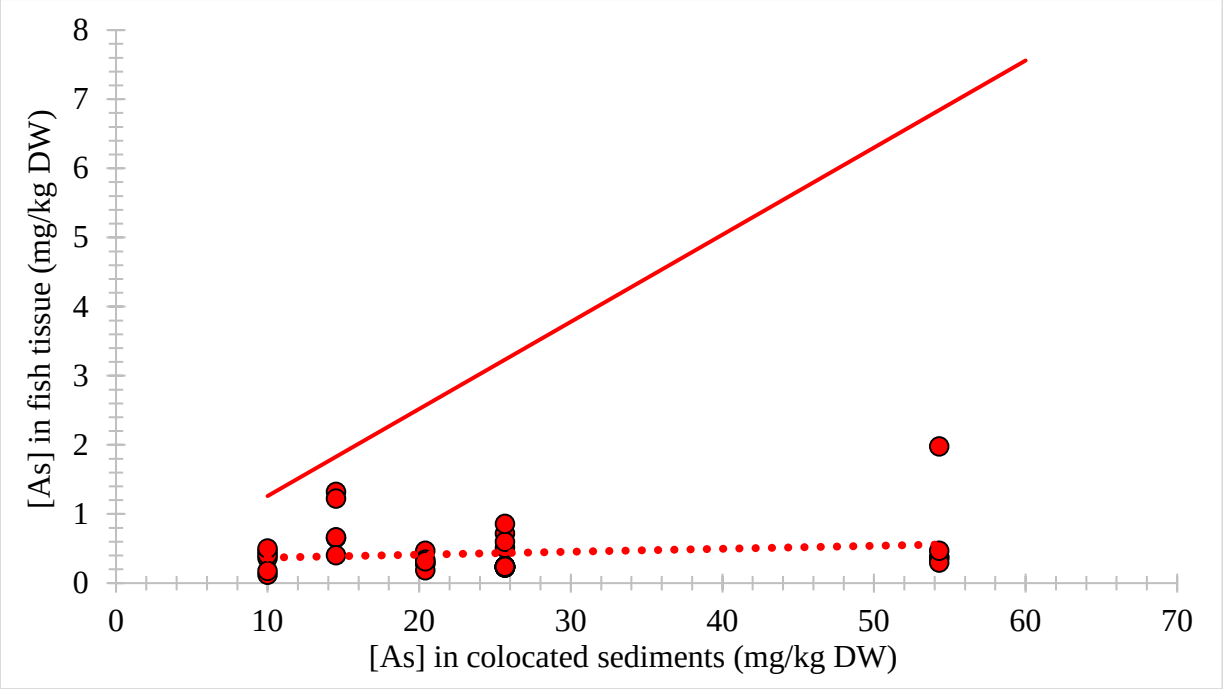
Figure A7-7 Whole Body Fish Tissue and Sediment Scatter Plot for Nickel

Figure A7-8 Whole Body Fish Tissue and Sediment Scatter Plot for Selenium

Figure A7-9 Whole Body Fish Tissue and Sediment Scatter Plot for Silver

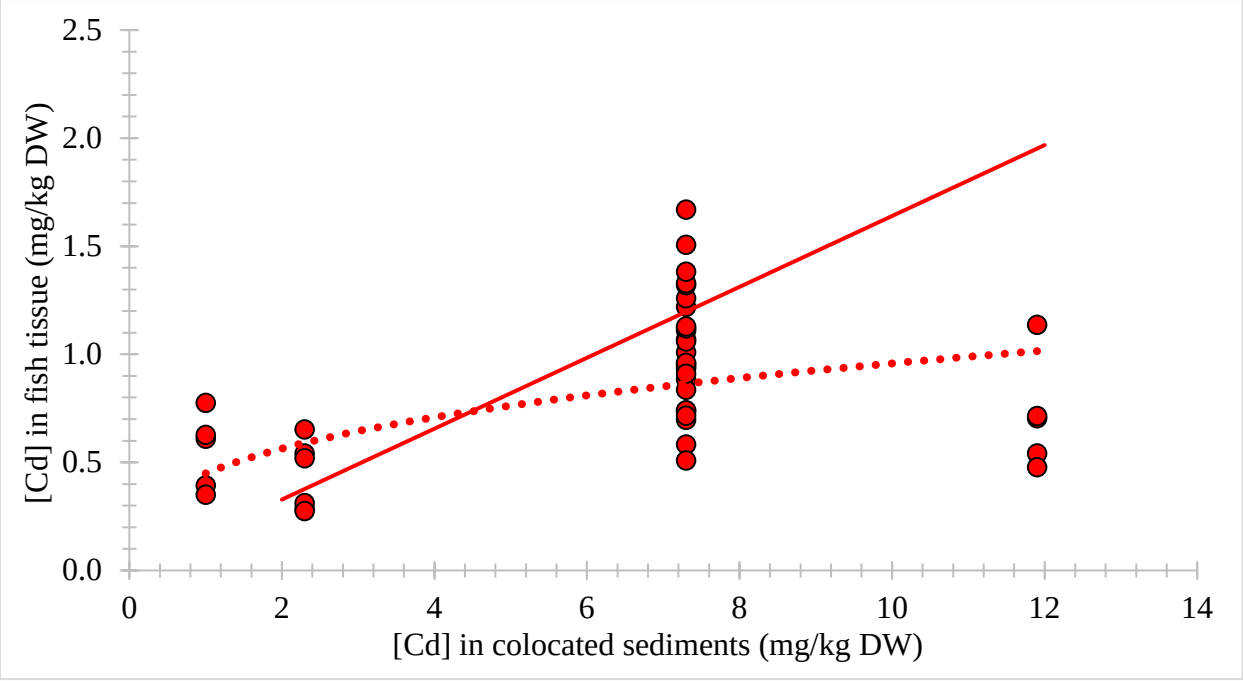
Figure A7-10 Whole Body Fish Tissue and Sediment Scatter Plot for Zinc

Figure A7-1 Whole Body Fish Tissue and Sediment Scatter Plot for Arsenic. Each point represents a paired sediment and tissue Arsenic (As) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; Fish tissue [As] (mg/kg) = 0.0043(sediment [As]) + 0.3264 (R^2 = 0.02). The solid line represents the sediment-to-fish tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); Fish tissue [As] (mg/kg) = 0.126*sediment [As]. The Upper Animas BERA sediment-to-fish tissue factor was selected for use in the current BPMD Aquatic BERA.



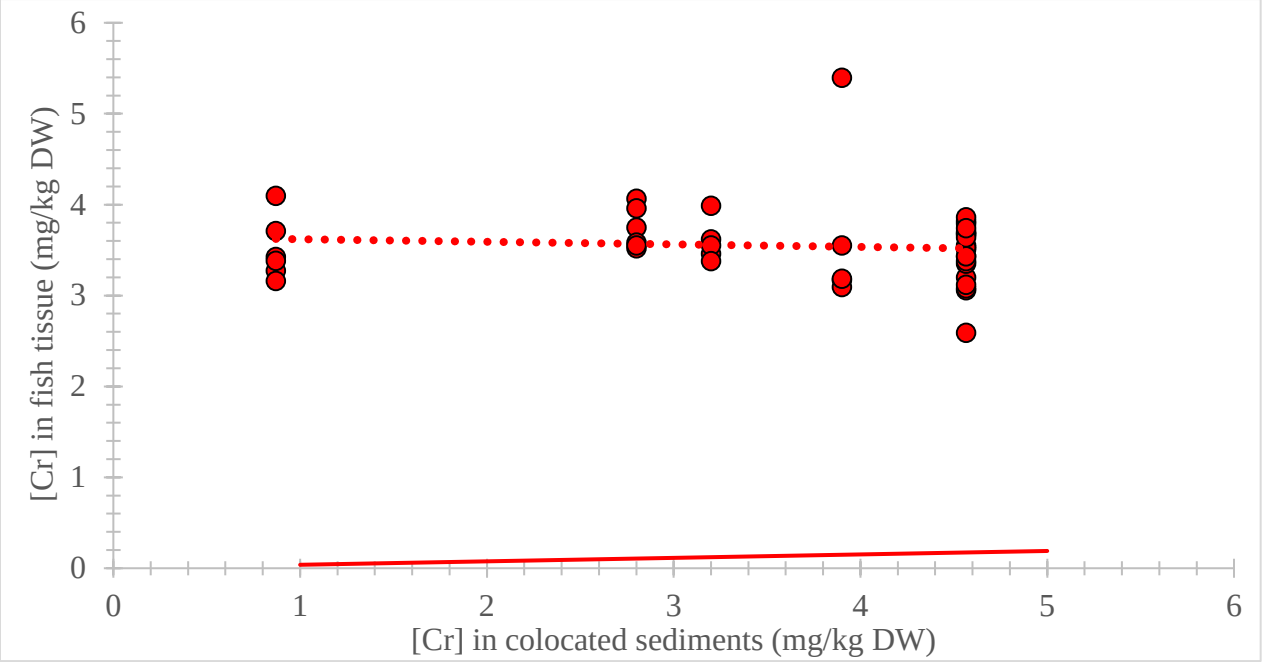
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A7-2 Whole Body Fish Tissue and Sediment Scatter Plot for Cadmium. Each point represents a paired sediment and tissue Cadmium (Cd) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; Fish tissue [Cd] (mg/kg) = 0.4487(sediment [Cd])$^{0.3294}$ (R^2 = 0.31). The solid line represents the sediment-to-fish tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); Fish tissue [Cd] (mg/kg) = 0.164*sediment [Cd]. The site-specific sediment-to-fish tissue model was selected for use in the current BPMD Aquatic BERA.



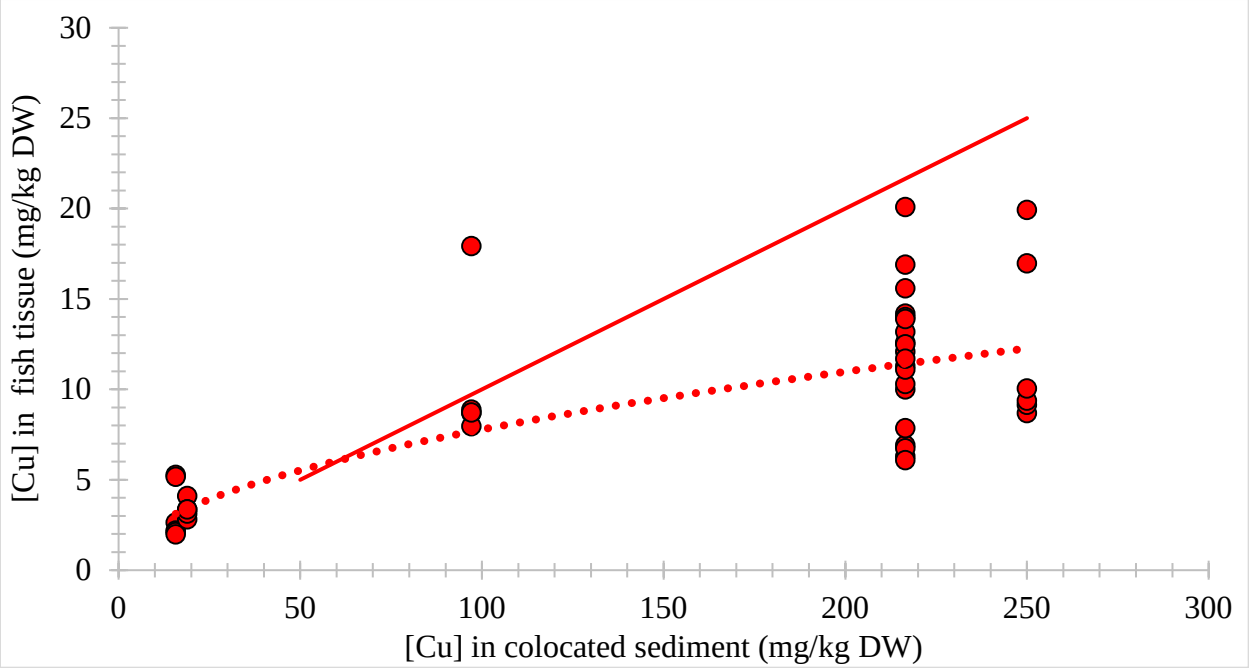
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A7-3 Whole Body Fish Tissue and Sediment Scatter Plot for Chromium. Each point represents a paired sediment and tissue Chromium (Cr) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; Fish tissue [Cr] (mg/kg) = -0.0282(sediment [Cr]) + 3.6474 (R^2 = 0.01). The solid line represents the sediment-to-fish tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); Fish tissue [Cr] (mg/kg) = 0.038*sediment [Cr]. The Upper Animas BERA sediment-to-fish tissue factor was selected for use in the current BPMD Aquatic BERA.



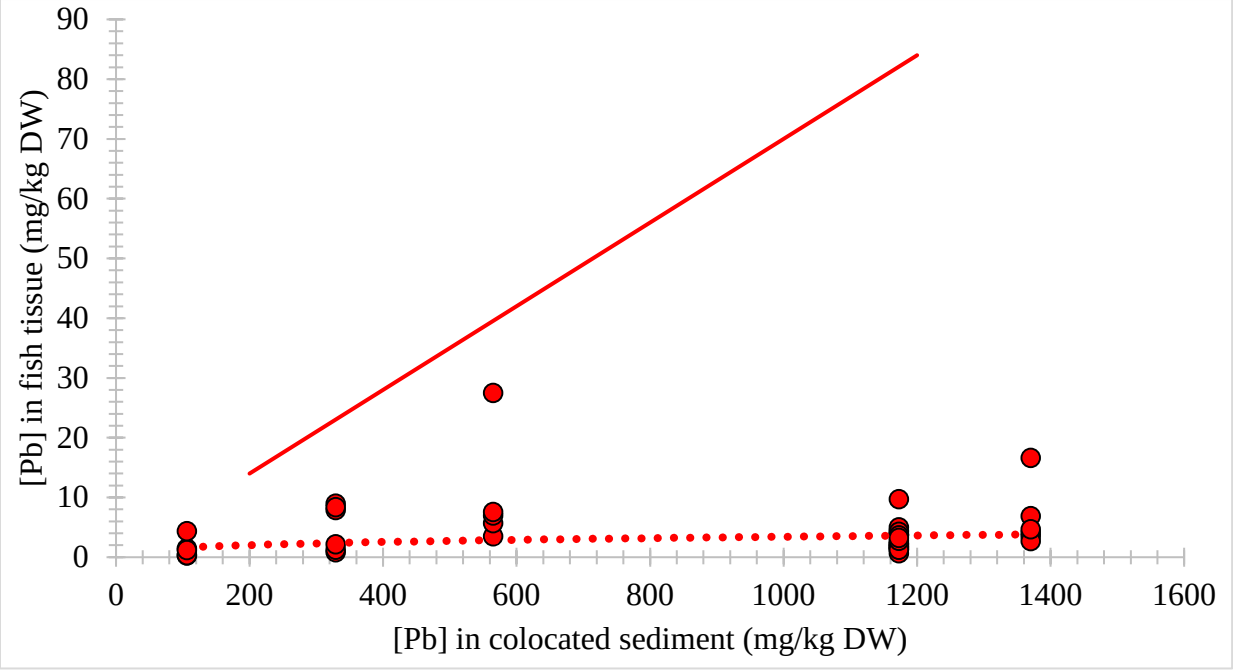
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A7-4 Whole Body Fish Tissue and Sediment Scatter Plot for Copper. Each point represents a paired sediment and tissue Copper (Cu) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and fish data points; Fish tissue [Cu] (mg/kg) = 0.7955(sediment [Cu])$^{0.4953}$ (R^2 = 0.73). The solid line represents the sediment-to-fish tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); Fish tissue [Cu] (mg/kg) = 0.100*Sediment [Cu]. The site-specific sediment-to-fish tissue model was selected for use in the current BPMD Aquatic BERA.



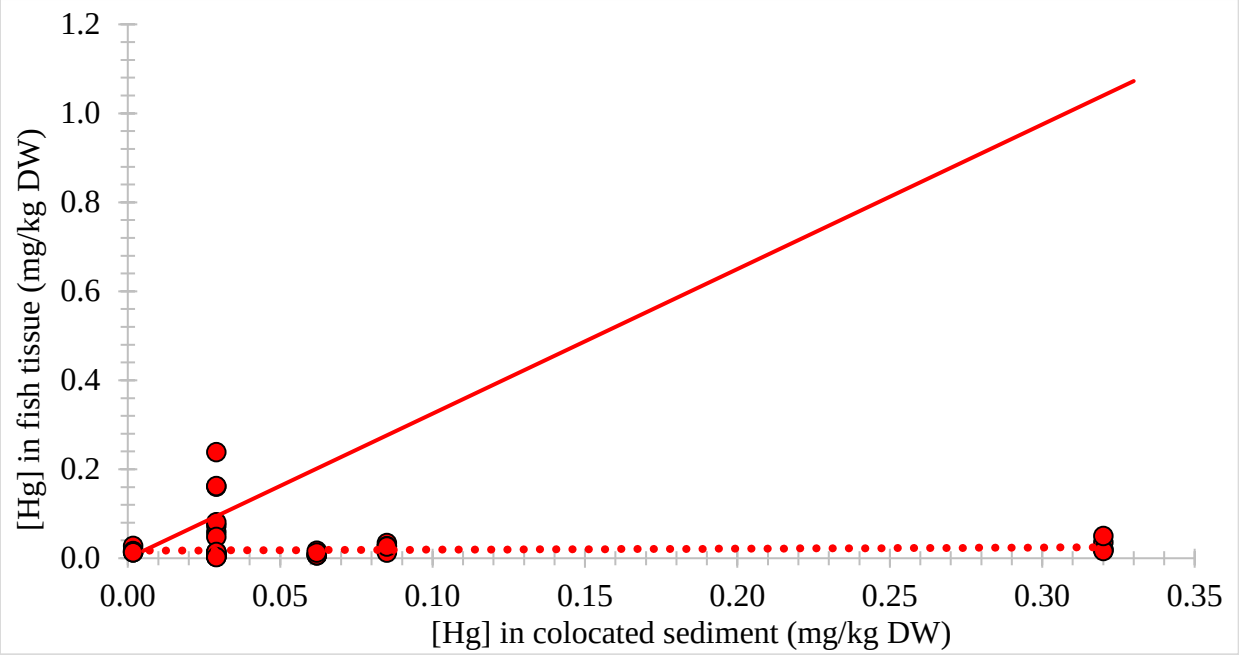
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A7-5 Whole Body Fish Tissue and Sediment Scatter Plot for Lead. Each point represents a paired sediment and tissue Lead (Pb) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; Fish tissue [Pb] (mg/kg) = 0.3554(sediment [Pb])$^{0.3284}$ (R^2 = 0.09). The solid line represents the sediment-to-fish tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); Fish tissue [Pb] (mg/kg) = 0.07*Sediment [Pb]. The Upper Animas BERA sediment-to-fish tissue factor was selected for use in the current BPMD Aquatic BERA.



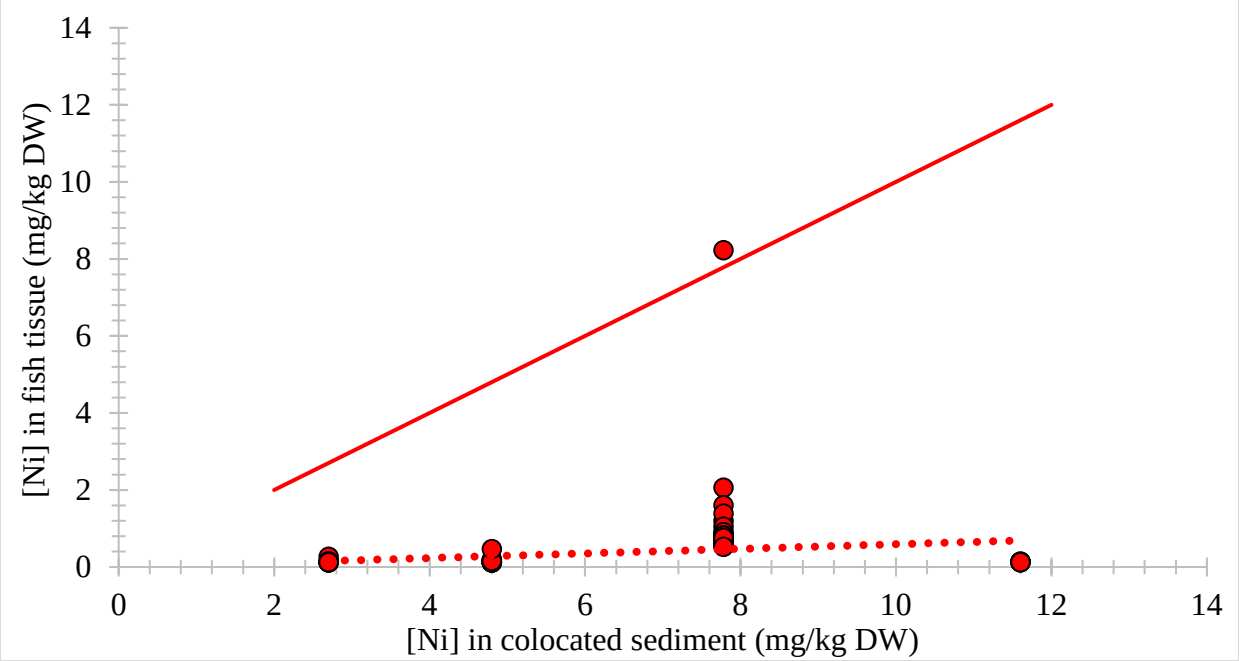
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A7-6 Whole Body Fish Tissue and Sediment Scatter Plot for Mercury. Each point represents a paired sediment and tissue Mercury (Hg) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; Fish tissue [Hg] (mg/kg) = $0.017e^{1.1539(\text{sediment [Hg]})}$ (R^2 = 0.01). The solid line represents the sediment-to-fish tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); Fish tissue [Hg] (mg/kg) = 3.25*Sediment [Hg]. The Upper Animas BERA sediment-to-fish tissue factor was selected for use in the current BPMD Aquatic BERA.



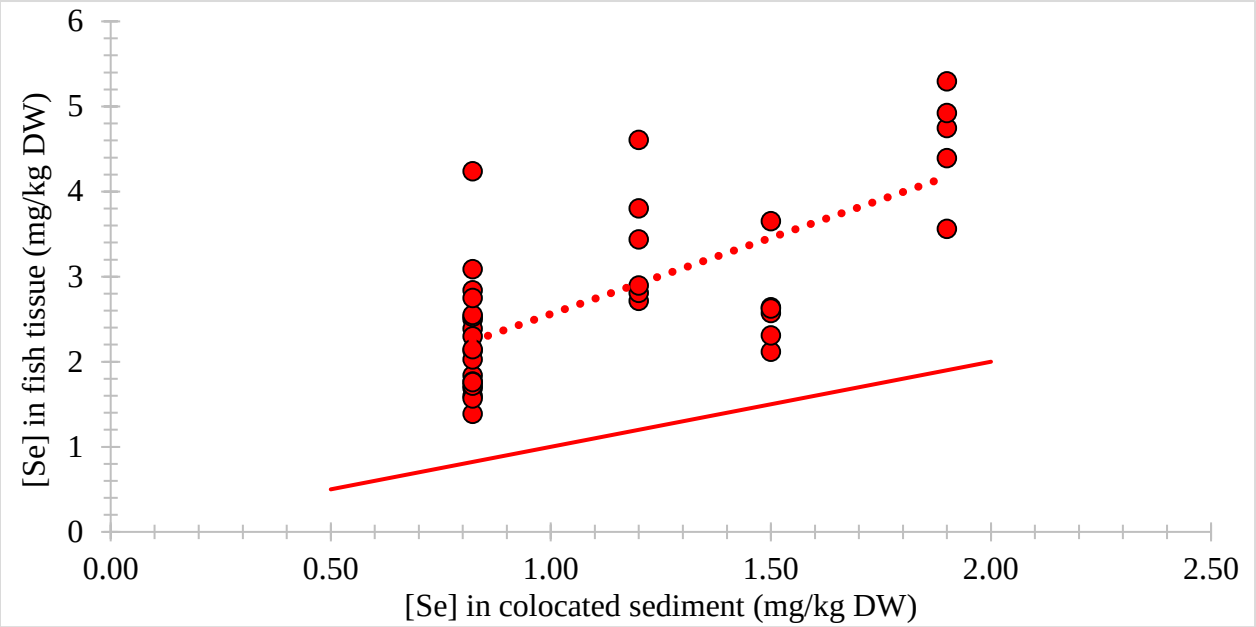
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A7-7 Whole Body Fish Tissue and Sediment Scatter Plot for Nickel. Each point represents a paired sediment and tissue Nickel (Ni) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; Fish tissue [Ni] (mg/kg) = 0.0562(sediment [Ni])$^{1.0229}$ (R^2 = 0.18). The solid line represents the sediment-to-fish tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); Fish tissue [Ni] (mg/kg) = 1.00*Sediment [Ni]. The Upper Animas BERA sediment-to-fish tissue factor was selected for use in the current BPMD Aquatic BERA.



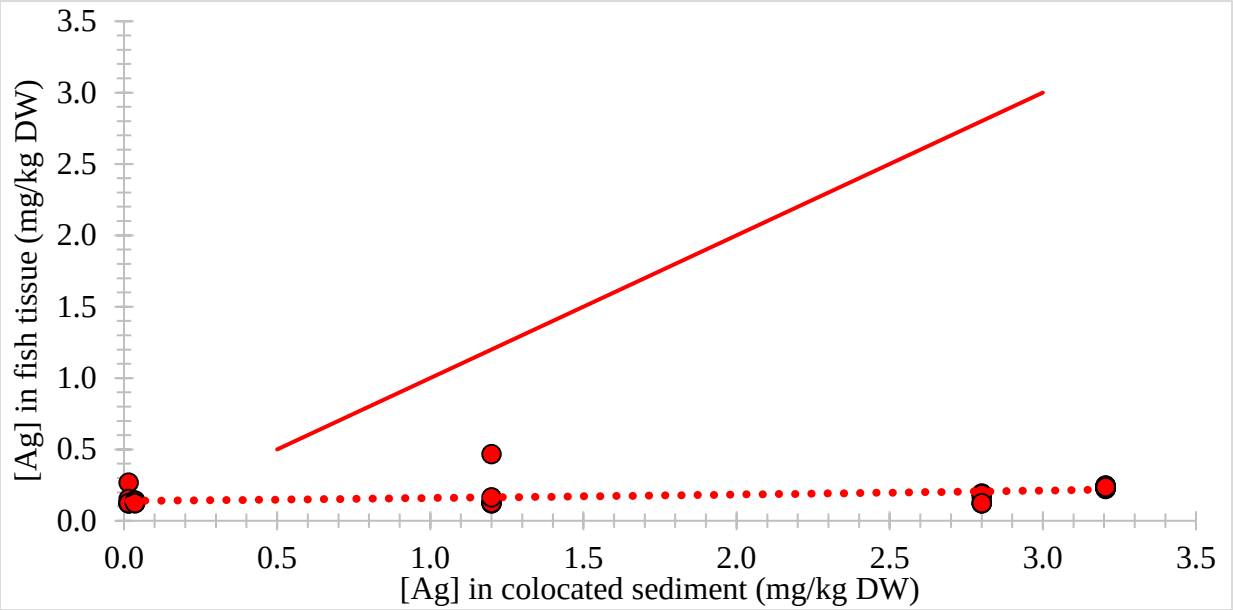
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A7-8 Whole Body Fish Tissue and Sediment Scatter Plot for Selenium. Each point represents a paired sediment and tissue Selenium (Se) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; Fish tissue [Se] (mg/kg) = 1.7917*(sediment [Se]) + 0.7695 (R^2 = 0.48). The solid line represents the sediment-to-fish tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); Fish tissue [Se] (mg/kg) = 1.00*Sediment [Se]. The site-specific sediment-to-fish tissue model was selected for use in the current BPMD Aquatic BERA.



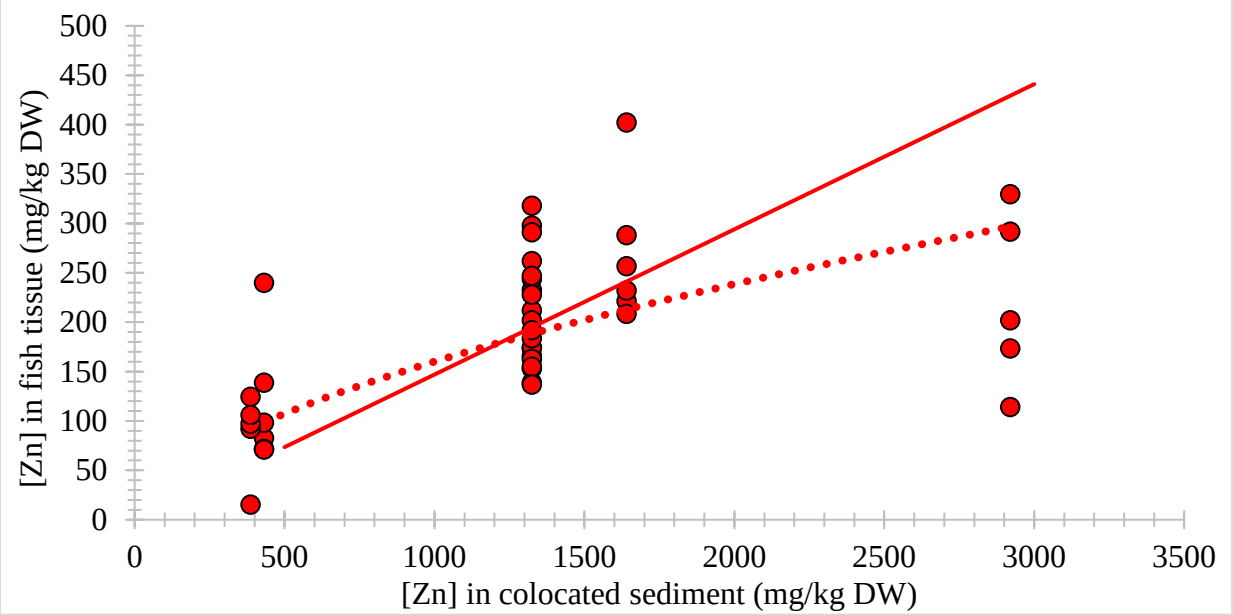
DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A7-9 Whole Body Fish Tissue and Sediment Scatter Plot for Silver. Each point represents a paired sediment and tissue Silver (Ag) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; Fish tissue [Ag] (mg/kg) = $0.1383e^{0.1417(\text{sediment [Se]})}$ (R^2 = 0.31). The solid line represents the sediment-to-fish tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); Fish tissue [Ag] (mg/kg) = 1.00*Sediment [Ag]. The Upper Animas BERA sediment-to-fish tissue factor was selected for use in the current BPMD Aquatic BERA.



DW = Dry weight; mg = Milligrams; kg = Kilograms

Figure A7-10 Whole Body Fish Tissue and Sediment Scatter Plot for Zinc. Each point represents a paired sediment and tissue Zinc (Zn) concentrations from samples collected throughout the Bonita Peak Mining District (BPMD). The dashed line represents the site-specific regression model that was based on plotted sediment and tissue data points; Fish tissue [Zn] (mg/kg) = 3.0009(sediment [Zn])$^{0.5757}$ (R^2 = 0.43). The solid line represents the sediment-to-fish tissue factor that was used in the Upper Animas Baseline Ecological Risk Assessment (BERA; Attachment 1); Fish tissue [Zn] (mg/kg) = 0.147*Sediment [Zn]. The site-specific sediment-to-fish tissue model was selected for use in the current BPMD Aquatic BERA.



DW = Dry weight; mg = Milligrams; kg = Kilograms

Appendix 8

Surface Water Aquatic Community-Level Receptor Contaminants of Potential Ecological Concern Derivation Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 8 Tables:

Table A8.1 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A.

Table A8.2 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

Table A8.3 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

Table A8.4 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

Table A8.5 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

Table A8.6 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

Table A8.7 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

Table A8.8 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48.

Table A8.9 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

Table A8.10 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

Table A8.11 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

Table A8.12 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

Table A8.13 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

Table A8.14 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

Table A8.15 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

Table A8.16 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-16; Placer Gulch to confluence with Upper West Fork Animas River Monitoring Site A20.

Table A8.17 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to Source Monitoring Site A15.

Table A8.18 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-18; North Fork Animas River - Burrows Gulch to Animas Forks Monitoring Site A08 and A09.

Table A8.19 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07.

Table A8.20 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

Table A8.21 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs.

Table A8.22 Selection of Surface Water COPECs for Aquatic Community-level Receptors in Bear Creek Reference EU Monitoring Site M30.

Table A8.23 Selection of Surface Water COPECs for Aquatic Community-level Receptors in Hermosa Creek Reference EU Monitoring Site HC01.

Table A8.24 Selection of Surface Water COPECs for Aquatic Community-level Receptors in Maggie Gulch Reference EU Monitoring Site A43.

Table A8.25 Selection of Surface Water COPECs for Aquatic Community-level Receptors in Mill Creek Reference EU Monitoring Site M08.

Table A8.26 Selection of Surface Water COPECs for Aquatic Community-level Receptors in Picayne Gulch Reference EU Monitoring Site A26.

Table A8.27 Selection of Surface Water COPECs for Aquatic Community-level Receptors in North Fork Animas River Reference EU Monitoring Site A05.

Table A8.1 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	44/44	4.97	8.06	M34	4.97	-	6.50	1	>1.00	Yes	a
Aluminum (TRM)	36/36	563	5950	M34	5950	309	87.0[f]	1	68.4	Yes	a
Antimony (TRM)	0/18	-	2.50 U	M34	1.25	-	240	2	0.01	No	b
Arsenic (DM)	1/37	0.37 J	0.37 J	M34	0.37	-	150	1	0.002	No	b
Barium (TRM)	7/11	25.2 JD	44.0	M34	44.0	54.0	228	2	0.19	No	b
Beryllium (TRM)	2/36	0.16 J	0.19 J	M34	1.00	53.6	2.33	2	0.43	No	b
Cadmium (DM)	35/37	0.20 J	2.00	M34	2.00	150	0.58	1	3.47	Yes	a
Chromium (DM)	0/37	-	5.00 U	M34	2.50	79.1	61.1	1	0.04	No	b
Cobalt (TRM)	11/11	1.21 D	7.40	M34	7.40	-	100	2	0.02	No	b
Copper (DM)	26/37	1.48	16.5	M34	12.3	150	12.7	1	0.97	No	b
Iron (TRM)	36/36	754	6830	M34	6830	309	1000	1	6.83	Yes	a
Lead (DM)	19/37	0.11 J	4.20	M34	1.03	54.9	1.30	1	0.79	No	b
Manganese (DM)	37/37	81.9	634	M34	634	308	2398	1	0.26	No	b
Mercury (TRM)	2/4	0.0003 J	0.01	M34	0.04	-	0.01	1	4.00	Yes	a
Molybdenum (TRM)	2/6	0.52 J	0.54	M34	2.50	-	3200	2	0.001	No	b
Nickel (DM)	12/37	0.51 J	5.30	M34	5.30	309	135	1	0.04	No	b
Selenium (DM)	0/37	-	2.50 U	M34	1.25	-	4.60	1	0.27	No	b
Silver (DM)	1/36	0.60	2.50 U	M34	1.25	79.1	0.05	1	24.9	Yes	a
Thallium (DM)	0/23	-	2.50 U	M34	1.25	-	15.0	1	0.08	No	b
Vanadium (TRM)	2/11	0.60 J	2.70	M34	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	36/37	33	499	M34	499	150	175	1	2.85	Yes	a

µg/L = microgram per liter
mg/L = milligram per liter
COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
D = Sample diluted prior to chemical analysis; actual result reported
J = Estimated result
JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.2 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	13/13	4.36	7.29	M27	4.36	-	6.50	1	>1.00	Yes	a
Aluminum (TRM)	13/13	1010	6830	M27	6830	275	87.0[f]	1	78.5	Yes	a
Antimony (TRM)	0/8	-	2.50 U	M27A/M27	1.25	-	240	2	0.01	No	b
Arsenic (DM)	2/13	0.55 J	0.70 J	M27	0.697	256	150	1	0.005	No	b
Barium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Beryllium (TRM)	0/13	-	2.00 U	M27	1.00	47.5	1.90	2	0.53	No	b
Cadmium (DM)	13/13	0.43	1.46	M27	1.07	104	0.44	1	2.45	Yes	a
Chromium (DM)	0/13	-	1.00 U	M27	0.50	47.5	40.3	1	0.01	No	b
Cobalt (TRM)	-	-	-	-	-	-	-	-	-	-	-
Copper (DM)	13/13	4.58	17.4	M27	17.0	148	12.5	1	1.36	Yes	a
Iron (TRM)	13/13	2180	9200	M27A	9200	272	1000	1	9.20	Yes	a
Lead (DM)	13/13	0.56	8.62	M27	8.62	148	3.85	1	2.24	Yes	a
Manganese (DM)	13/13	139	767	M27	767	275	2309	1	0.33	No	b
Molybdenum (TRM)	0/1	-	5.00 U	M27A/M27	2.50	-	3200	2	0.001	No	b
Nickel (DM)	6/13	0.66 J	1.66 J	M27	1.66	256	115	1	0.01	No	b
Selenium (DM)	0/13	-	1.00 U	M27A/M27	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/13	-	0.50 U	M27	0.25	47.5	0.02	1	12.0	Yes	a
Thallium (DM)	0/13	-	1.00 U	M27A/M27	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Zinc (DM)	13/13	97.4	360	M27	277	104	125	1	2.21	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.3 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	9/9	6.05	7.52	M11	6.05	-	6.50	1	>1.00	Yes	a
Aluminum (TRM)	9/9	109	1700	M14B	1700	34.8	87.0[f]	1	19.5	Yes	a
Antimony (TRM)	0/8	-	2.50 U	M14B/M11	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/9	-	0.50 U	M11	0.25	-	150	1	0.002	No	b
Barium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Beryllium (TRM)	0/9	-	2.00 U	M11	1.00	34.8	1.13	2	0.89	No	b
Cadmium (DM)	9/9	0.39	1.06	M11	0.62	50.0	0.25	1	2.47	Yes	a
Chromium (DM)	0/9	-	1.00 U	M11	0.50	34.8	31.2	1	0.02	No	b
Cobalt (TRM)	-	-	-	-	-	-	-	-	-	-	-
Copper (DM)	9/9	5.27	14.1	M11	14.1	50.0	4.95	1	2.85	Yes	a
Iron (TRM)	9/9	106 J	3530	M14B	3530	36.7	1000	1	3.53	Yes	a
Lead (DM)	9/9	0.41	11.6	M11	5.99	36.7	0.83	1	7.19	Yes	a
Manganese (DM)	9/9	63.7	294	M14B	294	186	2030	1	0.14	No	b
Molybdenum (TRM)	-	-	-	-	-	-	-	-	-	-	-
Nickel (DM)	0/9	-	0.50 U	M11	0.25	34.8	21.3	1	0.01	No	b
Selenium (DM)	0/9	-	1.00 U	M14B/M11	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/9	-	0.50 U	M11	0.25	34.8	0.01	1	20.4	Yes	a
Thallium (DM)	0/9	-	1.00 U	M14B/M11	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Zinc (DM)	9/9	106	375	M11	195	50.0	64.5	1	3.02	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.4 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-04; Mineral Creek upstream of Mill Creek Monitoring Site M10A.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	4/4	6.75	7.53	M10A	7.53	-	6.50	1	<1.00	No	b
Aluminum (TRM)	4/4	158	315	M10A	315	34.0	111	1	2.83	Yes	a
Antimony (TRM)	0/3	-	2.50 U	M10A	1.25	-	240	2	0.01	No	b
Arsenic (DM)	2/4	0.58 J	0.76 J	M10A	0.76	32.3	150	1	0.01	No	b
Barium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Beryllium (TRM)	0/4	-	2.00 U	M10A	1.00	32.3	0.99	2	1.01	Yes	a
Cadmium (DM)	4/4	0.58	2.53	M10A	2.53	106.0	0.44	1	5.71	Yes	a
Chromium (DM)	0/4	-	1.00 U	M10A	0.50	32.3	29.4	1	0.02	No	b
Cobalt (TRM)	-	-	-	-	-	-	-	-	-	-	-
Copper (DM)	4/4	10.3	20.7	M10A	20.7	34.0	3.56	1	5.81	Yes	a
Iron (TRM)	4/4	148 J	564	M10A	564	-	1000	1	0.56	No	b
Lead (DM)	4/4	7.75	43.9	M10A	43.9	106.0	2.68	1	16.4	Yes	a
Manganese (DM)	4/4	91	346	M10A	346	106.0	1682	1	0.21	No	b
Molybdenum (TRM)	-	-	-	-	-	-	-	-	-	-	-
Nickel (DM)	2/4	0.64 J	0.95 J	M10A	0.95	106.0	54.6	1	0.02	No	b
Selenium (DM)	0/4	-	1.00 U	M10A	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/4	-	0.50 U	M10A	0.25	32.3	0.01	1	23.3	Yes	a
Thallium (DM)	0/4	-	1.00 U	M10A	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Zinc (DM)	4/4	157	987	M10A	987	106.0	128	1	7.72	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.5 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	5/5	6.67	7.74	M28	6.67	-	6.50	1	<1.00	No	b
Aluminum (TRM)	5/5	457	628	M28	628	129	87.0[f]	1	7.22	Yes	a
Antimony (TRM)	0/4	-	2.50 U	M28	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/5	-	0.50 U	M28	0.25	-	150	1	0.002	No	b
Barium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Beryllium (TRM)	0/5	-	2.00 U	M28	1.00	54.8	2.42	2	0.41	No	b
Cadmium (DM)	1/5	0.14 J	0.14 J	M28	0.14	91.2	0.40	1	0.41	No	b
Chromium (DM)	1/5	1.05 J	1.05 J	M28	1.05	69.7	55.2	1	0.02	No	b
Cobalt (TRM)	-	-	-	-	-	-	-	-	-	-	-
Copper (DM)	5/5	0.53 J	0.85 J	M28	0.78	55.4	5.40	1	0.14	No	b
Iron (TRM)	5/5	269	1280	M28	1280	127	1000	1	1.28	Yes	a
Lead (DM)	1/5	0.11 J	0.11 J	M28	0.11	55.4	1.31	1	0.09	No	b
Manganese (DM)	5/5	24.6	81.2	M28	81.2	91.2	1600	1	0.05	No	b
Molybdenum (TRM)	-	-	-	-	-	-	-	-	-	-	-
Nickel (DM)	0/5	-	0.50 U	M28	0.25	54.8	31.3	1	0.01	No	b
Selenium (DM)	0/5	-	1.00 U	M28	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/5	-	0.50 U	M28	0.25	54.8	0.03	1	9.37	Yes	a
Thallium (DM)	0/5	-	1.00 U	M28	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Zinc (DM)	4/5	10.7 J	21.3	M28	13.5	69.7	87.3	1	0.15	No	b

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.6 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	4/4	4.16	6.42	M20	4.16	-	6.50	1	>1.00	Yes	a
Aluminum (TRM)	4/4	2200	15000	M20	15000	405	87.0[f]	1	172	Yes	a
Antimony (TRM)	0/4	-	2.50 U	M20	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/4	-	2.50 U	M20	1.25	-	150	1	0.01	No	b
Barium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Beryllium (TRM)	0/4	-	2.00 U	M20	1.00	74.4	4.05	2	0.25	No	b
Cadmium (DM)	4/4	0.20	1.29	M20	1.04	300	0.97	1	1.07	Yes	a
Chromium (DM)	0/4	-	5.00 U	M20	2.50	300	182	1	0.01	No	b
Cobalt (TRM)	-	-	-	-	-	-	-	-	-	-	-
Copper (DM)	4/4	1.15	6.00 D	M20	5.26	308	23.4	1	0.22	No	b
Iron (TRM)	4/4	5040	20800	M20	20800	413	1000	1	20.8	Yes	a
Lead (DM)	0/4	-	0.50 U	M20	0.25	300	8.13	1	0.03	No	b
Manganese (DM)	4/4	169	1340	M20	1340	405	2629	1	0.51	No	b
Molybdenum (TRM)	-	-	-	-	-	-	-	-	-	-	-
Nickel (DM)	1/4	3.64 JD	3.64 JD	M20	3.64	405	170	1	0.02	No	b
Selenium (DM)	0/4	-	5.00 U	M20	2.50	-	4.60	1	0.54	No	b
Silver (DM)	0/4	-	2.50 U	M20	0.25	74.4	0.05	1	5.54	Yes	a
Thallium (DM)	0/4	-	5.00 U	M20	2.50	-	15.0	1	0.17	No	b
Vanadium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Zinc (DM)	4/4	23.4	186	M20	186	405	433	1	0.43	No	b

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

D = Sample diluted prior to chemical analysis; actual result reported

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.7 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-07; Animas River from the confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	31/31	6.64	7.93	A56	6.64	-	6.50	1	<1.00	No	b
Aluminum (TRM)	67/68	20.9 J	955	A55	955	50.2	87.0[f]	1	11.0	Yes	a
Antimony (TRM)	2/58	4.42 JD	5.04 D	A55	5.04	131	240	2	0.02	No	b
Arsenic (DM)	1/68	0.69 J	0.69 J	A55	0.69	135	150	1	0.005	No	b
Barium (TRM)	5/49	25.1 JD	29.9 JD	A56	26.9	64.8	276	2	0.10	No	b
Beryllium (TRM)	0/68	-	10.0 U	A56/A55	1.00	50.2	2.09	2	0.48	No	b
Cadmium (DM)	68/68	0.42	2.67	A56	2.67	133	0.53	1	5.08	Yes	a
Chromium (DM)	7/68	1.04 J	3.76	A55	3.76	119	85.3	1	0.04	No	b
Cobalt (TRM)	1/49	0.53 J	0.53 J	A56	0.53	153	100	2	0.01	No	b
Copper (DM)	68/68	0.70 J	15.2	A55	15.2	81.0	7.48	1	2.03	Yes	a
Iron (TRM)	57/68	103 J	1100	A55	1100	49.0	1000	1	1.10	Yes	a
Lead (DM)	65/68	0.11 J	0.97	A56	0.87	50.2	1.18	1	0.74	No	b
Manganese (DM)	68/68	140	524	A55	524	112	1714	1	0.31	No	b
Molybdenum (TRM)	0/43	-	5.00 U	A56/A55	2.50	-	3200	2	0.001	No	b
Nickel (DM)	2/68	0.56 J	1.24	A56	1.24	151	73.8	1	0.02	No	b
Selenium (DM)	2/68	1.10 J	1.15 J	A55	1.15	138	4.60	1	0.25	No	b
Silver (DM)	0/68	-	0.50 U	A56/A55	0.25	50.2	0.02	1	10.9	Yes	a
Thallium (DM)	0/68	-	1.00 U	A56/A55	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/49	-	10.0 U	A56/A55	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	68/68	183	482	A56	319	50.2	64.8	1	4.93	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.8 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	6/6	7.10	8.01	A48	7.10	-	6.50	1	<1.00	No	b
Aluminum (TRM)	5/6	31.1	217	A48	217	43.7	157	1	1.38	Yes	a
Antimony (TRM)	0/6	-	2.50 U	A48	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/6	-	0.50 U	A48	0.25	-	150	1	0.00	No	b
Barium (TRM)	3/3	33.5 JD	44.9 JD	A48	33.5	50.5	212	2	0.16	No	b
Beryllium (TRM)	0/6	-	2.00 U	A48	1.00	43.7	1.65	2	0.60	No	b
Cadmium (DM)	5/6	0.14 J	0.23	A48	0.15	50.5	0.25	1	0.57	No	b
Chromium (DM)	4/6	1.01 J	1.40 J	A48	1.40	43.7	37.6	1	0.04	No	b
Cobalt (TRM)	0/3	-	0.50 U	A48	0.25	-	100	2	0.00	No	b
Copper (DM)	6/6	1.08	1.67	A48	1.67	43.7	4.41	1	0.38	No	b
Iron (TRM)	2/6	182 J	208 J	A48	208	43.8	1000	1	0.21	No	b
Lead (DM)	6/6	0.13 J	0.46	A48	0.44	43.7	1.01	1	0.43	No	b
Manganese (DM)	5/6	2.24 J	4.14 J	A48	4.14	43.7	1252	1	0.00	No	b
Molybdenum (TRM)	0/3	-	5.00 U	A48	2.50	-	3200	2	0.001	No	b
Nickel (DM)	0/6	-	0.50 U	A48	0.25	43.7	25.8	1	0.01	No	b
Selenium (DM)	0/6	-	1.00 U	A48	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/6	-	0.50 U	A48	0.25	43.7	0.02	1	13.8	Yes	a
Thallium (DM)	0/6	-	1.00 U	A48	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/3	-	10.0 U	A48	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	6/6	15.5 J	35.6	A48	31.5	50.5	65.1	1	0.48	No	b

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.9 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	16/16	5.78	7.68	A45	5.78	-	6.50	1	>1.00	Yes	a
Aluminum (TRM)	16/17	61.7	619	A45	619	53.0	87.0[f]	1	7.11	Yes	a
Antimony (TRM)	0/17	-	2.50 U	A41A	1.25	-	240	2	0.01	No	b
Arsenic (DM)	1/17	0.13 J	0.50 U	A41A	0.25	-	150	1	0.002	No	b
Barium (TRM)	1/9	14.3 J-	14.3 J-	A41A	12.5	49.5	207	2	0.06	No	b
Beryllium (TRM)	1/17	0.35 J	2.00 U	A41A	1.00	46.2	1.82	2	0.55	No	b
Cadmium (DM)	17/17	0.45	2.07	A41A	1.65	83.5	0.37	1	4.46	Yes	a
Chromium (DM)	1/17	1.09 J	1.09 J	A41A	1.09	46.2	39.4	1	0.03	No	b
Cobalt (TRM)	2/9	0.36 J	0.54 JD	A41A	0.54	156	100	2	0.01	No	b
Copper (DM)	17/17	1.21	28.0	A41A	28.0	83.5	7.68	1	3.65	Yes	a
Iron (TRM)	10/17	51.6 J	578	A45	578	53.9	1000	1	0.58	No	b
Lead (DM)	11/17	0.10	0.90	A41A	0.90	50.7	1.19	1	0.75	No	b
Manganese (DM)	17/17	26.1	1240	A41A	1240	144	1864	1	0.67	No	b
Molybdenum (TRM)	0/8	-	5.00 U	A41A	2.50	-	3200	2	0.001	No	b
Nickel (DM)	1/17	1.10 J	1.10 J	A41A	1.10	90.4	47.7	1	0.02	No	b
Selenium (DM)	0/17	-	1.10 UJ	A41A	0.55	-	4.60	1	0.12	No	b
Silver (DM)	0/17	-	0.50 U	A41A	0.25	46.2	0.02	1	12.6	Yes	a
Thallium (DM)	0/17	-	1.00 U	A41A	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/9	-	10.0 U	A41A	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	17/17	229	553	A41A	364	53.0	68.0	1	5.35	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

J- = Estimated result; result may be biased low

JD = Estimated result from a diluted sample

UJ = Analyte not detected; minimum detection limit may be inaccurate

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.10 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	18/18	6.81	7.91	A40	6.81	-	6.50	1	<1.00	No	b
Aluminum (TRM)	17/18	117	916	A35	916	139	87.0[f]	1	10.5	Yes	a
Antimony (TRM)	0/17	-	2.50 U	A35	1.25	-	240	2	0.01	No	b
Arsenic (DM)	1/18	0.17 J	0.50 U	A35	0.25	-	150	1	0.002	No	b
Barium (TRM)	1/9	13.6 J	13.6 J	A40	12.5	40.0	165	2	0.08	No	b
Beryllium (TRM)	1/18	0.37 J	2.00 U	A35	1.00	40.0	1.41	2	0.71	No	b
Cadmium (DM)	18/18	0.83	2.70	A35	1.57	39.8	0.21	1	7.42	Yes	a
Chromium (DM)	0/18	-	1.00 U	A35	0.50	39.8	34.8	1	0.01	No	b
Cobalt (TRM)	4/9	0.49 J	0.94 J	A35	0.94	138	100	2	0.01	No	b
Copper (DM)	18/18	3.18	33.5	A35	33.5	75.5	7.04	1	4.76	Yes	a
Iron (TRM)	13/18	71.8 J	611	A35	611	75.5	1000	1	0.61	No	b
Lead (DM)	14/18	0.14 J	1.63	A40	1.63	54.1	1.28	1	1.27	Yes	a
Manganese (DM)	18/18	132	1990	A35	1990	139	1840	1	1.08	Yes	a
Molybdenum (TRM)	0/8	-	5.00 U	A35	2.50	-	3200	2	0.001	No	b
Nickel (DM)	2/18	0.67 J	1.90 J	A35	1.90	87.7	46.5	1	0.04	No	b
Selenium (DM)	0/18	-	1.60 UJ	A40	0.80	-	4.60	1	0.17	No	b
Silver (DM)	0/18	-	0.50 U	A35	0.25	39.8	0.02	1	16.3	Yes	a
Thallium (DM)	0/18	-	1.00 U	A35	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	1/9	0.18 J	10.0 U	A35	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	18/18	317	828	A35	428	40.0	52.7	1	8.13	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

UJ = Analyte not detected; minimum detection limit may be inaccurate

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.11 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	6/6	7.14	7.66	A36	7.14	-	6.50	1	<1.00	No	b
Aluminum (TRM)	6/6	122	821	A36	213	49.4	186	1	1.15	Yes	a
Antimony (TRM)	0/6	-	2.50 U	A36	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/6	-	0.50 U	A36	0.25	-	150	1	0.002	No	b
Barium (TRM)	0/2	-	25.0 U	A36	12.5	51.4	216	2	0.06	No	b
Beryllium (TRM)	0/6	-	2.00 U	A36	1.00	48.9	2.00	2	0.50	No	b
Cadmium (DM)	5/6	0.11 J	0.44	A36	0.44	240	0.82	1	0.53	No	b
Chromium (DM)	0/6	-	1.00 U	A36	0.50	48.9	41.2	1	0.01	No	b
Cobalt (TRM)	1/2	2.73 JD	2.73 JD	A36	2.73	250	100	2	0.03	No	b
Copper (DM)	6/6	2.35	4.16	A36	3.17	51.4	5.07	1	0.62	No	b
Iron (TRM)	6/6	102 J	866	A36	866	250	1000	1	0.87	No	b
Lead (DM)	0/6	-	0.10 U	A36	0.05	48.9	1.15	1	0.04	No	b
Manganese (DM)	6/6	20.4	254	A36	254	240	2207	1	0.12	No	b
Molybdenum (TRM)	0/2	-	5.00 U	A36	2.50	-	3200	2	0.001	No	b
Nickel (DM)	0/6	-	0.50 U	A36	0.25	48.9	28.4	1	0.01	No	b
Selenium (DM)	0/6	-	1.00 U	A36	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/6	-	0.50 U	A36	0.25	48.9	0.02	1	11.4	Yes	a
Thallium (DM)	0/6	-	1.00 U	A36	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/2	-	10.0 U	A36	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	6/6	21.7	88.3	A36	27.4	51.4	66.2	1	0.41	No	b

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.12 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	6/6	7.41	7.78	A37	7.41	-	6.50	1	<1.00	No	b
Aluminum (TRM)	5/6	53.3	262	A37	262	50.6	192	1	1.36	Yes	a
Antimony (TRM)	0/6	-	2.50 U	A37	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/6	-	0.50 U	A37	0.25	-	150	1	0.002	No	b
Barium (TRM)	0/2	-	25.0 U	A37	12.5	50.6	212	2	0.06	No	b
Beryllium (TRM)	0/6	-	2.00 U	A37	1.00	50.6	2.12	2	0.47	No	b
Cadmium (DM)	6/6	0.27	2.53	A37	2.53	51.5	0.26	1	9.84	Yes	a
Chromium (DM)	0/6	-	1.00 U	A37	0.50	50.6	42.4	1	0.01	No	b
Cobalt (TRM)	0/2	-	0.50 U	A37	0.25	-	100	2	0.003	No	b
Copper (DM)	6/6	1.78	14.1	A37	14.1	50.6	5.00	1	2.82	Yes	a
Iron (TRM)	2/6	174 J	178 J	A37	178	49.9	1000	1	0.18	No	b
Lead (DM)	4/6	0.27	1.16	A37	1.16	50.6	1.19	1	0.97	No	b
Manganese (DM)	6/6	5.06	883	A37	883	50.6	1315	1	0.67	No	b
Molybdenum (TRM)	0/2	-	5.00 U	A37	2.50	-	3200	2	0.001	No	b
Nickel (DM)	1/6	0.90 J	0.90 J	A37	0.90	50.6	29.2	1	0.03	No	b
Selenium (DM)	0/6	-	1.00 U	A37	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/6	-	0.50 U	A37	0.25	50.6	0.02	1	10.7	Yes	a
Thallium (DM)	0/6	-	1.00 U	A37	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/2	-	10.0 U	A37	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	6/6	143	880	A37	880	51.5	66.2	1	13.3	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.13 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-13; mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	10/10	7.02	7.69	A34	7.02	-	6.50	1	<1.00	No	b
Aluminum (TRM)	9/10	179	1170	A34	643	49.7	187	1	3.43	Yes	a
Antimony (TRM)	0/9	-	2.50 U	A34	1.25	-	240	2	0.01	No	b
Arsenic (DM)	1/10	0.13 J	0.50 U	A34	0.25	-	150	1	0.002	No	b
Barium (TRM)	1/5	14.6 J	14.6 J	A34	12.5	52.7	221	2	0.06	No	b
Beryllium (TRM)	0/10	-	2.00 U	A34	1.00	48.8	1.99	2	0.50	No	b
Cadmium (DM)	9/10	0.67	3.37	A34	3.37	197	0.71	1	4.77	Yes	a
Chromium (DM)	0/10	-	1.00 U	A34	0.50	48.8	41.2	1	0.01	No	b
Cobalt (TRM)	4/5	0.46 J	1.39	A34	1.39	198	100	2	0.01	No	b
Copper (DM)	10/10	4.83	21.9	A34	10.3	52.7	5.18	1	1.99	Yes	a
Iron (TRM)	9/10	96.6 J	1180	A34	1180	135	1000	1	1.18	Yes	a
Lead (DM)	5/10	0.31	3.87	A34	3.87	132	3.40	1	1.14	Yes	a
Manganese (DM)	10/10	88.6 J	565	A34	565	197	2067	1	0.27	No	b
Molybdenum (TRM)	0/4	-	5.00 U	A34	2.50	-	3200	2	0.001	No	b
Nickel (DM)	1/10	1.50 J	1.50 J	A34	1.50	119	60.2	1	0.02	No	b
Selenium (DM)	0/10	-	1.00 U	A34	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/10	-	0.50 U	A34	0.25	48.8	0.02	1	11.4	Yes	a
Thallium (DM)	0/10	-	1.00 U	A34	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	1/5	0.12 J	10.0 U	A34	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	10/10	182 J+	950	A34	352	48.8	63.2	1	5.57	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

J+ = Estimated result; result may be biased high

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.14 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	15/15	3.48	7.60	A14	3.48	-	6.50	1	>1.00	Yes	a
Aluminum (TRM)	14/15	359	5100	A14	5100	155	87.0[f]	1	58.6	Yes	a
Antimony (TRM)	0/14	-	2.50 U	A33	1.25	-	240	2	0.01	No	b
Arsenic (DM)	1/15	0.20 J	0.50 U	A14	0.25	-	150	1	0.002	No	b
Barium (TRM)	1/6	13.4 J	13.4 J	A33	12.5	31.3	127	2	0.10	No	b
Beryllium (TRM)	4/15	1.10 J	6.55	A14	1.00	27.0	0.74	2	1.36	Yes	a
Cadmium (DM)	15/15	1.56	10.7	A14	10.7	155	0.59	1	18.2	Yes	a
Chromium (DM)	0/15	-	1.00 U	A14	0.50	27.0	25.4	1	0.02	No	b
Cobalt (TRM)	4/6	0.70 JD	3.29 D	A14	3.29	165	100	2	0.03	No	b
Copper (DM)	15/15	5.40 J+	42.2	A33	42.2	50.6	5.01	1	8.43	Yes	a
Iron (TRM)	12/15	114 J	880	A33	880	35.0	1000	1	0.88	No	b
Lead (DM)	14/15	0.17 J	11.3	A14	3.05	34.3	0.77	1	3.95	Yes	a
Manganese (DM)	15/15	435	13600	A14	13600	165	1947	1	6.98	Yes	a
Molybdenum (TRM)	0/5	-	5.00 U	A14	2.50	-	3200	2	0.001	No	b
Nickel (DM)	8/15	0.97	7.20	A14	5.34	113	57.8	1	0.09	No	b
Selenium (DM)	0/15	-	1.00 U	A14	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/15	-	0.50 U	A14	0.25	27.0	0.01	1	31.6	Yes	a
Thallium (DM)	0/15	-	1.00 U	A14	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	1/6	0.15 J	10.0 U	A14	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	15/15	389	3800	A14	850	31.3	42.2	1	20.2	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

J+ = Estimated result; result may be biased high

D = Sample diluted prior to chemical analysis; actual result reported

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.15 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-15; lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	5/5	5.13	6.20	A10	5.13	-	6.50	1	>1.00	Yes	a
Aluminum (TRM)	6/6	991	9050	A10	9050	158	87.0[f]	1	104	Yes	a
Antimony (TRM)	0/6	-	2.50 U	A10	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/6	-	0.50 U	A10	0.25	-	150	1	0.002	No	b
Barium (TRM)	0/2	-	25.0 U	A10	12.5	32.0	130	2	0.10	No	b
Beryllium (TRM)	3/6	8.34	10.70	A10	1.00	30.6	0.91	2	1.10	Yes	a
Cadmium (DM)	6/6	2.58	11.6	A10	3.02	32.0	0.18	1	16.8	Yes	a
Chromium (DM)	0/6	-	1.00 U	A10	0.50	30.6	28.1	1	0.02	No	b
Cobalt (TRM)	2/2	0.78 JD	3.97 D	A10	3.97	199	100	2	0.04	No	b
Copper (DM)	6/6	12.9	39.4	A10	16.2	32.0	3.38	1	4.79	Yes	a
Iron (TRM)	6/6	195 J	410	A10	410	166	1000	1	0.41	No	b
Lead (DM)	6/6	2.66	7.22	A10	3.67	37.3	0.85	1	4.34	Yes	a
Manganese (DM)	6/6	2080	18000	A10	18000	191	2046	1	8.80	Yes	a
Molybdenum (TRM)	0/2	-	5.00 U	A10	2.50	-	3200	2	0.001	No	b
Nickel (DM)	6/6	1.50	8.38	A10	6.68	127	63.8	1	0.10	No	b
Selenium (DM)	0/6	-	1.00 U	A10	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/6	-	0.50 U	A10	0.25	30.6	0.01	1	25.5	Yes	a
Thallium (DM)	0/6	-	1.00 U	A10	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/2	-	10.0 U	A10	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	6/6	828	4560	A10	969	32.0	43.0	1	22.5	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

D = Sample diluted prior to chemical analysis; actual result reported

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.16 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	5/5	5.87	6.95	A20	5.87	-	6.50	1	>1.00	Yes	a
Aluminum (TRM)	6/6	507	1270	A20	1270	121	87.0[f]	1	14.6	Yes	a
Antimony (TRM)	0/6	-	2.50 U	A20	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/6	-	0.50 U	A20	0.25	-	150	1	0.002	No	b
Barium (TRM)	0/2	-	25.0 U	A20	12.5	33.5	137	2	0.09	No	b
Beryllium (TRM)	0/6	-	2.00 U	A20	1.00	33.5	1.06	2	0.94	No	b
Cadmium (DM)	6/6	1.83	3.66	A20	1.83	33.5	0.19	1	9.84	Yes	a
Chromium (DM)	0/6	-	1.00 U	A20	0.50	33.5	30.3	1	0.02	No	b
Cobalt (TRM)	1/2	1.32 D	1.32 D	A20	1.32	117	100	2	0.01	No	b
Copper (DM)	6/6	9.55	19.5	A20	17.6	33.5	3.52	1	5.00	Yes	a
Iron (TRM)	4/6	161 J	437	A20	437	113	1000	1	0.44	No	b
Lead (DM)	6/6	2.55	20.3	A20	20.3	113	2.86	1	7.09	Yes	a
Manganese (DM)	6/6	843	2320	A20	2320	63.0	1414	1	1.64	Yes	a
Molybdenum (TRM)	0/2	-	5.00 U	A20	2.50	-	3200	2	0.001	No	b
Nickel (DM)	6/6	0.98 J	3.35	A20	3.35	60.1	33.8	1	0.10	No	b
Selenium (DM)	0/6	-	1.00 U	A20	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/6	-	0.50 U	A20	0.25	33.5	0.01	1	21.8	Yes	a
Thallium (DM)	0/6	-	1.00 U	A20	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/2	-	10.0 U	A20	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	6/6	719	1750	A20	719	33.5	44.9	1	16.0	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

D = Sample diluted prior to chemical analysis; actual result reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.17 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to Source Monitoring Site A15.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	6/6	5.17	5.90	A15	5.17	-	6.50	1	>1.00	Yes	a
Aluminum (TRM)	6/6	3000	13100	A15	13100	200	87.0[f]	1	151	Yes	a
Antimony (TRM)	0/6	-	2.50 U	A15	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/6	-	0.50 U	A15	0.25	-	150	1	0.002	No	b
Barium (TRM)	0/2	-	25.0 U	A15	12.5	37.2	153	2	0.08	No	b
Beryllium (TRM)	6/6	2.69 J	17.4	A15	4.36	47.4	1.89	2	2.30	Yes	a
Cadmium (DM)	6/6	3.55	15.5	A15	15.5	207	0.73	1	21.1	Yes	a
Chromium (DM)	0/6	-	1.00 U	A15	0.50	37.2	33.0	1	0.02	No	b
Cobalt (TRM)	2/2	1.60 D	4.54 D	A15	4.54	207	100	2	0.05	No	b
Copper (DM)	6/6	9.59	36.4	A15	10.0	37.2	3.85	1	2.60	Yes	a
Iron (TRM)	6/6	122 J	496	A15	496	33.8	1000	1	0.50	No	b
Lead (DM)	6/6	0.41	1.82	A15	1.82	37.2	0.85	1	2.15	Yes	a
Manganese (DM)	6/6	4630	29700	A15	29700	207	2102	1	14.1	Yes	a
Molybdenum (TRM)	0/2	-	5.00 U	A15	2.50	-	3200	2	0.001	No	b
Nickel (DM)	6/6	3.03	15.4	A15	15.4	207	96.2	1	0.16	No	b
Selenium (DM)	1/6	1.03 J	1.03 J	A15	1.03	200	4.60	1	0.22	No	b
Silver (DM)	0/6	-	0.50 U	A15	0.25	37.2	0.01	1	18.2	Yes	a
Thallium (DM)	0/6	-	1.00 U	A15	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/2	-	10.0 U	A15	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	6/6	1200	5100	A15	1200	37.2	49.4	1	24.3	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

D = Sample diluted prior to chemical analysis; actual result reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.18 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-18; North Fork Animas River - Burrows Gulch to Animas Forks Monitoring Sites A08 and A09.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	11/11	4.74	7.19	A08	4.74	-	6.50	1	>1.00	Yes	a
Aluminum (TRM)	12/12	839	5230	A09	5230	71.7	87.0[f]	1	60.1	Yes	a
Antimony (TRM)	0/12	-	2.50 U	A08	1.25	-	240	2	0.01	No	b
Arsenic (DM)	1/12	0.65 J	0.65 J	A08	0.65	75.2	150	1	0.004	No	b
Barium (TRM)	0/4	-	25.0 U	A08	12.5	23.6	94.3	2	0.13	No	b
Beryllium (TRM)	0/12	-	2.00 U	A08	1.00	20.9	0.48	2	2.09	Yes	a
Cadmium (DM)	12/12	2.47	7.80	A08	4.18	31.2	0.18	1	23.7	Yes	a
Chromium (DM)	0/12	-	1.00 U	A08	0.50	20.9	20.6	1	0.02	No	b
Cobalt (TRM)	4/4	0.89 JD	2.57 D	A08	2.57	103	100	2	0.03	No	b
Copper (DM)	12/12	5.30	23.7	A08	18.0	31.2	3.31	1	5.44	Yes	a
Iron (TRM)	6/12	128 J	338	A08	338	24.2	1000	1	0.34	No	b
Lead (DM)	12/12	0.84	22.4	A09	22.4	94.7	2.37	1	9.45	Yes	a
Manganese (DM)	12/12	353	2060	A08	2060	75.2	1500	1	1.35	Yes	a
Molybdenum (TRM)	0/4	-	5.00 U	A08	2.50	-	3200	2	0.001	No	b
Nickel (DM)	12/12	0.66 J	3.51	A08	2.06	31.2	19.4	1	0.11	No	b
Selenium (DM)	0/12	-	1.00 U	A08	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/12	-	0.50 U	A08	0.25	20.9	0.01	1	49.1	Yes	a
Thallium (DM)	0/12	-	1.00 U	A08	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/4	-	10.0 U	A08	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	12/12	417	1380	A09	597	25.3	34.7	1	17.2	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

D = Sample diluted prior to chemical analysis; actual result reported

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.19 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	5/5	4.37	5.85	A07	4.37	-	6.50	1	>1.00	Yes	a
Aluminum (TRM)	5/5	3470	11900	A07	11900	67.6	87.0[f]	1	137	Yes	a
Antimony (TRM)	0/5	-	2.50 U	A07	1.25	-	240	2	0.01	No	b
Arsenic (DM)	1/5	0.68 J	0.68 J	A07	0.68	75.2	150	1	0.005	No	b
Barium (TRM)	0/1	-	25.0 U	A07	12.5	87.5	380	2	0.03	No	b
Beryllium (TRM)	3/5	3.51	4.01 J	A07	1.00	25.1	0.65	2	1.54	Yes	a
Cadmium (DM)	5/5	6.78	19.6	A07	17.7	67.6	0.32	1	56.0	Yes	a
Chromium (DM)	0/5	-	1.00 U	A07	0.50	25.1	23.9	1	0.02	No	b
Cobalt (TRM)	1/1	7.70 D	7.70 D	A07	7.70	93.2	100	2	0.08	No	b
Copper (DM)	5/5	23.6	69.9	A07	43.0	31.7	3.35	1	12.8	Yes	a
Iron (TRM)	3/5	104 J	368	A07	368	24.4	1000	1	0.37	No	b
Lead (DM)	5/5	5.27	10.8	A07	10.8	31.7	0.71	1	15.3	Yes	a
Manganese (DM)	5/5	1460	5980	A07	5980	87.5	1578	1	3.79	Yes	a
Molybdenum (TRM)	0/1	-	5.00 U	A07	2.50	-	3200	2	0.001	No	b
Nickel (DM)	5/5	3.13	12.60	A07	12.6	67.6	37.3	1	0.32	No	b
Selenium (DM)	0/5	-	1.00 U	A07	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/5	-	0.50 U	A07	0.25	25.1	0.01	1	35.8	Yes	a
Thallium (DM)	0/5	-	1.00 U	A07	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/1	-	10.0 U	A07	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	5/5	1200	3240	A07	1200	25.1	34.5	1	34.8	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

D = Sample diluted prior to chemical analysis; actual result reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.20 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)		Max. detect[b] (µg/L)		Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	17/17	6.72		7.98		9426	6.72	-	6.50	1	<1.00	No	b
Aluminum (TRM)	12/12	64.0	J	2800		32nd St Bridge	2800	60.2	244	1	11.5	Yes	a
Antimony (TRM)	2/12	0.43	J-	0.52	J-	32nd St Bridge	0.52	-	240	2	<1.00	No	b
Arsenic (DM)	1/12	0.54	J	0.54	J	32nd St Bridge	0.54	-	150	1	0.004	No	b
Barium (TRM)	12/12	31.3	JD	70.0		Oxbow Park	67.0	60.2	255	2	0.26	No	b
Beryllium (TRM)	3/12	0.16	J	0.21	J	32nd St Bridge	1.00	95.3	6.15	2	0.16	No	b
Cadmium (DM)	12/12	0.12	J	0.56		9426	0.56	195	0.70	1	0.80	No	b
Chromium (DM)	0/12	-		1.00	U	32nd St Bridge	0.50	95.3	71.3	1	0.01	No	b
Cobalt (TRM)	11/12	0.30	J	2.40	J	32nd St Bridge	2.40	-	100	2	0.02	No	b
Copper (DM)	12/12	1.30		3.10	J	9426	3.10	69.8	6.59	1	0.47	No	b
Iron (TRM)	6/12	150		4700	J+	9426	4700	-	1000	1	4.70	Yes	a
Lead (DM)	5/12	0.06	J	0.11	J	32nd St Bridge	0.90	60.2	1.44	1	0.62	No	b
Manganese (DM)	12/12	49.0		280	J	9426	280	195	2061	1	0.14	No	b
Mercury (TRM)	6/12	0.0003	J	0.04	U	9426	0.04	-	0.01	1	4.00	Yes	a
Molybdenum (TRM)	10/10	0.55	J	1.20		32nd St Bridge	1.20	-	3200	2	0.0004	No	b
Nickel (DM)	10/12	0.51	J	4.20	J	9426	4.20	219	101	1	0.04	No	b
Selenium (DM)	0/12	-		1.00	U	32nd St Bridge	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/12	-		0.50	U	32nd St Bridge	0.25	95.3	0.07	1	3.61	Yes	a
Thallium (DM)	0/12	-		0.50	U	32nd St Bridge	0.25	-	15.0	1	0.02	No	b
Vanadium (TRM)	5/12	0.39	J	4.30	J-	32nd St Bridge	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	12/12	27.0		120		9426	80.5	95.3	116	1	0.69	No	b

µg/L = microgram per liter
mg/L = milligram per liter
COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
J = Estimated result
J+ = Estimated result; result may be biased high
J- = Estimated result; result may be biased low
JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.21 Selection of Surface Water COPECs for Aquatic Community-level Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)		Max. detect[b] (µg/L)		Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	30/30	6.00		8.68		AR19-3	6.00	-	6.50	1	<1.00	Yes	a
Aluminum (TRM)	25/25	150	J	4100		AR19-3	4100	57.3	228	1	18.0	Yes	a
Antimony (TRM)	10/25	0.05	J	0.57	J	AR19-3	1.25	-	240	2	0.01	No	b
Arsenic (DM)	3/25	0.39	J	0.68	J	GKM05	0.68	-	150	1	0.005	No	b
Barium (TRM)	25/25	37.5	JD	130		GKM05	82.0	57.3	242	2	0.34	No	b
Beryllium (TRM)	4/25	0.18	J	0.40	J	Rotary Park	0.34	57.3	2.61	2	0.13	No	b
Cadmium (DM)	20/25	0.09	J	1.00		AR19-3	1.00	187	0.68	1	1.47	Yes	a
Chromium (DM)	1/25	1.01	J	1.01	J	Purple Cliffs	1.01	120	86.3	1	0.01	No	b
Cobalt (TRM)	24/25	0.24	J	4.20		AR19-3	4.20	57.3	100	2	0.04	No	b
Copper (DM)	21/25	0.54	J	3.40	J	Rotary Park	3.40	78.2	7.26	1	0.47	No	b
Iron (TRM)	25/25	220		7600	J-	AR19-3	7600	-	1000	1	7.60	Yes	a
Lead (DM)	14/25	0.09	J	1.20		AR19-3	1.20	57.3	1.37	1	0.88	No	b
Manganese (DM)	25/25	13.0		140		Rotary Park	140	195	2061	1	0.07	No	b
Mercury (TRM)	10/18	0.0003	J	0.02		AR19-3	0.04	-	0.01	1	4.00	Yes	a
Molybdenum (TRM)	23/23	0.66	J	11.2		Rotary Park	11.2	-	3200	2	0.004	No	b
Nickel (DM)	15/25	0.49	J	3.60	J	GKM05	3.60	232	106	1	0.03	No	b
Selenium (DM)	6/25	0.20	J	0.40	J	Rotary Park	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/25	-		0.50	U	Lightner Cr	0.50	65.5	0.04	1	13.8	Yes	a
Thallium (DM)	0/27	-		0.50	U	Lightner Cr	0.25	-	15.0	1	0.02	No	b
Vanadium (TRM)	11/25	0.35	J	7.00		AR19-3	7.00	-	27.0	2	0.26	No	b
Zinc (DM)	25/25	2.80	J	65.0		Rotary Park	40.5	78.2	96.9	1	0.42	No	b

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

J- = Estimated result; result may be biased low

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.22 Selection of Surface Water COPECs for Aquatic Community-level Receptors in Bear Creek Reference EU Monitoring Site M30.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	2/2	7.14	8.04	M30	7.14	-	6.50	1	<1.00	No	b
Aluminum (TRM)	2/2	54.5	68.3	M30	68.3	73.3	319	1	0.21	No	b
Antimony (TRM)	0/2	-	2.50 U	M30	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/2	-	0.50 U	M30	0.25	-	150	1	0.002	No	b
Barium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Beryllium (TRM)	0/2	-	2.00 U	M30	1.00	73.3	3.95	2	0.25	No	b
Cadmium (DM)	0/2	-	0.10 U	M30	0.05	73.3	0.34	1	0.15	No	b
Chromium (DM)	0/2	-	1.00 U	M30	0.50	73.3	57.5	1	0.01	No	b
Cobalt (TRM)	-	-	-	-	-	-	-	2	-	-	-
Copper (DM)	2/2	0.54 J	0.54 J	M30	0.54	73.3	6.87	1	0.08	No	b
Iron (TRM)	0/2	-	100 U	M30	50.0	-	1000	1	0.05	No	b
Lead (DM)	0/2	-	0.10 U	M30	0.05	73.3	1.79	1	0.03	No	b
Manganese (DM)	2/2	5.33	6.31	M30	6.31	73.3	1488	1	0.004	No	b
Molybdenum (TRM)	-	-	-	-	-	-	-	-	-	-	-
Nickel (DM)	0/2	-	0.50 U	M30	0.25	73.3	40.0	1	0.01	No	b
Selenium (DM)	0/2	-	1.00 U	M30	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/2	-	0.50 U	M30	0.25	73.3	0.04	1	5.68	Yes	a
Thallium (DM)	0/2	-	1.00 U	M30	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	-	-	-	-	-	-	-	-	-	-	-
Zinc (DM)	0/2	-	10.0 U	M30	5.00	73.3	91.4	1	0.05	No	b

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.23 Selection of Surface Water COPECs for Aquatic Community-level Receptors in Hermosa Creek Reference EU Monitoring Site HC01.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	2/2	7.87	8.46	HC01	7.87	-	6.50	1	<1.00	No	b
Aluminum (TRM)	1/1	31.0 J	31.0 J	HC01	31.0	257	1438	1	0.02	No	b
Antimony (TRM)	0/1	-	2.50 U	HC01	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/1	-	0.50 U	HC01	0.25	-	150	1	0.002	No	b
Barium (TRM)	-	-	-	-	-	-	-	2	-	-	-
Beryllium (TRM)	0/1	-	2.00 U	HC01	1.00	257	32.7	2	0.03	No	b
Cadmium (DM)	0/1	-	0.10 U	HC01	0.05	257	0.86	1	0.06	No	b
Chromium (DM)	1/1	2.58	2.58	HC01	2.58	257	161	1	0.02	No	b
Cobalt (TRM)	-	-	-	-	-	-	-	2	-	-	-
Copper (DM)	1/1	0.66 J	0.66 J	HC01	0.66	257	20.1	1	0.03	No	b
Iron (TRM)	0/1	-	100 U	HC01	50.0	-	1000	1	0.05	No	b
Lead (DM)	0/1	-	0.10 U	HC01	0.05	257	6.92	1	0.01	No	b
Manganese (DM)	0/1	-	2.00 U	HC01	1.00	257	2260	1	0.0004	No	b
Molybdenum (TRM)	-	-	-	-	-	-	-	2	-	-	-
Nickel (DM)	0/1	-	0.50 U	HC01	0.25	257	116	1	0.002	No	b
Selenium (DM)	0/1	-	1.00 U	HC01	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/1	-	0.50 U	HC01	0.25	257	0.38	1	0.66	No	b
Thallium (DM)	0/1	-	1.00 U	HC01	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	-	-	-	-	-	-	-	2	-	-	-
Zinc (DM)	0/1	-	10.0 U	HC01	5.00	257	286	1	0.02	No	b

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.24 Selection of Surface Water COPECs for Aquatic Community-level Receptors in Maggie Gulch Reference EU Monitoring Aite A43.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	4/4	6.83	7.79	A43	6.83	-	6.50	1	<1.00	No	b
Aluminum (TRM)	3/4	73.5	372	A43	372	42.5	87.0[f]	1	4.28	Yes	a
Antimony (TRM)	0/4	-	2.50 U	A43	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/4	-	0.50 U	A43	0.25	-	150	1	0.002	No	b
Barium (TRM)	2/2	26.8 JD	47.8 JD	A43	26.8	43.3	180	2	0.15	No	b
Beryllium (TRM)	0/4	-	2.00 U	A43	1.00	42.5	1.58	2	0.63	No	b
Cadmium (DM)	0/4	-	0.10 U	A43	0.05	42.5	0.22	1	0.22	No	b
Chromium (DM)	1/4	1.18	1.18	A43	1.18	100	73.8	1	0.02	No	b
Cobalt (TRM)	0/2	-	0.50 U	A43	0.25	-	100	2	0.003	No	b
Copper (DM)	4/4	0.66 J	1.06	A43	1.06	43.3	4.38	1	0.24	No	b
Iron (TRM)	2/4	216 J	342	A43	342	43.3	1000	1	0.34	No	b
Lead (DM)	0/4	-	0.10 U	A43	0.05	42.5	0.98	1	0.05	No	b
Manganese (DM)	3/4	2.09	19.4	A43	19.4	43.3	1248	1	0.02	No	b
Molybdenum (TRM)	0/2	-	5.00 U	A43	2.50	-	3200	2	0.001	No	b
Nickel (DM)	0/4	-	0.50 U	A43	0.25	42.5	25.2	1	0.01	No	b
Selenium (DM)	0/4	-	1.00 U	A43	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/4	-	0.50 U	A43	0.25	42.5	0.02	1	14.5	Yes	a
Thallium (DM)	0/4	-	1.00 U	A43	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/2	-	10.0 U	A43	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	0/4	-	10.0 U	A43	5.00	42.5	55.6	1	0.09	No	b

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.25 Selection of Surface Water COPECs for Aquatic Community-level Receptors in Mill Creek Reference EU Monitoring Site M08.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	2/2	7.59	7.73	M08	7.59	-	6.50	1	<1.00	No	b
Aluminum (TRM)	2/2	117	265	M08	117	24.8	72.4	1	1.62	Yes	a
Antimony (TRM)	0/2	-	2.50 U	M08	1.25	-	240	2	0.01	No	b
Arsenic (DM)	0/2	-	0.50 U	M08	0.25	-	150	1	0.002	No	b
Barium (TRM)	-	-	-	-	-	-	-	2	-	-	-
Beryllium (TRM)	0/2	-	2.00 U	M08	1.00	24.8	0.64	2	1.57	Yes	a
Cadmium (DM)	1/2	0.22	0.22	M08	0.22	56.1	0.27	1	0.79	No	b
Chromium (DM)	0/2	-	1.00 U	M08	0.50	24.8	23.7	1	0.02	No	b
Cobalt (TRM)	-	-	-	-	-	-	-	-	-	-	-
Copper (DM)	2/2	0.98 J	1.02	M08	1.02	24.8	2.72	1	0.37	No	b
Iron (TRM)	0/2	-	100 U	M08	50.0	-	1000	1	0.05	No	b
Lead (DM)	2/2	0.25	0.83	M08	0.83	24.8	0.54	1	1.55	Yes	a
Manganese (DM)	2/2	8.73	85.3	M08	85.3	56.1	1361	1	0.06	No	b
Molybdenum (TRM)	-	-	-	-	-	-	-	2	-	-	-
Nickel (DM)	0/2	-	0.50 U	M08	0.25	24.8	16.0	1	0.02	No	b
Selenium (DM)	0/2	-	1.00 U	M08	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/2	-	0.50 U	M08	0.25	24.8	0.01	1	36.6	Yes	a
Thallium (DM)	0/2	-	1.00 U	M08	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	-	-	-	-	-	-	-	2	-	-	-
Zinc (DM)	2/2	11.8 J	37.1	M08	37.1	56.1	71.6	1	0.52	No	b

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.26 Selection of Surface Water COPECs for Aquatic Community-level Receptors in Picayne Gulch Reference EU Monitoring Site A26.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	3/3	7.75	7.90	A26	7.75	-	6.50	1	<1.00	No	b
Aluminum (TRM)	2/3	81.9	200	A26	200	39.6	138	1	1.45	Yes	a
Antimony (TRM)	0/3	-	2.50 U	A26	1.25	-	240	2	0.01	No	b
Arsenic (DM)	2/3	0.58	0.97 J	A26	0.97	285	150	1	0.01	No	b
Barium (TRM)	1/2	33.1 JD	33.1 JD	A26	12.5	39.6	164	2	0.08	No	b
Beryllium (TRM)	0/3	-	2.00 U	A26	1.00	39.6	1.40	2	0.71	No	b
Cadmium (DM)	1/3	0.13 J	0.13 J	A26	0.13	39.6	0.21	1	0.62	No	b
Chromium (DM)	2/3	1.98	2.09	A26	1.98	183	121	1	0.02	No	b
Cobalt (TRM)	0/2	-	0.50 U	A26	0.25	-	100	2	0.003	No	b
Copper (DM)	3/3	0.78	1.37	A26	1.37	39.6	4.06	1	0.34	No	b
Iron (TRM)	1/3	207 J	207 J	A26	207	37.4	1000	1	0.21	No	b
Lead (DM)	0/3	-	0.10 U	A26	0.05	39.6	0.91	1	0.06	No	b
Manganese (DM)	3/3	31.9	124	A26	101	39.6	1212	1	0.08	No	b
Molybdenum (TRM)	0/2	-	5.00 U	A26	2.50	-	3200	2	0.001	No	b
Nickel (DM)	0/3	-	0.50 U	A26	0.25	39.6	23.8	1	0.01	No	b
Selenium (DM)	0/3	-	1.00 U	A26	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/3	-	0.50 U	A26	0.25	39.6	0.02	1	16.3	Yes	a
Thallium (DM)	0/3	-	0.50 U	A26	0.25	-	15.0	1	0.02	No	b
Vanadium (TRM)	0/2	-	10.0 U	A26	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	1/3	34.7	34.7	A26	34.7	39.6	52.3	1	0.66	No	b

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Table A8.27 Selection of Surface Water COPECs for Aquatic Community-level Receptors in North Fork Animas River Reference EU monitoring site A05.

Contaminant of interest (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason Code
pH	4/4	6.77	7.30	A05	6.79	-	6.50	1	<1.00	No	b
Aluminum (TRM)	6/7	28.1 J	767	A05	767	26.9	87.0[f]	1	8.82	Yes	a
Antimony (TRM)	0/7	-	2.50 U	A05	1.25	-	240	2	0.01	No	b
Arsenic (DM)	1/7	0.92 J	0.92 J	A05	0.92	72.5	150	1	0.01	No	b
Barium (TRM)	0/2	-	25.0 U	A05	12.5	26.9	108	2	0.12	No	b
Beryllium (TRM)	0/7	-	2.00 U	A05	1.00	23.0	0.56	2	1.78	Yes	a
Cadmium (DM)	7/7	0.34	1.84	A05	1.84	26.9	0.16	1	11.7	Yes	a
Chromium (DM)	0/7	-	1.00 U	A05	0.50	23.0	22.3	1	0.02	No	b
Cobalt (TRM)	0/2	-	0.50 U	A05	0.25	-	100	2	0.003	No	b
Copper (DM)	7/7	0.77 J	2.13	A05	2.13	23.0	2.55	1	0.83	No	b
Iron (TRM)	3/7	264	627	A05	627	27.6	1000	1	0.63	No	b
Lead (DM)	4/7	0.17 J	0.75	A05	0.75	26.9	0.59	1	1.28	Yes	a
Manganese (DM)	5/7	2.28	77.2	A05	77.2	26.9	1065	1	0.07	No	b
Molybdenum (TRM)	0/2	-	5.00 U	A05	2.50	-	3200	2	0.001	No	b
Nickel (DM)	1/7	0.74 J	0.74 J	A05	0.25	23.0	15.0	1	0.02	No	b
Selenium (DM)	0/7	-	1.00 U	A05	0.50	-	4.60	1	0.11	No	b
Silver (DM)	0/7	-	0.50 U	A05	0.25	23.0	0.01	1	41.6	Yes	a
Thallium (DM)	0/7	-	1.00 U	A05	0.50	-	15.0	1	0.03	No	b
Vanadium (TRM)	0/2	-	10.0 U	A05	5.00	-	27.0	2	0.19	No	b
Zinc (DM)	7/7	63.3	268	A05	268	26.9	36.7	1	7.30	Yes	a

µg/L = microgram per liter

mg/L = milligram per liter

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

TRM = Total Recoverable Metal

DM = Dissolved Metal

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic Al equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 ug/L TRM criterion was used

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)

2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4.

Appendix 9

Pore Water Aquatic Community-Level Receptor Contaminants of Potential Ecological Concern Derivation Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 9 Tables:

Table A9.1 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Site M34.

Table A9.2 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

Table A9.3 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

Table A9.4 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-04; Mineral Creek upstream of Mill Creek Monitoring Site M10A.

Table A9.5 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

Table A9.6 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

Table A9.7 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-07; Animas River from the confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

Table A9.8 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48.

Table A9.9 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

Table A9.10 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

Table A9.11 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

Table A9.12 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

Table A9.13 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

Table A9.14 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

Table A9.15 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

Table A9.16 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

Table A9.17 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-17; Mainstem West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

Table A9.18 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-18; North Fork Animas River - Burrows Gulch to Animas Forks Monitoring Site A08 and A09.

Table A9.19 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07.

Table A9.20 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

Table A9.21 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs.

Table A9.22 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in Bear Creek Reference EU Monitoring Site M30.

Table A9.23 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in Hermosa Creek Reference EU Monitoring Site HC01.

Table A9.24 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in Maggie Gulch Reference EU Monitoring Site A43.

Table A9.25 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in Mill Creek Reference EU Monitoring Site M08.

Table A9.26 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in Picayne Gulch Reference EU Monitoring Site A26.

Table A9.27 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in North Fork Animas River Reference EU Monitoring Site A05.

Table A9.1 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Site M34.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	5.82	5.82	M34	5.82	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	2/2	1460	3590	M34	3590	218	87.0[f]	1	41.3	Yes	a
Antimony (TRM)	0/2	--	2.50 U	M34	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/3	--	0.50 U	M34	0.25	--	150	1	0.002	No	b
Barium (TRM)	1/1	40.2 JD	40.2 JD	M34	40.2	218	1003	2	0.04	No	b
Beryllium (TRM)	0/2	--	2.00 U	M34	1.00	116	8.53	2	0.12	No	b
Cadmium (DM)	2/3	0.127 J	1.01	M34	1.01	218	0.76	1	1.32	Yes	a
Chromium (DM)	0/3	--	1.00 U	M34	0.50	116	83.5	1	0.01	No	b
Cobalt (TRM)	1/1	24.8 D	24.8 D	M34	24.8	--	100	2	0.25	No	b
Copper (DM)	3/3	0.74 J	2.86	M34	2.86	218	17.4	1	0.16	No	b
Iron (TRM)	2/2	3950	8070	M34	8070	--	1000	1	8.07	Yes	a
Lead (DM)	0/3	--	0.10 U	M34	0.05	116	2.95	1	0.02	No	b
Manganese (DM)	3/3	7.21	653	M34	653	218	2139	1	0.31	No	b
Molybdenum (TRM)	0/1	--	5.00 U	M34	2.50	--	3200	2	0.001	No	b
Nickel (DM)	1/3	2.03	2.03	M34	2.03	218	101	1	0.02	No	b
Selenium (DM)	0/3	--	1.00 U	M34	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/3	--	0.50 U	M34	0.25	116	0.10	1	2.59	Yes	a
Thallium (DM)	0/3	--	1.00 U	M34	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	0/1	--	10.0 U	M34	5.00	--	27.0	2	0.19	No	b
Zinc (DM)	3/3	23.6	232	M34	232	218	246	1	0.94	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
D = Sample diluted prior to chemical analysis; actual result reported
J = Estimated result
JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.2 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	2/2	3.76	5.42	M27	3.762	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	2/2	973	15100	M27	15100	187	87.0[f]	1	174	Yes	a
Antimony (TRM)	0/2	--	2.50 U	M27/M27A	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/2	--	0.50 U	M27/M27A	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	--	--
Beryllium (TRM)	0/2	--	2.00 U	M27/M27A	1.00	67.6	3.44	2	0.29	No	b
Cadmium (DM)	1/2	0.72	0.72	M27	0.72	187	0.68	1	1.05	Yes	a
Chromium (DM)	0/2	--	1.00 U	M27/M27A	0.50	67.6	53.8	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	100	--	--	--	--
Copper (DM)	2/2	0.58 J	15.7	M27	15.7	187	15.3	1	1.03	Yes	a
Iron (TRM)	2/2	7760	72000	M27	72000	--	1000	1	72.0	Yes	a
Lead (DM)	1/2	85.6	85.6	M27	85.6	187	4.95	1	17.3	Yes	a
Manganese (DM)	2/2	97.0	1960	M27	1960	187	2033	1	0.96	No	b
Molybdenum (TRM)	--	--	--	--	--	--	100	--	--	--	--
Nickel (DM)	2/2	0.80 J	13.3	M27	13.3	187	88.4	1	0.15	No	b
Selenium (DM)	0/2	--	1.00 U	M27/M27A	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/2	--	0.50 U	M27/M27A	0.25	67.6	0.04	1	6.54	Yes	a
Thallium (DM)	0/2	--	1.00 U	M27/M27A	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	27.0	--	--	--	--
Zinc (DM)	2/2	15.3 J	285	M27	285	187	214	1	1.33	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.3 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek monitoring sites M14B and M11.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	2/2	5.78	7.05	M11	5.78	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	2/2	451	10600	M14B	10600	126	87.0[f]	1	122	Yes	a
Antimony (TRM)	0/2	--	2.50 U	M11/M14A	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/2	--	0.50 U	M11/M14A	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/2	--	2.00 U	M11/M14A	1.00	126	9.80	2	0.10	No	b
Cadmium (DM)	2/2	0.81	1.06	M11	1.06	148	0.57	1	1.86	Yes	a
Chromium (DM)	0/2	--	1.00 U	M11/M14A	0.50	126	89.4	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	2/2	3.99	6.56	M11	6.56	148	12.5	1	0.52	No	b
Iron (TRM)	2/2	953	16000	M14B	16000	--	1000	1	16.0	Yes	a
Lead (DM)	2/2	0.98	2.15	M11	2.15	148	3.84	1	0.56	No	b
Manganese (DM)	2/2	5.23	51.3	M14B	51.3	126	1780	1	0.03	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/2	--	0.5 U	M11/M14A	0.25	126	63.1	1	0.004	No	b
Selenium (DM)	0/2	--	1.00 U	M11/M14A	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/2	--	0.50 U	M11/M14A	0.25	126	0.11	1	2.25	Yes	a
Thallium (DM)	0/2	--	1.00 U	M11/M14A	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	2/2	317	376	M11	376	148	173	1	2.17	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.4 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	6.55	6.55	M10A	6.55	--	6.50	1	<1.00	No	b
Aluminum (TRM)	1/1	47.6 J	47.6 J	M10A	47.6	100	87.0[f]	1	0.55	No	b
Antimony (TRM)	0/1	--	2.50 U	M10A	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	M10A	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--		M10A	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	M10A	1.00	100	6.70	2	0.15	No	b
Cadmium (DM)	1/1	1.65	1.65	M10A	1.65	100	0.43	1	3.88	Yes	a
Chromium (DM)	0/1	--	1.00 U	M10A	0.50	100	74.3	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	9.99	9.99	M10A	9.99	100	9.0	1	1.11	Yes	a
Iron (TRM)	0/1	--	100 U	M10A	50.0	--	1000	1	0.05	No	b
Lead (DM)	1/1	2.24	2.24	M10A	2.24	100	2.53	1	0.89	No	b
Manganese (DM)	1/1	12.5	12.5	M10A	12.5	100	1651	1	0.01	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/1	--	0.50 U	M10A	0.25	100	52.2	1	0.005	No	b
Selenium (DM)	0/1	--	1.00 U	M10A	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	M10A	0.25	100	0.08	1	3.31	Yes	a
Thallium (DM)	0/1	--	1.00 U	M10A	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	589	589	M10A	589	100	122	1	4.85	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.5 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	4.01	4.01	M28	4.01	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	1/1	7950	7950	M28	7950	248	87.0[f]	1	91.4	Yes	a
Antimony (TRM)	0/1	--	2.50 U	M28	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	M28	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	M28	1.00	248	30.7	2	0.03	No	b
Cadmium (DM)	1/1	1.35	1.35	M28	1.35	248	0.84	1	1.61	Yes	a
Chromium (DM)	0/1	--	1.00 U	M28	0.50	248	156	1	0.00	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	5.42	5.42	M28	5.42	248	19.4	1	0.28	No	b
Iron (TRM)	1/1	27700	27700	M28	27700	--	1000	1	27.7	Yes	a
Lead (DM)	1/1	6.19	6.19	M28	6.19	248	6.65	1	0.93	No	b
Manganese (DM)	1/1	1820	1820	M28	1820	248	2231	1	0.82	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	1/1	8.59	8.59	M28	8.59	248	112	1	0.08	No	b
Selenium (DM)	0/1	--	1.00 U	M28	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	M28	0.25	248	0.36	1	0.70	No	b
Thallium (DM)	1/1	2.02	2.02	M28	2.02	--	15.0	1	0.13	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	153	153	M28	153	248	276	1	0.55	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.6 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	3.94	3.94	M20	3.94	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	1/1	11700	11700	M20	11700	305	87.0[f]	1	134	Yes	a
Antimony (TRM)	0/1	--	2.50 U	M20	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	2.50 U	M20	1.25	--	150	1	0.008	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	M20	1.00	305	43.6	2	0.02	No	b
Cadmium (DM)	1/1	1.20 D	1.20 D	M20	1.20	305	0.98	1	1.22	Yes	a
Chromium (DM)	0/1	--	5.00 U	M20	2.50	305	185	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	5.52 D	5.52 D	M20	5.52	305	23.2	1	0.24	No	b
Iron (TRM)	1/1	35700	35700	M20	35700	--	1000	1	35.7	Yes	a
Lead (DM)	1/1	1.62 D	1.62 D	M20	1.62	305	8.27	1	0.20	No	b
Manganese (DM)	1/1	1030	1030	M20	1030	305	2392	1	0.43	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	1/1	2.95 JD	2.95 JD	M20	2.95	305	134	1	0.02	No	b
Selenium (DM)	0/1	--	5.00 U	M20	2.50	--	4.60	1	0.54	No	b
Silver (DM)	0/1	--	2.50 U	M20	1.25	305	0.51	1	2.45	Yes	a
Thallium (DM)	0/1	--	5.00 U	M20	2.50	--	15.0	1	0.17	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	140	140	M20	140	305	334	1	0.42	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
D = Sample diluted prior to chemical analysis; actual result reported
JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.7 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	2/2	6.98	7.00	A55	6.98	--	6.50	1	<1.00	No	b
Aluminum (TRM)	3/3	234	2050	A56	2050	148	87.0[f]	1	23.6	Yes	a
Antimony (TRM)	0/3	--	2.50 U	A56/A55	1.25	--	240	2	0.01	No	b
Arsenic (DM)	2/9	1.03 J	2.44	A55	2.44	--	150	1	0.02	No	b
Barium (TRM)	1/1	49.1 JD	49.1 JD	A56	49.1	148	663	2	0.07	No	b
Beryllium (TRM)	0/3	--	2.00 U	A56/A55	1.00	135	11.1	2	0.09	No	b
Cadmium (DM)	9/9	0.16 J	1.47	A56	1.47	99.3	0.42	1	3.48	Yes	a
Chromium (DM)	3/9	1.05 J	2.27	A55	2.27	99.3	73.7	1	0.03	No	b
Cobalt (TRM)	1/1	1.96 D	1.96 D	A56	1.96	--	100	2	0.02	No	b
Copper (DM)	9/9	1.30	59.4	A56	59.4	99.3	8.9	1	6.67	Yes	a
Iron (TRM)	3/3	258	2540	A56	2540	--	1000	1	2.54	Yes	a
Lead (DM)	5/9	0.24	33.3	A55	33.3	99.3	2.50	1	13.3	Yes	a
Manganese (DM)	8/9	4.16	13300	A55	13300	99.3	1646	1	8.08	Yes	a
Molybdenum (TRM)	0/1	--	5.00 U	A56/A55	2.50	--	100	2	0.001	No	b
Nickel (DM)	0/9	--	0.50 U	A56	0.25	99.3	52	1	0.005	No	b
Selenium (DM)	2/9	1.07 J	1.19 J	A55	1.19	--	4.60	1	0.30	No	b
Silver (DM)	0/9	--	0.50	A56/A55	0.25	99.3	0.07	1	3.37	Yes	a
Thallium (DM)	0/9	--	1.00 U	A56/A55	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	0/1	--	10.0 U	A56/A55	5.00	--	27.0	2	0.19	No	b
Zinc (DM)	9/9	54.0	597	A56	597	135	159	1	3.75	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
D = Sample diluted prior to chemical analysis; actual result reported
J = Estimated result
JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.8 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-08; Cunningham Creek Monitoring Site A48.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	7.61	7.61	A48	7.61	--	6.50	1	<1.00	No	b
Aluminum (TRM)	1/1	3850	3850	A48	3850	97.7	473	1	8.14	Yes	a
Antimony (TRM)	0/1	--	2.50 U	A48	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	A48	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	A48	1.00	97.7	6.41	2	0.16	No	b
Cadmium (DM)	1/1	0.10	0.10	A48	0.10	97.7	0.42	1	0.24	No	b
Chromium (DM)	1/1	1.09	1.09	A48	1.09	97.7	72.7	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	1.40	1.40	A48	1.40	97.7	8.78	1	0.16	No	b
Iron (TRM)	1/1	4960	4960	A48	4960	--	1000	1	4.96	Yes	a
Lead (DM)	1/1	0.32	0.32	A48	0.32	97.7	2.45	1	0.13	No	b
Manganese (DM)	0/1	--	2.00 U	A48	1.00	97.7	1637	1	0.001	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/1	--	0.50 U	A48	0.25	97.7	51.0	1	0.005	No	b
Selenium (DM)	0/1	--	1.00 U	A48	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	A48	0.25	97.7	0.07	1	3.47	Yes	a
Thallium (DM)	0/1	--	1.00 U	A48	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	13.2	13.2	A48	13.2	97.7	119	1	0.11	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.9 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	2/2	6.94	7.49	A41A	6.94	--	6.50	1	<1.00	No	b
Aluminum (TRM)	3/3	341	2260	A45	2260	127	87.0[f]	1	26.0	Yes	a
Antimony (TRM)	0/3	--	2.50 UJ	A41A	1.25	--	240	2	0.01	No	b
Arsenic (DM)	1/3	0.07 J	0.07 J	A41A	0.25	--	150	1	0.002	No	b
Barium (TRM)	1/1	22.0 J-	22.0 J-	A41A	22.0	95	413	2	0.05	No	b
Beryllium (TRM)	0/3	--	2.00 UJ	A41A/A45	1.00	122	9.26	2	0.11	No	b
Cadmium (DM)	2/3	0.61	0.66	A41A	0.66	122	0.49	1	1.33	Yes	a
Chromium (DM)	0/3	--	1.00 U	A41A/A45	0.50	122	87.0	1	0.01	No	b
Cobalt (TRM)	1/1	0.32 J	0.32 J	A41A	0.32	--	100	2	0.003	No	b
Copper (DM)	3/3	1.42	2.80 J	A41A	2.80	94.6	8.54	1	0.33	No	b
Iron (TRM)	3/3	133	4120	A45	4120	--	1000	1	4.12	Yes	a
Lead (DM)	0/3	--	0.10 U	A41A/A45	0.05	122	3.11	1	0.02	No	b
Manganese (DM)	2/3	4.40 J	465 J	A41A	465	122	1761	1	0.26	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	1/3	1.60 J	1.60 J	A41A	1.60	94.6	49.6	1	0.03	No	b
Selenium (DM)	0/3	--	1.00 U	A41A/A45	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/3	--	0.50 U	A41A/A45	0.25	122	0.11	1	2.38	Yes	a
Thallium (DM)	0/3	--	1.00 U	A41A/A45	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	1/1	0.37 J	0.37 J	A41A	0.37	--	27.0	2	0.01	No	b
Zinc (DM)	3/3	179	476 J	A41A	476	94.6	115	1	4.13	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
J = Estimated result
J- = Estimated result; result may be biased low
UJ = Analyte not detected; minimum detection limit may be inaccurate

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.10 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	2/2	6.07	7.28	A35	6.07	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	2/2	467	886	A35	886	133	87.0[f]	1	10.2	Yes	a
Antimony (TRM)	0/2	--	2.50 U	A40/A35	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/2	--	0.50 U	A40/A35	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/2	--	2.00 U	A40/A35	1.00	133	10.8	2	0.09	No	b
Cadmium (DM)	2/2	2.10	2.50	A35	2.50	138	0.54	1	4.62	Yes	a
Chromium (DM)	0/2	--	1.00 U	A40/A35	0.50	133	93.6	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	2/2	4.04	4.78	A35	4.78	138	11.8	1	0.41	No	b
Iron (TRM)	2/2	130	211	A35	211	--	1000	1	0.21	No	b
Lead (DM)	2/2	0.16	0.21	A40	0.21	133	3.42	1	0.06	No	b
Manganese (DM)	2/2	1640	1840	A35	1840	138	1836	1	1.00	Yes	a
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/2	--	0.50 U	A40/A35	0.25	133	66.1	1	0.004	No	b
Selenium (DM)	0/2	--	1.00 U	A40/A35	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/2	--	0.50 U	A40/A35	0.25	133	0.12	1	2.04	Yes	a
Thallium (DM)	0/2	--	1.00 U	A40/A35	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	2/2	589	662	A35	662	138	162	1	4.08	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.11 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	6.84	6.84	A36	6.84	--	6.50	1	<1.00	No	b
Aluminum (TRM)	1/1	585	585	A36	585	168	87.0[f]	1	6.72	Yes	a
Antimony (TRM)	0/1	--	2.50 U	A36	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	A36	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	A36	1.00	168	15.9	2	0.06	No	b
Cadmium (DM)	0/1	--	0.10 U	A36	0.05	168	0.63	1	0.08	No	b
Chromium (DM)	0/1	--	1.00 U	A36	0.50	168	113	1	0.004	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	1.30	1.30	A36	1.30	168	13.9	1	0.09	No	b
Iron (TRM)	1/1	1630	1630	A36	1630	--	1000	1	1.63	Yes	a
Lead (DM)	0/1	--	0.10 U	A36	0.05	168	4.39	1	0.01	No	b
Manganese (DM)	1/1	3.62	3.62	A36	3.62	168	1959	1	0.002	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/1	--	0.50 U	A36	0.25	168	80.5	1	0.003	No	b
Selenium (DM)	0/1	--	1.00 U	A36	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	A36	0.25	168	0.18	1	1.37	Yes	a
Thallium (DM)	0/1	--	1.00 U	A36	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	25.1	25.1	A36	25.1	168	194	1	0.13	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.12 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	6.58	6.58	A37	6.58	--	6.50	1	<1.00	No	b
Aluminum (TRM)	1/1	223	223	A37	223	115	87.0[f]	1	3.41	Yes	a
Antimony (TRM)	0/1	--	2.50 U	A37	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	A37	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	A37	1.00	115	8.48	2	0.12	No	b
Cadmium (DM)	1/1	0.43	0.43	A37	0.43	115	0.47	1	0.91	No	b
Chromium (DM)	0/1	--	1.00 U	A37	0.50	115	83.3	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	5.42	5.42	A37	5.42	115	10.1	1	0.54	No	b
Iron (TRM)	1/1	307	307	A37	307	--	1000	1	0.31	No	b
Lead (DM)	0/1	--	0.10 U	A37	0.05	115	2.94	1	0.02	No	b
Manganese (DM)	1/1	8.45	8.45	A37	8.45	115	1730	1	0.005	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/1	--	0.50 U	A37	0.25	115	58.7	1	0.004	No	b
Selenium (DM)	0/1	--	1.00 U	A37	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	A37	0.25	115	0.10	1	2.61	Yes	a
Thallium (DM)	0/1	--	1.00 U	A37	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	200	200	A37	200	115	138	1	1.45	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.13 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	6.50	6.50	A34	6.50	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	1/1	169	169	A34	169	154	87.0[f]	1	1.94	Yes	a
Antimony (TRM)	0/1	--	2.50 U	A34	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	A34	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	A34	1.00	154	13.8	2	0.07	No	b
Cadmium (DM)	1/1	0.53	0.53	A34	0.53	154	0.59	1	0.90	No	b
Chromium (DM)	0/1	--	1.00 U	A34	0.50	154	105	1	0.005	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	3.63	3.63	A34	3.63	154	12.9	1	0.28	No	b
Iron (TRM)	1/1	187	187	A34	187	--	1000	1	0.19	No	b
Lead (DM)	0/1	--	0.10 U	A34	0.05	154	4.01	1	0.01	No	b
Manganese (DM)	1/1	49.5	49.5	A34	49.5	154	1904	1	0.03	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/1	--	0.50 U	A34	0.25	154	74.9	1	0.003	No	b
Selenium (DM)	0/1	--	1.00 U	A34	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	A34	0.25	154	0.16	1	1.59	Yes	a
Thallium (DM)	0/1	--	1.00 U	A34	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	150	150	A34	150	154	179	1	0.84	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.14 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	2/2	5.13	6.27	A33	5.13	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	2/2	1310	32300	A14	32300	113	87.0[f]	1	371	Yes	a
Antimony (TRM)	0/2	--	2.50 U	A14/A33	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/2	--	0.50 U	A14/A33	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	1/2	24.9	24.9	A14	24.9	113	8.17	2	3.05	Yes	a
Cadmium (DM)	2/2	3.64	7.39	A14	7.39	113	0.46	1	15.9	Yes	a
Chromium (DM)	0/2	--	1.00 U	A14/A33	0.50	113	81.8	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	2/2	6.06	22.30	A14	22.3	113	9.93	1	2.25	Yes	a
Iron (TRM)	1/2	6580	6580	A14	6580	--	1000	1	6.58	Yes	a
Lead (DM)	2/2	0.30	8.55	A14	8.55	113	2.87	1	2.98	Yes	a
Manganese (DM)	2/2	3180	9390	A14	9390	113	1717	1	5.47	Yes	a
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	2/2	1.35	5.86	A14	5.86	113	57.6	1	0.10	No	b
Selenium (DM)	0/2	--	1.00 U	A14/A33	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/2	--	0.50 U	A14/A33	0.25	113	0.09	1	2.70	Yes	a
Thallium (DM)	0/2	--	1.00 U	A14/A33	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	2/2	968	2200	A14	2200	113	135	1	16.3	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.15 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	5.46	5.46	A10	5.46	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	1/1	4830	4830	A10	4830	34.4	87.0[f]	1	85.9	Yes	a
Antimony (TRM)	0/1	--	2.50 U	A10	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	A10	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	1/1	2.01	2.01	A10	2.01	34.4	1.11	2	1.82	Yes	a
Cadmium (DM)	1/1	2.28	2.28	A10	2.28	34.4	0.19	1	12.0	Yes	a
Chromium (DM)	0/1	--	1.00 U	A10	0.50	34.4	30.9	1	0.02	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	8.11	8.11	A10	8.11	34.4	3.60	1	2.25	Yes	a
Iron (TRM)	1/1	5670	5670	A10	5670	--	1000	1	5.67	Yes	a
Lead (DM)	1/1	7.46	7.46	A10	7.46	34.4	0.77	1	9.63	Yes	a
Manganese (DM)	1/1	863	863	A10	863	34.4	1156	1	0.75	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	1/1	0.66	0.66	A10	0.66	34.4	21.1	1	0.03	No	b
Selenium (DM)	0/1	--	1.00 U	A10	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	A10	0.25	34.4	0.01	1	20.9	Yes	a
Thallium (DM)	0/1	--	1.00 U	A10	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	779	779	A10	779	34.4	45.9	1	17.0	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.16 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	6.09	6.09	A20	6.09	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	1/1	1320	1320	A20	1320	88.1	87.0[f]	1	15.2	Yes	a
Antimony (TRM)	0/1	--	2.50 U	A20	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	A20	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	A20	1.00	88.1	6.01	2	0.17	No	b
Cadmium (DM)	1/1	2.54	2.54	A20	2.54	88.1	0.39	1	6.59	Yes	a
Chromium (DM)	0/1	--	1.00 U	A20	0.50	88.1	66.8	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	8.72	8.72	A20	8.72	88.1	8.04	1	1.09	Yes	a
Iron (TRM)	1/1	675	675	A20	675	--	1000	1	0.68	No	b
Lead (DM)	1/1	3.56	3.56	A20	3.56	88.1	2.19	1	1.62	Yes	a
Manganese (DM)	1/1	856	856	A20	856	88.1	1581	1	0.54	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	1/1	2.34	2.34	A20	2.34	88.1	46.7	1	0.05	No	b
Selenium (DM)	0/1	--	1.00 U	A20	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	A20	0.25	88.1	0.06	1	4.14	Yes	a
Thallium (DM)	0/1	--	1.00 U	A20	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	1120	1120	A20	1120	88.1	108	1	10.4	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.17 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-17; Mainstem West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	--	--	--	--	--	--	--	--	--	No	--
Aluminum (TRM)	1/1	11900	11900	A15	11900	151	87.0[f]	1	137	Yes	a
Antimony (TRM)	0/1	--	2.50 U	A15	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	A15	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	1/1	16.3	16.3	A15	16.3	151	13.4	2	1.22	Yes	a
Cadmium (DM)	1/1	10.8	10.8	A15	10.8	151	0.58	1	18.6	Yes	a
Chromium (DM)	0/1	--	1.00 U	A15	0.50	151	104	1	0.005	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	30.2	30.2	A15	30.2	151	12.8	1	2.37	Yes	a
Iron (TRM)	1/1	1790	1790	A15	1790	--	1000	1	1.79	Yes	a
Lead (DM)	1/1	0.41	0.41	A15	0.41	151	3.94	1	0.10	No	b
Manganese (DM)	1/1	23000	23000	A15	23000	151	1893	1	12.1	Yes	a
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	1/1	12.0	12.0	A15	12.0	151	73.8	1	0.16	No	b
Selenium (DM)	0/1	--	1.00 U	A15	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	A15	0.25	151	0.15	1	1.63	Yes	a
Thallium (DM)	0/1	--	1.00 U	A15	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	3380	3380	A15	3380	151	177	1	19.1	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.18 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-18; North Fork Animas River - Burrows Gulch to Animas Forks Monitoring Site A08 and A09.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	2/2	4.74	4.94	A08	4.74	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	2/2	3190	10500	A09	10500	84.7	87.0[f]	1	121	Yes	a
Antimony (TRM)	0/2	--	2.50 U	A09	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/2	--	0.50 U	A09	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	1/2	2.07	2.07	A09	2.07	84.7	5.04	2	0.41	No	b
Cadmium (DM)	2/2	7.35	9.03	A08	9.03	84.7	0.37	1	24.1	Yes	a
Chromium (DM)	0/2	--	1.00 U	A09	0.50	84.0	64.2	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	2/2	12.3	16.8	A09	16.8	84.0	7.71	1	2.18	Yes	a
Iron (TRM)	1/2	3060	3060	A08	3060	--	1000	1	3.06	Yes	a
Lead (DM)	2/2	0.37	14.0	A09	14.0	84.0	2.08	1	6.73	Yes	a
Manganese (DM)	2/2	1320	1680	A08	1680	84.7	1561	1	1.08	Yes	a
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	2/2	3.07	10.0	A08	10.0	84.7	45.2	1	0.22	No	b
Selenium (DM)	0/2	--	1.00 U	A09	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/2	--	0.50 U	A09	0.25	84.0	0.06	1	4.50	Yes	a
Thallium (DM)	0/2	--	1.00 U	A09	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	2/2	1180	1300	A08	1300	84.7	104	1	12.5	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.19 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-19; Burrows Gulch Monitoring Site A07.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	4.63	4.63	A07	4.63	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	1/1	14200	14200	A07	14200	67.8	87.0[f]	1	163	Yes	a
Antimony (TRM)	0/1	--	2.50 U	A07	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	A07	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	1/1	3.70	3.70	A07	3.70	67.8	3.47	2	1.07	Yes	a
Cadmium (DM)	1/1	16.9	16.9	A07	16.9	67.8	0.32	1	53.4	Yes	a
Chromium (DM)	0/1	--	1.00 U	A07	0.50	67.8	53.9	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	52.1	52.1	A07	52.1	67.8	6.43	1	8.10	Yes	a
Iron (TRM)	1/1	1480	1480	A07	1480	--	1000	1	1.48	Yes	a
Lead (DM)	1/1	5.52	5.52	A07	5.52	67.8	1.65	1	3.35	Yes	a
Manganese (DM)	1/1	4720	4720	A07	4720	67.8	1450	1	3.26	Yes	a
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	1/1	9.95	10.0	A07	10.0	67.8	37.5	1	0.27	No	b
Selenium (DM)	0/1	--	1.00 U	A07	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	A07	0.25	67.8	0.04	1	6.49	Yes	a
Thallium (DM)	0/1	--	1.00 U	A07	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	2940	2940	A07	2940	67.8	85.2	1	34.5	Yes	a

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.20 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	--	--	--	--	--	--	--	--	--	No	--
Aluminum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Antimony (TRM)	--	--	--	--	--	--	--	--	--	No	--
Arsenic (DM)	2/3	2.74	8.05	32nd St Bridge	8.05	--	150	1	0.05	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Cadmium (DM)	2/3	0.16 J	0.41	James Ranch	0.41	187	0.68	1	0.60	No	b
Chromium (DM)	1/3	4.73	4.73	32nd St Bridge	4.73	252	158	1	0.03	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	2/3	1.78	18.2	James Ranch	18.2	187	15.3	1	1.19	Yes	a
Iron (TRM)	--	--	--	--	--	--	--	--	--	No	--
Lead (DM)	2/3	0.17 J	0.99	James Ranch	0.99	187	4.94	1	0.20	No	b
Manganese (DM)	3/3	12.1	9300	James Ranch	9300	187	2033	1	4.58	Yes	a
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/3	--	0.50 U	J Ranch/32nd St	0.25	93.0	48.9	1	0.01	No	b
Selenium (DM)	1/3	3.33	3.33	James Ranch	3.33	--	4.60	1	0.72	No	b
Silver (DM)	0/3	--	0.50 U	J Ranch/32nd St	0.25	93.0	0.07	1	3.77	Yes	a
Thallium (DM)	0/3	--	0.50 U	J Ranch/32nd St	0.25	--	15.0	1	0.02	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	3/3	10.6 J	46.7	James Ranch	46.7	93.0	113	1	0.41	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.21 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	--	--	--	--	--	--	--	--	--	No	--
Aluminum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Antimony (TRM)	--	--	--	--	--	--	--	--	--	No	--
Arsenic (DM)	2/2	3.47 JD	3.74	Purple Cliffs	3.74	--	150	1	0.02	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Cadmium (DM)	0/2	--	0.50 U	P Cliffs/Lightner	0.25	596	1.62	1	0.15	No	b
Chromium (DM)	1/2	3.23	3.23	Purple Cliffs	3.23	271	168	1	0.02	No	b
Cobalt (TRM)	--	--		--	--	--	--	--	--	No	--
Copper (DM)	0/2		2.50 U	Purple Cliffs	1.25	596	41.2	1	0.03	No	b
Iron (TRM)	--	--	--	--	--	--	--	--	--	No	--
Lead (DM)	1/2	0.19 J	0.50 U	Lightner Creek	0.19	271	7.30	1	0.03	No	b
Manganese (DM)	2/2	766	5870	Purple Cliffs	5870	271	2299	1	2.55	Yes	a
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	1/2	0.85 J	2.50 U	Lightner Creek	0.85	271	121	1	0.01	No	b
Selenium (DM)	0/2	--	5.00 U	Lightner Creek	2.50	--	4.60	1	0.54	No	b
Silver (DM)	0/2	--	2.50 U	Lightner Creek	1.25	596	1.62	1	0.77	No	b
Thallium (DM)	0/2	--	2.50 U	Lightner Creek	1.25	--	15.0	1	0.08	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	2/2	10.0 J	13.3 J	Lightner Creek	13.3	271	300	1	0.04	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
J = Estimated result
JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.22 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in Bear Creek Reference EU Monitoring Site M30.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	6.30	6.30	M30	6.30	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	1/1	641	641	M30	641	72.5	87.0[f]	1	7.37	Yes	a
Antimony (TRM)	0/1	--	2.50 U	M30	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	M30	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	M30	1.00	72.5	3.88	2	0.26	No	b
Cadmium (DM)	0/1	--	0.10 U	M30	0.05	72.5	0.33	1	0.15	No	b
Chromium (DM)	0/1	--	1.00 U	M30	0.50	72.5	56.9	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	0/1	--	0.50 U	M30	0.25	72.5	6.80	1	0.04	No	b
Iron (TRM)	1/1	593	593	M30	593	--	1000	1	0.59	No	b
Lead (DM)	0/1	--	0.10 U	M30	0.05	72.5	1.77	1	0.03	No	b
Manganese (DM)	1/1	3.53 J	3.53 J	M30	3.53	72.5	1482	1	0.002	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/1	--	0.50 U	M30	0.25	72.5	39.6	1	0.01	No	b
Selenium (DM)	0/1	--	1.00 U	M30	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	M30	0.25	72.5	0.04	1	5.79	Yes	a
Thallium (DM)	0/1	--	1.00 U	M30	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	0/1	--	10.0 U	M30	5.00	72.5	90.4	1	0.06	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.23 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in Hermosa Creek Reference EU Monitoring Site HC01.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	7.42	7.42	HC01	7.42	--	6.50	1	<1.00	No	b
Aluminum (TRM)	1/1	34.2	34.2 J	HC01	34.2	275	1438	1	0.02	No	b
Antimony (TRM)	0/1	--	2.50 U	HC01	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	HC01	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	HC01	1.00	275	36.6	2	0.03	No	b
Cadmium (DM)	0/1	--	0.10 U	HC01	0.05	275	0.91	1	0.06	No	b
Chromium (DM)	1/1	2.94	2.94	HC01	2.94	275	170	1	0.02	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	0/1	--	0.50 U	HC01	0.25	275	21.3	1	0.01	No	b
Iron (TRM)	1/1	282	282	HC01	282	--	1000	1	0.28	No	b
Lead (DM)	0/1	--	0.10 U	HC01	0.05	275	7.43	1	0.01	No	b
Manganese (DM)	1/1	195	195	HC01	195	275	2311	1	0.08	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/1	--	0.50 U	HC01	0.25	275	122	1	0.002	No	b
Selenium (DM)	0/1	--	1.00 U	HC01	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	HC01	0.25	275	0.43	1	0.58	No	b
Thallium (DM)	0/1	--	1.00 U	HC01	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	NA	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	0/1	--	10.0 U	HC01	5.00	275	304	1	0.02	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.24 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in Maggie Gulch Reference EU Monitoring Site A43.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	7.65	7.65	A43	7.65	--	6.50	1	<1.00	No	b
Aluminum (TRM)	1/1	235	235	A43	235	100	486	1	0.48	No	b
Antimony (TRM)	0/1	--	2.50 U	A43	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	A43	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	A43	1.00	100	6.63	2	0.15	No	b
Cadmium (DM)	0/1	--	0.10 U	A43	0.05	100	0.42	1	0.12	No	b
Chromium (DM)	0/1	--	1.00 U	A43	0.50	100	73.9	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	0.98	0.98	A43	0.98	100	8.93	1	0.11	No	b
Iron (TRM)	1/1	299	299	A43	299	--	1000	1	0.30	No	b
Lead (DM)	0/1	--	0.10 U	A43	0.05	100	2.51	1	0.02	No	b
Manganese (DM)	0/1	--	2.00 U	A43	1.00	100	1648	1	0.001	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/1	--	0.50 U	A43	0.25	100	51.9	1	0.005	No	b
Selenium (DM)	0/1	--	1.00 U	A43	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	A43	0.25	100	0.07	1	3.35	Yes	a
Thallium (DM)	0/1	--	1.00 U	A43	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	0/1	--	10.0 U	A43	5.00	100	121	1	0.04	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.25 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in Mill Creek Reference EU Monitoring Site M08.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	6.02	6.02	M08	6.02	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	1/1	211	211	M08	211	65.1	87.0[f]	1	2.43	Yes	a
Antimony (TRM)	0/1	--	2.50 U	M08	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	M08	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	M08	1.00	65.1	3.23	2	0.31	No	b
Cadmium (DM)	1/1	0.16 J	0.16 J	M08	0.16	65.1	0.31	1	0.53	No	b
Chromium (DM)	0/1	--	1.00 U	M08	0.50	65.1	52.1	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	0.72 J	0.72 J	M08	0.72	65.1	6.20	1	0.12	No	b
Iron (TRM)	0/1	--	100 U	M08	50.0	--	1000	1	0.05	No	b
Lead (DM)	0/1	--	0.10 U	M08	0.05	65.1	1.57	1	0.03	No	b
Manganese (DM)	1/1	44.8	44.8	M08	44.8	65.1	1430	1	0.03	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/1	--	0.50 U	M08	0.25	65.1	36.2	1	0.01	No	b
Selenium (DM)	0/1	--	1.00 U	M08	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	M08	0.25	65.1	0.04	1	6.97	Yes	a
Thallium (DM)	0/1	--	1.00 U	M08	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	34.5	34.5	M08	34.5	65.1	82.0	1	0.42	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported
J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.26 Selection of Pore Water COPECs for Community-level Benthic Macroinvertebrate Receptors in Picayne Gulch Reference EU Monitoring Site A26.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	7.85	7.85	A26	7.85	--	6.50	1	<1.00	No	b
Aluminum (TRM)	1/1	282	282	A26	282	181	1100	1	0.26	No	b
Antimony (TRM)	0/1	--	2.50 U	A26	1.25	--	240	2	0.01	No	b
Arsenic (DM)	1/1	0.61	0.61	A26	0.61	--	150	1	0.004	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	A26	1.00	181	18.1	2	0.06	No	b
Cadmium (DM)	0/1	--	0.10 U	A26	0.05	181	0.66	1	0.08	No	b
Chromium (DM)	1/1	1.42	1.42	A26	1.42	181	120	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	0.84	0.84	A26	0.84	181	14.9	1	0.06	No	b
Iron (TRM)	1/1	505	505	A26	505	--	1000	1	0.51	No	b
Lead (DM)	0/1	--	0.10 U	A26	0.05	181	4.77	1	0.01	No	b
Manganese (DM)	1/1	50.0	50.0	A26	50.0	181	2010	1	0.02	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/1	--	0.50 U	A26	0.25	181	85.9	1	0.003	No	b
Selenium (DM)	0/1	--	1.00 U	A26	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	A26	0.25	181	0.21	1	1.20	Yes	a
Thallium (DM)	0/1	--	1.00 U	A26	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	0/1	--	10.0 U	A26	5.00	181	208	1	0.02	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Table A9.27 Selection of Pore Water COPECs for Benthic Macroinvertebrate Community-level Receptors in North Fork Animas River Reference EU Monitoring Site A05.

Contaminant (fraction)	FOD	Min. detect[a] (µg/L)	Max. detect[b] (µg/L)	Location of max	Concentration screening value[c]	Hardness[d] (mg/L)	Hardness adj. ESV (µg/L)	ESV source	HQ[e]	COPEC?	Reason code
pH	1/1	5.78	5.78	A05	5.78	--	6.50	1	>1.00	Yes	a
Aluminum (TRM)	1/1	1570	1570	A05	1570	100	87.0[f]	1	18.0	Yes	a
Antimony (TRM)	0/1	--	2.50 U	A05	1.25	--	240	2	0.01	No	b
Arsenic (DM)	0/1	--	0.50 U	A05	0.25	--	150	1	0.002	No	b
Barium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Beryllium (TRM)	0/1	--	2.00 U	A05	1.00	100	6.63	2	0.15	No	b
Cadmium (DM)	1/1	0.66	0.66	A05	0.66	100	0.42	1	1.57	Yes	a
Chromium (DM)	0/1	--	1.00 U	A05	0.50	100	73.9	1	0.01	No	b
Cobalt (TRM)	--	--	--	--	--	--	--	--	--	No	--
Copper (DM)	1/1	0.93	0.93	A05	0.93	100	8.93	1	0.10	No	b
Iron (TRM)	1/1	1780	1780	A05	1780	--	1000	1	1.78	Yes	a
Lead (DM)	0/1	--	0.10 U	A05	0.05	100	2.51	1	0.02	No	b
Manganese (DM)	1/1	2.73	2.73	A05	2.73	100	1648	1	0.002	No	b
Molybdenum (TRM)	--	--	--	--	--	--	--	--	--	No	--
Nickel (DM)	0/1	--	0.50 U	A05	0.25	100	51.9	1	0.005	No	b
Selenium (DM)	0/1	--	1.00 U	A05	0.50	--	4.60	1	0.11	No	b
Silver (DM)	0/1	--	0.50 U	A05	0.25	100	0.07	1	3.35	Yes	a
Thallium (DM)	0/1	--	1.00 U	A05	0.50	--	15.0	1	0.03	No	b
Vanadium (TRM)	--	--	--	--	--	--	--	--	--	No	--
Zinc (DM)	1/1	120	120	A05	120	100	121	1	0.99	No	b

COPEC = Contaminants of Potential Ecological Concern
FOD = Frequency of Detection
ESV = Ecological Screening Value
HQ = Hazard Quotient
TRM = Total Recoverable Metal
DM = Dissolved Metal
µg/L = microgram per liter
mg/L = milligram per liter

Data Qualifier Definitions:
U = Analyte was analyzed but not detected; minimum detection limit reported

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations, except for pH which represents the lowest reported value. When not detected, reported values represent the Minimum Detection Limit

[c] For metals with hardness-based ESVs, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher HQ than the one associated with the maximum concentration. When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] Reported hardness values associated with the sample-specific COPEC concentration that resulted in the highest HQ

[e] The HQ is calculated by dividing a screening concentration by its ESV. Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[f] As directed by Colorado Department of Public Health and the Environment (CDPHE, 2017c) the chronic aluminum equation was not applied when pH is below 7.0. When pH is below 7.0, the 87.0 µg/L TRM criterion was used

Reason codes:
a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00
b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

Benchmark sources:
1 = CDPHE (2017c) Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31)
2 = Michigan Department of Environmental Quality (MDEQ, 2015) Rule 57 Water Quality Values based on Rule 323.1057 of the Part 4.

Appendix 10

Sediment Aquatic Community-level Receptor Contaminants of Potential Ecological Concern Derivation Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 10 Tables:

Table A10.1 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek monitoring site M34.

Table A10.2 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

Table A10.3 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

Table A10.4 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

Table A10.5 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

Table A10.6 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

Table A10.7 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

Table A10.8 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48.

Table A10.9 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

Table A10.10 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Sites A35 and A40.

Table A10.11 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

Table A10.12 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

Table A10.13 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

Table A10.14 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

Table A10.15 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

Table A10.16 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

Table A10.17 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

Table A10.18 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-18; North Fork Animas River - Burrows Gulch to Animas Forks Monitoring Site A09.

Table A10.19 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07.

Table A10.20 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

Table A10.21 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs.

Table A10.22 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in Bear Creek Reference Exposure Unit Monitoring Site M30.

Table A10.23 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in Hermosa Creek Reference Exposure Unit Monitoring Site HC01.

Table A10.24 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in Maggie Gulch Reference Exposure Unit Monitoring Site A43.

Table A10.25 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08.

Table A10.26 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in Picayne Gulch Reference Exposure Unit Monitoring Site A26.

Table A10.27 Selection of Sediment COPECs for Benthic Macroinvertebrate Community-level Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05.

Table A10.1 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Site M34.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	10/10	9300		45000		M34	45000	14000	f	3.21	Yes	a
Antimony	8/10	0.17	J-	3.00	J+	M34	3.00	12.0	d	0.25	No	b
Arsenic	10/10	15.0		77.0		M34	77.0	9.79	a	7.87	Yes	a
Barium	8/8	35.0		220		M34	220	48.0	h	4.58	Yes	a
Cadmium	10/10	0.55		3.00	J+	M34	3.00	0.99	a	3.03	Yes	a
Chromium	9/10	2.79	D	7.80		M34	7.80	43.4	a	0.18	No	b
Cobalt	8/8	9.80		59.0	J+	M34	59.0	50.0	e	1.18	Yes	a
Copper	10/10	53.8	D	180	D	M34	180	31.6	a	5.70	Yes	a
Iron	10/10	34000		110000		M34	110000	20000	c	5.50	Yes	a
Lead	10/10	129	D	365		M34	365	35.8	a	10.2	Yes	a
Manganese	10/10	710		2200		M34	2200	460	c	4.78	Yes	a
Mercury	10/10	0.02	J	0.51	D	M34	0.51	0.18	a	2.84	Yes	a
Molybdenum	6/6	1.80		10.0		M34	10.0	8.30	g	1.20	Yes	a
Nickel	10/10	2.60		10.0		M34	10.0	22.7	a	0.44	No	b
Selenium	7/10	0.67		15.0		M34	15.0	0.90	g	16.7	Yes	a
Silver	8/10	0.21		3.30		M34	3.30	1.00	b	3.30	Yes	a
Vanadium	8/8	16.0		49.0	J+	M34	49.0	27.3	g	1.79	Yes	a
Zinc	10/10	170		1250		M34	1250	121	a	10.3	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

J- = Estimated result; result may be biased low

J+ = Estimated result; result may be biased high

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

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b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

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e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.2 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)	Max. detection[b] (mg/kg)	Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	4/4	8780 D	11500 D	M27	11500	14000	f	0.82	No	b
Antimony	2/4	0.64 J	0.97 J	M27	0.97	12.0	d	0.08	No	b
Arsenic	4/4	34.9	62.9	M27	62.9	9.79	a	6.42	Yes	a
Barium	2/2	47.1	56.7	M27A	56.7	48.0	h	1.18	Yes	a
Cadmium	4/4	0.83 D	1.90	M27A	1.90	0.99	a	1.92	Yes	a
Chromium	2/4	2.00	2.40	M27A	2.40	43.4	a	0.06	No	b
Cobalt	2/2	6.60	10.2	M27A	10.2	50.0	e	0.20	No	b
Copper	4/4	68.9	84.0	M27A	84.0	31.6	a	2.66	Yes	a
Iron	4/4	46900	81700 D	M27	81700	20000	c	4.09	Yes	a
Lead	4/4	283	386 D	M27	386	35.8	a	10.8	Yes	a
Manganese	4/4	751 D	1560 D	M27	1560	460	c	3.39	Yes	a
Mercury	4/4	0.01 J	0.08 D	M27	0.08	0.18	a	0.47	No	b
Molybdenum	2/2	3.90	4.90	M27A	4.90	8.30	g	0.59	No	b
Nickel	4/4	2.30	3.43 D	M27	3.43	22.7	a	0.15	No	b
Selenium	2/4	1.70 J	1.90 J	M27	1.90	0.90	g	2.11	Yes	a
Silver	0/4	-	1.25 U	M27	0.63	1.00	b	0.63	No	b
Vanadium	2/2	17.1	19.3	M27A	19.3	27.3	g	0.71	No	b
Zinc	4/4	306 D	1440	M27	1440	121	a	11.9	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.3 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)	Max. detection[b] (mg/kg)	Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	4/4	8550 D	10300	M11	10300	14000	f	0.74	No	b
Antimony	2/4	0.38 JD	0.88 J	M14B	0.88	12.0	d	0.07	No	b
Arsenic	4/4	34.7 D	55.9 D	M11	55.9	9.79	a	5.71	Yes	a
Barium	2/2	45.4	63.8	M11	63.8	48.0	h	1.33	Yes	a
Cadmium	4/4	2.00	11.9	M11	11.9	0.99	a	12.0	Yes	a
Chromium	4/4	1.05 D	3.90	M11	3.90	43.4	a	0.09	No	b
Cobalt	2/2	13.5	18.9	M11	18.9	50.0	e	0.38	No	b
Copper	4/4	60.6	196 D	M11	196	31.6	a	6.20	Yes	a
Iron	4/4	32600	37300 D	M14B	37300	20000	c	1.87	Yes	a
Lead	4/4	173	786 D	M11	786	35.8	a	22.0	Yes	a
Manganese	4/4	1190	2320 D	M11	2320	460	c	5.04	Yes	a
Mercury	4/4	0.03 J	0.32	M11	0.32	0.18	a	1.78	Yes	a
Molybdenum	0/2	-	0.06 U	M11	0.03	8.30	g	0.003	No	b
Nickel	4/4	2.97 D	5.91 D	M11	5.91	22.7	a	0.26	No	b
Selenium	3/4	0.99 JD	1.40 J	M14B	1.40	0.90	g	1.56	Yes	a
Silver	4/4	0.49 JD	1.34 D	M11	1.34	1.00	b	1.34	Yes	a
Vanadium	2/2	15.3	22.2	M11	22.2	27.3	g	0.81	No	b
Zinc	4/4	296	2920	M11	2920	121	a	24.1	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.4 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)	Max. detection[b] (mg/kg)	Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	2/2	6860	7940 D	M10A	7940	14000	f	0.57	No	b
Antimony	2/2	0.02 J	1.36 D	M10A	1.36	12.0	d	0.11	No	b
Arsenic	2/2	92.7	160 D	M10A	160	9.79	a	16.3	Yes	a
Barium	1/1	25.7	25.7	M10A	25.7	48.0	h	0.54	No	b
Cadmium	2/2	3.30	12.70 D	M10A	12.7	0.99	a	12.8	Yes	a
Chromium	2/2	1.30	2.43 D	M10A	2.43	43.4	a	0.06	No	b
Cobalt	1/1	6.10	6.10	M10A	6.10	50.0	e	0.12	No	b
Copper	2/2	168	439 D	M10A	439	31.6	a	13.9	Yes	a
Iron	2/2	34100	40500 D	M10A	40500	20000	c	2.03	Yes	a
Lead	2/2	761	1890 D	M10A	1890	35.8	a	52.8	Yes	a
Manganese	2/2	1020	2110 D	M10A	2110	460	c	4.59	Yes	a
Mercury	2/2	0.03 J	0.31 D	M10A	0.31	0.18	a	1.69	Yes	b
Molybdenum	0/1	-	0.05 U	M10A	0.03	8.30	g	0.00	No	b
Nickel	2/2	2.20	8.89 D	M10A	8.89	22.7	a	0.39	No	b
Selenium	1/2	0.70 J	0.70 J	M10A	0.70	0.90	g	0.78	No	b
Silver	1/2	3.55 D	3.55 D	M10A	0.02	1.00	b	0.02	No	b
Vanadium	1/1	7.30	7.30	M10A	7.30	27.3	g	0.27	No	b
Zinc	2/2	5640 D	5900	M10A	5900	121	a	48.8	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.5 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	2/2	5820	D	12000		M28	12000	14000	f	0.86	No	b
Antimony	2/2	0.31	J	0.75	D	M28	0.75	12.0	d	0.06	No	b
Arsenic	2/2	10.5	D	14.5		M28	14.5	9.79	a	1.48	Yes	a
Barium	1/1	57.4		57.4		M28	57.4	48.0	h	1.20	Yes	a
Cadmium	2/2	0.20	D	1.00		M28	1.00	0.99	a	1.01	Yes	a
Chromium	2/2	3.02	D	3.20		M28	3.20	43.4	a	0.07	No	b
Cobalt	1/1	13.9		13.9		M28	13.9	50.0	e	0.28	No	b
Copper	2/2	18.7	D	18.9		M28	18.9	31.6	a	0.60	No	b
Iron	2/2	28000		30200	D	M28	30200	20000	c	1.51	Yes	a
Lead	2/2	68.5	D	106		M28	106	35.8	a	2.96	Yes	a
Manganese	2/2	357	D	1380		M28	1380	460	c	3.00	Yes	a
Mercury	1/2	0.09	J	0.09	J	M28	0.09	0.18	a	0.47	No	b
Molybdenum	0/1	-		0.06	U	M28	0.03	8.30	g	0.004	No	b
Nickel	2/2	5.3	D	11.6		M28	11.6	22.7	a	0.51	No	b
Selenium	2/2	0.73	JD	1.90	J	M28	1.90	0.90	g	2.11	Yes	a
Silver	1/2	0.72	D	0.72	D	M28	0.72	1.00	b	0.72	No	b
Vanadium	1/1	11.4		11.4		M28	11.4	27.3	g	0.42	No	b
Zinc	2/2	124	D	386		M28	386	121	a	3.19	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.6 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)	Max. detection[b] (mg/kg)	Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	2/2	12600	14300 D	M20	14300	14000	f	1.02	Yes	a
Antimony	1/2	0.43 J	1.25 U	M20	0.63	12.0	d	0.05	No	b
Arsenic	2/2	13.5 D	16.9	M20	16.9	9.79	a	1.73	Yes	a
Barium	1/1	30.3	30.3	M20	30.3	48.0	h	0.63	No	b
Cadmium	2/2	0.18 J	0.60 D	M20	0.60	0.99	a	0.61	No	b
Chromium	1/2	1.60	1.60	M20	1.60	43.4	a	0.04	No	b
Cobalt	1/1	4.90	4.90	M20	4.90	50.0	e	0.10	No	b
Copper	2/2	12.8	24.3 D	M20	24.3	31.6	a	0.77	No	b
Iron	2/2	87300	131000 D	M20	131000	20000	c	6.55	Yes	a
Lead	2/2	67.2	100 D	M20	100	35.8	a	2.79	Yes	a
Manganese	2/2	678	1170 D	M20	1170	460	c	2.54	Yes	a
Mercury	2/2	0.01 J	0.01 JD	M20	0.01	0.18	a	0.07	No	b
Molybdenum	1/1	4.90	4.90	M20	4.90	8.30	g	0.59	No	b
Nickel	2/2	1.10	1.77 JD	M20	1.77	22.7	a	0.08	No	b
Selenium	1/2	1.50 J	1.50 J	M20	1.50	0.90	g	1.67	Yes	a
Silver	0/2	-	1.25 U	M20	0.63	1.00	b	0.63	No	b
Vanadium	1/1	23.5	23.5	M20	23.5	27.3	g	0.86	Yes	a
Zinc	2/2	121	130 D	M20	130	121	a	1.07	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.7 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)	Max. detection[b] (mg/kg)	Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	12/12	6860 D	15100 D	A56	15100	14000	f	1.08	Yes	a
Antimony	10/12	1.03 JD	3.30 J	A55	3.30	12.0	d	0.28	No	b
Arsenic	12/12	6.00	33.1 D	A56	33.1	9.79	a	3.38	Yes	a
Barium	11/11	45.7	166 D	A56	166	48.0	h	3.46	Yes	a
Cadmium	12/12	2.80	17.8 D	A56	17.8	0.99	a	18.0	Yes	a
Chromium	12/12	2.60	7.47 D	A56	7.47	43.4	a	0.17	No	b
Cobalt	11/11	5.80	15.6 D	A56	15.6	50.0	e	0.31	No	b
Copper	12/12	79.6	432 D	A56	432	31.6	a	13.7	Yes	a
Iron	12/12	19600	40700 D	A56	40700	20000	c	2.04	Yes	a
Lead	12/12	512	1820 D	A56	1820	35.8	a	50.8	Yes	a
Manganese	12/12	2770	12700 J	A55	12700	460	c	27.6	Yes	a
Mercury	9/11	0.02 D	0.17 D	A56	0.17	0.18	a	0.95	No	b
Molybdenum	3/4	3.20	7.45 D	A56	7.45	8.30	g	0.90	No	b
Nickel	12/12	3.30	9.92 D	A56	9.92	22.7	a	0.44	No	b
Selenium	8/12	0.55 JD	1.64 D	A56	1.64	0.90	g	1.82	Yes	a
Silver	12/12	0.59 J	7.64 D	A56	7.64	1.00	b	7.64	Yes	a
Vanadium	11/11	8.50	19.3 D	A56	19.3	27.3	g	0.71	No	b
Zinc	12/12	858	6200 D	A56	6200	121	a	51.2	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.8 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-08; Cunningham Creek Monitoring Site A48.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	4/4	6380	D	10300		A48	10300	14000	f	0.74	No	b
Antimony	1/4	1.20	J	1.20	J	A48	1.20	12.0	d	0.10	No	b
Arsenic	4/4	6.40		12.1	D	A48	12.1	9.79	a	1.24	Yes	a
Barium	3/3	55.9		107	J	A48	107	48.0	h	2.23	Yes	a
Cadmium	4/4	1.40		2.87	D	A48	2.87	0.99	a	2.90	Yes	a
Chromium	4/4	2.70		4.10	J	A48	4.10	43.4	a	0.09	No	b
Cobalt	3/3	6.80		10.8	J	A48	10.8	50.0	e	0.22	No	b
Copper	4/4	37.5		114	D	A48	114	31.6	a	3.61	Yes	a
Iron	4/4	17600	D	26400	J	A48	26400	20000	c	1.32	Yes	a
Lead	4/4	306		683	D	A48	683	35.8	a	19.1	Yes	a
Manganese	4/4	824	D	1240		A48	1240	460	c	2.70	Yes	a
Mercury	2/4	0.02		0.04	D	A48	0.04	0.18	a	0.22	No	b
Molybdenum	1/2	4.91	D	4.91	D	A48	4.91	8.30	g	0.59	No	b
Nickel	4/4	3.10		4.50	J	A48	4.50	22.7	a	0.20	No	b
Selenium	2/4	1.20	J	4.60	J	A48	4.60	0.90	g	5.11	Yes	a
Silver	4/4	0.61	J	1.64	D	A48	1.64	1.00	b	1.64	Yes	a
Vanadium	3/3	13.0	D	21.7	J	A48	21.7	27.3	g	0.79	No	b
Zinc	4/4	338		507	D	A48	507	121	a	4.19	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.9 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	8/8	6700	D	17900	D	A41A	17900	14000	f	1.28	Yes	a
Antimony	7/8	1.84	D	4.30	J	A41A	4.30	12.0	d	0.36	No	b
Arsenic	8/8	20.4		48.9	D	A41A	48.9	9.79	a	4.99	Yes	a
Barium	6/6	45.5	J	135	D	A41A	135	48.0	h	2.81	Yes	a
Cadmium	8/8	3.70	J	21.0	D	A41A	21.0	0.99	a	21.2	Yes	a
Chromium	8/8	2.60		5.60	J	A45	5.60	43.4	a	0.13	No	b
Cobalt	6/6	8.70		13.6	D	A41A	13.6	50.0	e	0.27	No	b
Copper	8/8	109	J	682	D	A41A	682	31.6	a	21.6	Yes	a
Iron	8/8	21500	D	32000	D	A41A	32000	20000	c	1.60	Yes	a
Lead	8/8	265	J	2080	D	A45	2080	35.8	a	58.1	Yes	a
Manganese	8/8	729	J	15700		A41A	15700	460	c	34.1	Yes	a
Mercury	6/8	0.02	JD	0.18	D	A45	0.18	0.18	a	1.02	Yes	a
Molybdenum	4/4	5.00		7.81	D	A41A	7.81	8.30	g	0.94	No	b
Nickel	8/8	4.80		13.9	D	A41A	13.9	22.7	a	0.61	No	b
Selenium	5/8	1.36		7.80	J	A41A	7.80	0.90	g	8.67	Yes	a
Silver	8/8	1.90	J	7.30	D	A45	7.30	1.00	b	7.30	Yes	a
Vanadium	6/6	12.2		24.40	J	A45	24.4	27.3	g	0.89	No	b
Zinc	8/8	539	J	5790	D	A41A	5790	121	a	47.9	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.10 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Sites A35 and A40.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	8/8	8170	J	26100	D	A40	26100	14000	f	1.86	Yes	a
Antimony	8/8	1.22	JD	21.4		A40	21.4	12.0	d	1.78	Yes	a
Arsenic	8/8	30.6		57.2	D	A40	57.2	9.79	a	5.84	Yes	a
Barium	6/6	69.4		134	D	A40	134	48.0	h	2.79	Yes	a
Cadmium	8/8	6.95	D	51.2	D	A40	51.2	0.99	a	51.7	Yes	a
Chromium	8/8	3.70		5.40	J	A40	5.40	43.4	a	0.12	No	b
Cobalt	6/6	3.90		17.6	J	A35	17.6	50.0	e	0.35	No	b
Copper	8/8	202	JD	1420	D	A40	1420	31.6	a	44.9	Yes	a
Iron	8/8	21800		41300	D	A35	41300	20000	c	2.07	Yes	a
Lead	8/8	730	D	2640	D	A40	2640	35.8	a	73.7	Yes	a
Manganese	8/8	5410	D	26100	D	A40	26100	460	c	56.7	Yes	a
Mercury	6/8	0.03	D	0.16		A40	0.16	0.18	a	0.89	No	b
Molybdenum	4/4	6.56	D	14.6		A40	14.6	8.30	g	1.76	Yes	a
Nickel	8/8	1.50		22.0	D	A40	22.0	22.7	a	0.97	No	b
Selenium	6/8	1.38		4.90	J	A35	4.90	0.90	g	5.44	Yes	a
Silver	8/8	2.00	D	38.1		A40	38.1	1.00	b	38.1	Yes	a
Vanadium	6/6	10.1		20.70	J	A40	20.7	27.3	g	0.76	No	b
Zinc	8/8	1670	D	9650	D	A40	9650	121	a	79.8	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.11 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	4/4	6920	D	11200		A36	11200	14000	f	0.80	No	b
Antimony	4/4	0.89	J	1.10	J	A36	1.10	12.0	d	0.09	No	b
Arsenic	4/4	18.8	J	40.9	D	A36	40.9	9.79	a	4.18	Yes	a
Barium	3/3	65.0	J	102	D	A36	102	48.0	h	2.13	Yes	a
Cadmium	4/4	0.72	D	1.56	D	A36	1.56	0.99	a	1.58	Yes	a
Chromium	4/4	4.90		6.22	D	A36	6.22	43.4	a	0.14	No	b
Cobalt	3/3	10.2		14.6	D	A36	14.6	50.0	e	0.29	No	b
Copper	4/4	80.6		115	D	A36	115	31.6	a	3.64	Yes	a
Iron	4/4	37000	J	58300	D	A36	58300	20000	c	2.92	Yes	a
Lead	4/4	106	J	317	D	A36	317	35.8	a	8.85	Yes	a
Manganese	4/4	861	D	1410	D	A36	1410	460	c	3.07	Yes	a
Mercury	1/4	0.01	J	0.01	J	A36	0.01	0.18	a	0.05	No	b
Molybdenum	2/2	7.59	D	10.6		A36	10.6	8.30	g	1.28	Yes	a
Nickel	4/4	4.80	JD	10.1	D	A36	10.1	22.7	a	0.44	No	b
Selenium	3/4	1.64	JD	2.60	J	A36	2.60	0.90	g	2.89	Yes	a
Silver	4/4	0.80	J	1.54	D	A36	1.54	1.00	b	1.54	Yes	a
Vanadium	3/3	20.4		22.9	D	A36	22.9	27.3	g	0.84	No	b
Zinc	4/4	235	D	492	D	A36	492	121	a	4.07	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.12 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	4/4	9450	D	18700		A37	18700	14000	f	1.34	Yes	a
Antimony	2/4	0.56	JD	1.90	J	A37	1.90	12.0	d	0.16	No	b
Arsenic	4/4	13.5	J	27.1	D	A37	27.1	9.79	a	2.77	Yes	a
Barium	3/3	83.9		103	D	A37	103	48.0	h	2.15	Yes	a
Cadmium	4/4	8.00	J	15.1	D	A37	15.1	0.99	a	15.3	Yes	a
Chromium	4/4	3.40	J	4.93	JD	A37	4.93	43.4	a	0.11	No	b
Cobalt	3/3	10.5		14.5	J	A37	14.5	50.0	e	0.29	No	b
Copper	4/4	185	J	333	JD	A37	333	31.6	a	10.5	Yes	a
Iron	4/4	28400	J	40200		A37	40200	20000	c	2.01	Yes	a
Lead	4/4	452		732	D	A37	732	35.8	a	20.4	Yes	a
Manganese	4/4	7300	D	8710		A37	8710	460	c	18.9	Yes	a
Mercury	3/4	0.02	D	0.04	J	A37	0.04	0.18	a	0.19	No	b
Molybdenum	2/2	2.10	J	3.01	D	A37	3.01	8.30	g	0.36	No	b
Nickel	4/4	7.80		11.3	JD	A37	11.3	22.7	a	0.50	No	b
Selenium	2/4	1.50	J	4.20	J	A37	4.20	0.90	g	4.67	Yes	a
Silver	4/4	1.04	D	4.07	D	A37	4.07	1.00	b	4.07	Yes	a
Vanadium	3/3	15.8	D	20.4		A37	20.4	27.3	g	0.75	No	b
Zinc	4/4	1580	J	4420	D	A37	4420	121	a	36.5	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.13 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	4/4	8120	D	12300		A34	12300	14000	f	0.88	No	b
Antimony	4/4	0.84	JD	2.00	J	A34	2.00	12.0	d	0.17	No	b
Arsenic	4/4	16.6		38.2	D	A34	38.2	9.79	a	3.90	Yes	a
Barium	3/3	75.9		81.0	D	A34	81.0	48.0	h	1.69	Yes	a
Cadmium	4/4	6.20		7.41	D	A34	7.41	0.99	a	7.48	Yes	a
Chromium	4/4	5.11	D	6.50		A34	6.50	43.4	a	0.15	No	b
Cobalt	3/3	15.8		18.7	D	A34	18.7	50.0	e	0.37	No	b
Copper	4/4	193		236	J	A34	236	31.6	a	7.47	Yes	a
Iron	4/4	38400		46200	D	A34	46200	20000	c	2.31	Yes	a
Lead	4/4	375	D	767	D	A34	767	35.8	a	21.4	Yes	a
Manganese	4/4	2490	D	5120		A34	5120	460	c	11.1	Yes	a
Mercury	4/4	0.03	D	0.55		A34	0.55	0.18	a	3.06	Yes	a
Molybdenum	2/2	4.40		4.68	D	A34	4.68	8.30	g	0.56	No	b
Nickel	4/4	7.85		12.5	D	A34	12.5	22.7	a	0.55	No	b
Selenium	3/4	1.58		4.50	J	A34	4.50	0.90	g	5.00	Yes	a
Silver	4/4	1.47	D	2.80	J	A34	2.80	1.00	b	2.80	Yes	a
Vanadium	3/3	19.3	D	23.3		A34	23.3	27.3	g	0.85	No	b
Zinc	4/4	1490	J	2420	D	A34	2420	121	a	20.0	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.14 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	8/8	8430	J	25000	D	A33	25000	14000	f	1.79	Yes	a
Antimony	8/8	0.99	J	6.30		A33	6.30	12.0	d	0.53	No	b
Arsenic	8/8	14.8	J	72.8	D	A33	72.8	9.79	a	7.44	Yes	a
Barium	6/6	40.6	J	102	J	A33	102	48.0	h	2.13	Yes	a
Cadmium	8/8	2.60	J	15.8	D	A33	15.8	0.99	a	16.0	Yes	a
Chromium	8/8	3.12	D	5.03	D	A14	5.03	43.4	a	0.12	No	b
Cobalt	6/6	8.30		13.6	J	A33	13.6	50.0	e	0.27	No	b
Copper	8/8	66.8	J	726	D	A33	726	31.6	a	23.0	Yes	a
Iron	8/8	17400	J	25600	D	A33	25600	20000	c	1.28	Yes	a
Lead	8/8	279	J	1880	D	A14	1880	35.8	a	52.5	Yes	a
Manganese	8/8	2950	J	13600	D	A33	13600	460	c	29.6	Yes	a
Mercury	7/8	0.02	D	0.14	D	A14	0.14	0.18	a	0.75	No	b
Molybdenum	4/4	5.90		9.80		A33	9.80	8.30	g	1.18	Yes	a
Nickel	8/8	3.85	D	10.6	JD	A33	10.6	22.7	a	0.47	No	b
Selenium	6/8	0.56	JD	4.80	J	A33	4.80	0.90	g	5.33	Yes	a
Silver	8/8	0.54	J	6.09	D	A14	6.09	1.00	b	6.09	Yes	a
Vanadium	6/6	14.2	J	17.7		A14	17.7	27.3	g	0.65	No	b
Zinc	8/8	432	J	4800	D	A33	4800	121	a	39.7	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.15 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)	Max. detection[b] (mg/kg)	Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	4/4	8170	44600 D	A10	44600	14000	f	3.19	Yes	a
Antimony	3/4	2.14 D	4.40 J	A10	4.40	12.0	d	0.37	No	b
Arsenic	4/4	18.3	41.7 D	A10	41.7	9.79	a	4.26	Yes	a
Barium	3/3	31.7	114 J	A10	114	48.0	h	2.38	Yes	a
Cadmium	4/4	1.20	10.4 D	A10	10.4	0.99	a	10.5	Yes	a
Chromium	4/4	2.70	4.81 D	A10	4.81	43.4	a	0.11	No	b
Cobalt	3/3	5.70	21.8 J	A10	21.8	50.0	e	0.44	No	b
Copper	4/4	57.2	477 D	A10	477	31.6	a	15.1	Yes	a
Iron	4/4	18700	28400 D	A10	28400	20000	c	1.42	Yes	a
Lead	4/4	455	2320 D	A10	2320	35.8	a	64.8	Yes	a
Manganese	4/4	1660 J	15600 J	A10	15600	460	c	33.9	Yes	a
Mercury	4/4	0.11	0.23 D	A10	0.23	0.18	a	1.30	Yes	a
Molybdenum	2/2	5.20	8.79 D	A10	8.79	8.30	g	1.06	Yes	a
Nickel	4/4	2.40	7.30 J	A10	7.30	22.7	a	0.32	No	b
Selenium	1/4	0.84 J	0.84 J	A10	0.84	0.90	g	0.93	No	b
Silver	4/4	1.30	6.19 D	A10	6.19	1.00	b	6.19	Yes	a
Vanadium	3/3	14.2	16.5 D	A10	16.5	27.3	g	0.60	No	b
Zinc	4/4	359	2770 D	A10	2770	121	a	22.9	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.16 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	4/4	9460	D	13200		A20	13200	14000	f	0.94	No	b
Antimony	4/4	5.23	D	17.4	J	A20	17.4	12.0	d	1.45	Yes	a
Arsenic	4/4	40.9	D	66.4		A20	66.4	9.79	a	6.78	Yes	a
Barium	3/3	76.4	D	392	J	A20	392	48.0	h	8.17	Yes	a
Cadmium	4/4	14.3	D	67.2	D	A20	67.2	0.99	a	67.9	Yes	a
Chromium	4/4	3.08	JD	4.50	J	A20	4.50	43.4	a	0.10	No	b
Cobalt	3/3	16.5	D	71.5	J	A20	71.5	50.0	e	1.43	Yes	a
Copper	4/4	555	D	1700	JD	A20	1700	31.6	a	53.8	Yes	a
Iron	4/4	22900		31300	J	A20	31300	20000	c	1.57	Yes	a
Lead	4/4	4260	D	9250	J	A20	9250	35.8	a	258	Yes	a
Manganese	4/4	15500	D	64500	J	A20	64500	460	c	140	Yes	a
Mercury	4/4	0.32	D	0.98	D	A20	0.98	0.18	a	5.42	Yes	a
Molybdenum	2/2	5.55	D	9.70		A20	9.70	8.30	g	1.17	Yes	a
Nickel	4/4	5.12	JD	18.7	J	A20	18.7	22.7	a	0.82	No	b
Selenium	2/4	2.07	D	4.60		A20	4.60	0.90	g	5.11	Yes	a
Silver	4/4	6.37	D	24.7	D	A20	24.7	1.00	b	24.7	Yes	a
Vanadium	3/3	10.3	D	20.7	J	A20	20.7	27.3	g	0.76	No	b
Zinc	4/4	3220	D	21500	D	A20	21500	121	a	178	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.17 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)	Max. detection[b] (mg/kg)	Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	4/4	17400	33000 D	A15	33000	14000	f	2.36	Yes	a
Antimony	2/4	0.48 JD	1.50 J	A15	1.50	12.0	d	0.13	No	b
Arsenic	4/4	17.5	39.2 D	A15	39.2	9.79	a	4.00	Yes	a
Barium	3/3	14.1	57.6 J	A15	57.6	48.0	h	1.20	Yes	a
Cadmium	3/4	1.92 D	2.70 J	A15	2.70	0.99	a	2.73	Yes	a
Chromium	4/4	3.70	9.10 J	A15	9.10	43.4	a	0.21	No	b
Cobalt	3/3	6.20	26.1 J	A15	26.1	50.0	e	0.52	No	b
Copper	4/4	110	277 J	A15	277	31.6	a	8.77	Yes	a
Iron	4/4	28300	47200 J	A15	47200	20000	c	2.36	Yes	a
Lead	4/4	112	339 D	A15	339	35.8	a	9.47	Yes	a
Manganese	4/4	2970	8660 J	A15	8660	460	c	18.8	Yes	a
Mercury	4/4	0.02 J	0.04 J	A15	0.04	0.18	a	0.21	No	b
Molybdenum	1/2	6.42 D	6.42 D	A15	6.42	8.30	g	0.77	No	b
Nickel	4/4	2.90	12.6 J	A15	12.6	22.7	a	0.56	No	b
Selenium	1/4	1.80 J	1.80 J	A15	1.80	0.90	g	2.00	Yes	a
Silver	3/4	1.10 J	2.16 D	A15	2.16	1.00	b	2.16	Yes	a
Vanadium	3/3	25.6 D	39.9 J	A15	39.9	27.3	g	1.46	Yes	a
Zinc	4/4	399	834 D	A15	834	121	a	6.89	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.18 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-18; North Fork Animas River - Burrows Gulch to Animas Forks Monitoring Site A09.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	8/8	7240	J	34100	D	A08	34100	14000	f	2.44	Yes	a
Antimony	7/8	0.36	JD	2.70	J	A08	2.70	12.0	d	0.23	No	b
Arsenic	8/8	26.4	D	99.3		A08	99.3	9.79	a	10.1	Yes	a
Barium	6/6	22.3	JD	95.0		A08	95.0	48.0	h	1.98	Yes	a
Cadmium	8/8	1.47	D	8.65	D	A09	8.65	0.99	a	8.74	Yes	a
Chromium	8/8	1.70	J	4.30		A08	4.30	43.4	a	0.10	No	b
Cobalt	6/6	10.00	D	19.9		A09	19.9	50.0	e	0.40	No	b
Copper	8/8	53.4	J	111	D	A09	111	31.6	a	3.51	Yes	a
Iron	8/8	11200	D	30700		A08	30700	20000	c	1.54	Yes	a
Lead	8/8	115	D	721	D	A09	721	35.8	a	20.1	Yes	a
Manganese	8/8	1240	D	5590	J	A09	5590	460	c	12.2	Yes	a
Mercury	6/8	0.01	JD	0.09	J-	A08	0.09	0.18	a	0.52	No	b
Molybdenum	4/4	6.33	D	9.74	D	A09	9.74	8.30	g	1.17	Yes	a
Nickel	8/8	2.18	D	6.70		A08	6.70	22.7	a	0.30	No	b
Selenium	2/8	1.40	J	4.20	J	A08	4.20	0.90	g	4.67	Yes	a
Silver	8/8	0.68		3.40		A08	3.40	1.00	b	3.40	Yes	a
Vanadium	6/6	9.90		16.2		A08	16.2	27.3	g	0.59	No	b
Zinc	8/8	288	D	2600		A09	2600	121	a	21.5	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

J- = Estimated result; result may be biased low

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.19 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-19; Burrows Gulch Monitoring Site A07.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	4/4	18000		37900	D	A07	37900	14000	f	2.71	Yes	a
Antimony	4/4	0.97	JD	2.60	J	A07	2.60	12.0	d	0.22	No	b
Arsenic	4/4	42.3	J	54.4		A07	54.4	9.79	a	5.56	Yes	a
Barium	3/3	32.9	JD	79.6	J	A07	79.6	48.0	h	1.66	Yes	a
Cadmium	4/4	5.64	D	7.70	J	A07	7.70	0.99	a	7.78	Yes	a
Chromium	4/4	2.00		4.21	D	A07	4.21	43.4	a	0.10	No	b
Cobalt	3/3	22.8	D	28.3	J	A07	28.3	50.0	e	0.57	No	b
Copper	4/4	171		224		A07	224	31.6	a	7.09	Yes	a
Iron	4/4	25400		37000	D	A07	37000	20000	c	1.85	Yes	a
Lead	4/4	358	D	593	J	A07	593	35.8	a	16.6	Yes	a
Manganese	4/4	7500		22000	J	A07	22000	460	c	47.8	Yes	a
Mercury	4/4	0.01	J-	0.04	J	A07	0.04	0.18	a	0.20	No	b
Molybdenum	2/2	12.7		14.90	D	A07	14.9	8.30	g	1.80	Yes	a
Nickel	4/4	4.82	D	7.70	J	A07	7.70	22.7	a	0.34	No	b
Selenium	1/4	1.40	J	1.40	J	A07	1.40	0.90	g	1.56	Yes	a
Silver	4/4	0.93	J	2.13	D	A07	2.13	1.00	b	2.13	Yes	a
Vanadium	3/3	7.60		12.1	D	A07	12.1	27.3	g	0.44	No	b
Zinc	4/4	605	D	869	J	A07	869	121	a	7.18	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

J- = Estimated result; result may be biased low

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.20 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	15/15	4900		10600	D	James Ranch	10600	14000	f	0.76	No	b
Antimony	15/15	0.10	J-	1.80		Oxbow Park	1.80	12.0	d	0.15	No	b
Arsenic	15/15	6.40	J+	19.0	J+	Oxbow Park	19.0	9.79	a	1.94	Yes	a
Barium	15/15	41.0		190		Oxbow Park	190	48.0	h	3.96	Yes	a
Cadmium	15/15	0.40	J+	4.97	D	James Ranch	4.97	0.99	a	5.02	Yes	a
Chromium	15/15	4.30		13.0	J+	Oxbow Park	13.0	43.4	a	0.30	No	b
Cobalt	15/15	4.80	J+	17.8	D	James Ranch	17.8	50.0	e	0.36	No	b
Copper	15/15	28.0		150		Oxbow Park	150	31.6	a	4.75	Yes	a
Iron	15/15	13000		29900	D	James Ranch	29900	20000	c	1.50	Yes	a
Lead	15/15	48.0		390		Oxbow Park	390	35.8	a	10.9	Yes	a
Manganese	15/15	430		4250	D	James Ranch	4250	460	c	9.24	Yes	a
Mercury	7/15	0.01	J	0.04	D	James Ranch	0.04	0.18	a	0.22	No	b
Molybdenum	13/13	0.90	J	5.10	J+	Oxbow Park	5.10	8.30	g	0.61	No	b
Nickel	15/15	4.50		13.0	J+	Oxbow Park	13.0	22.7	a	0.57	No	b
Selenium	13/15	0.18	J	7.50		Oxbow Park	0.51	0.90	g	0.57	No	b
Silver	15/15	0.18	J+	3.50	J+	Oxbow Park	3.50	1.00	b	3.50	Yes	a
Vanadium	15/15	11.3	D	31.0	J+	Oxbow Park	31.0	27.3	g	1.14	Yes	a
Zinc	15/15	150		1730	D	James Ranch	1730	121	a	14.3	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

J- = Estimated result; result may be biased low

J+ = Estimated result; result may be biased high

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.21 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	25/25	4470	D	13000		Rotary Park	13000	14000	f	0.93	No	b
Antimony	24/25	0.04	J-	2.40		Rotary Park	2.40	12.0	d	0.20	No	b
Arsenic	25/25	5.00	J-	14.0		Rotary Park	14.0	9.79	a	1.43	Yes	a
Barium	25/25	64.0	J+	250		AR19-3	250	48.0	h	5.21	Yes	a
Cadmium	25/25	0.69		5.50	J+	Rotary Park	5.50	0.99	a	5.56	Yes	a
Chromium	25/25	3.60	J	17.0	J+	Rotary Park	17.0	43.4	a	0.39	No	b
Cobalt	25/25	5.15	D	14.7	D	Rotary Park	14.7	50.0	e	0.29	No	b
Copper	25/25	19.0	D	120	J+	Rotary Park	120	31.6	a	3.80	Yes	a
Iron	25/25	14000		30000		Rotary Park	30000	20000	c	1.50	Yes	a
Lead	25/25	35.5	D	340		Rotary Park	340	35.8	a	9.50	Yes	a
Manganese	25/25	399	D	3430	D	Rotary Park	3430	460	c	7.46	Yes	a
Mercury	16/17	0.01	J	0.08	J+	Rotary Park	0.08	0.18	a	0.44	No	b
Molybdenum	23/23	1.30		5.40	D	Rotary Park	5.40	8.30	g	0.65	No	b
Nickel	25/25	5.70		22.0	J+	Rotary Park	22.0	22.7	a	0.97	No	b
Selenium	23/25	0.20	D	7.40		Rotary Park	7.40	0.90	g	8.22	Yes	a
Silver	24/25	0.23		2.00	J-	Rotary Park	2.00	1.00	b	2.00	Yes	a
Vanadium	25/25	9.90		40.0	J+	Rotary Park	40.0	27.3	g	1.47	Yes	a
Zinc	25/25	110	J-	1400	J	Rotary Park	1400	121	a	11.6	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

J- = Estimated result; result may be biased low

J+ = Estimated result; result may be biased high

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.22 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in Bear Creek Reference Exposure Unit Monitoring Site M30.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	2/2	6220	D	9150		M30	9150	14000	f	0.65	No	b
Antimony	2/2	0.26	J	0.37	JD	M30	0.37	12.0	d	0.03	No	b
Arsenic	2/2	10.4		14.6	D	M30	14.6	9.79	a	1.49	Yes	a
Barium	1/1	68.0		68.0		M30	68.0	48.0	h	1.42	Yes	a
Cadmium	2/2	0.69		0.95	D	M30	0.95	0.99	a	0.96	No	b
Chromium	2/2	3.80		3.83	D	M30	3.83	43.4	a	0.09	No	b
Cobalt	1/1	11.5		11.5		M30	11.5	50.0	e	0.23	No	b
Copper	2/2	21.2		25.9	D	M30	25.9	31.6	a	0.82	No	b
Iron	2/2	15000	D	20500		M30	20500	20000	c	1.03	Yes	a
Lead	2/2	41.8		65.2	D	M30	65.2	35.8	a	1.82	Yes	a
Manganese	2/2	1270		1390	D	M30	1390	460	c	3.02	Yes	a
Mercury	1/2	0.01	J	0.01	J	M30	0.01	0.18	a	0.03	No	b
Molybdenum	0/1	-		0.06	U	M30	0.031	8.30	g	0.004	No	b
Nickel	2/2	6.66	D	7.20		M30	7.20	22.7	a	0.32	No	b
Selenium	2/2	1.13	D	1.50	J	M30	1.50	0.90	g	1.67	Yes	a
Silver	0/2	-		0.25	U	M30	0.12	1.00	b	0.12	No	b
Vanadium	1/1	17.2		17.2		M30	17.2	27.3	g	0.63	No	b
Zinc	2/2	251		263	D	M30	263	121	a	2.17	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.23 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in Hermosa Creek Reference Exposure Unit Monitoring Site HC01.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)	Max. detection[b] (mg/kg)	Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	1/1	17300	17300	HC01	17300	14000	f	1.24	Yes	a
Antimony	0/1	-	0.05 U	HC01	0.02	12.0	d	0.002	No	b
Arsenic	1/1	1.10 J	1.10 J	HC01	1.10	9.79	a	0.11	No	b
Barium	1/1	107	107	HC01	107	48.0	h	2.23	Yes	a
Cadmium	0/1	-	0.07 U	HC01	0.03	0.99	a	0.03	No	b
Chromium	1/1	23.0	23.0	HC01	23.0	43.4	a	0.53	No	b
Cobalt	1/1	7.00	7.00	HC01	7.00	50.0	e	0.14	No	b
Copper	1/1	11.5	11.5	HC01	11.5	31.6	a	0.36	No	b
Iron	1/1	22000	22000	HC01	22000	20000	c	1.10	Yes	a
Lead	1/1	11.7	11.7	HC01	11.7	35.8	a	0.33	No	b
Manganese	1/1	323	323	HC01	323	460	c	0.70	No	b
Mercury	0/1	-	0.01 U	HC01	0.003	0.18	a	0.01	No	b
Molybdenum	0/1	-	0.07 U	HC01	0.04	8.30	g	0.004	No	b
Nickel	1/1	15.0	15.0	HC01	15.0	22.7	a	0.66	No	b
Selenium	1/1	2.40 J	2.40 J	HC01	2.40	0.90	g	2.67	Yes	a
Silver	0/1	-	0.05 U	HC01	0.02	1.00	b	0.02	No	b
Vanadium	1/1	29.9	29.9	HC01	29.9	27.3	g	1.10	Yes	a
Zinc	1/1	65.9	65.9	HC01	65.9	121	a	0.54	No	b

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.24 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in Maggie Gulch Reference Exposure Unit Monitoring Site A43.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	3/3	5680	D	9420		A43	9420	14000	f	0.67	No	b
Antimony	0/3	-		0.51	U	A43	0.25	12.0	d	0.02	No	b
Arsenic	3/3	7.60	J	12.5	D	A43	12.5	9.79	a	1.28	Yes	a
Barium	3/3	84.1		140	D	A43	140	48.0	h	2.92	Yes	a
Cadmium	2/3	0.52	J	0.79	D	A43	0.79	0.99	a	0.80	No	b
Chromium	3/3	2.30	D	3.20		A43	3.2	43.4	a	0.07	No	b
Cobalt	3/3	10.5		14.2	D	A43	14.2	50.0	e	0.28	No	b
Copper	3/3	21.7		33.1	J	A43	33.1	31.6	a	1.05	Yes	a
Iron	3/3	19600	D	30500		A43	30500	20000	c	1.53	Yes	a
Lead	3/3	28.0	D	36.3	J	A43	36.3	35.8	a	1.01	Yes	a
Manganese	3/3	1240	J	1730	D	A43	1730	460	c	3.76	Yes	a
Mercury	2/3	0.04	J	0.22	D	A43	0.22	0.18	a	1.20	Yes	a
Molybdenum	1/2	1.02	D	1.02	D	A43	1.02	8.30	g	0.12	No	b
Nickel	3/3	5.70		6.70	D	A43	6.70	22.7	a	0.30	No	b
Selenium	2/3	0.65	J	4.80	J	A43	4.80	0.90	g	5.33	Yes	a
Silver	1/3	0.70		0.70		A43	0.70	1.00	b	0.70	No	b
Vanadium	3/3	13.3	D	19.8		A43	19.8	27.3	g	0.73	No	b
Zinc	3/3	120	J	168	D	A43	168	121	a	1.39	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.25 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)	Max. detection[b] (mg/kg)	Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	1/1	7370	7370	M08	7370	14000	f	0.53	No	b
Antimony	0/1	-	0.49 J	M08	0.49	12.0	d	0.04	No	b
Arsenic	1/1	10.0	10.0	M08	10.0	9.79	a	1.02	Yes	a
Barium	1/1	62.1	62.1	M08	62.1	48.0	h	1.29	Yes	a
Cadmium	1/1	2.30	2.30	M08	2.30	0.99	a	2.32	Yes	a
Chromium	1/1	0.87 J	0.87 J	M08	0.87	43.4	a	0.02	No	b
Cobalt	1/1	9.90	9.90	M08	9.90	50.0	e	0.20	No	b
Copper	1/1	15.7	15.7	M08	15.7	31.6	a	0.50	No	b
Iron	1/1	16200	16200	M08	16200	20000	c	0.81	No	b
Lead	1/1	329	329	M08	329	35.8	a	9.19	Yes	a
Manganese	1/1	1720	1720	M08	1720	460	c	3.74	Yes	a
Mercury	0/1	-	0.004 U	M08	0.002	0.18	a	0.01	No	b
Molybdenum	0/1	-	0.05 U	M08	0.03	8.30	g	0.003	No	b
Nickel	1/1	2.70	2.70	M08	2.70	22.7	a	0.12	No	b
Selenium	1/1	1.20 J	1.20 J	M08	1.20	0.90	g	1.33	Yes	a
Silver	0/1	-	0.03 U	M08	0.02	1.00	b	0.02	No	b
Vanadium	1/1	7.20	7.20	M08	7.20	27.3	g	0.26	No	b
Zinc	1/1	431	431	M08	431	121	a	3.56	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

U = Analyte was analyzed but not detected; minimum detection limit reported

J = Estimated result

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.26 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in Picayne Gulch Reference Exposure Unit Monitoring Site A26.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	3/3	8970	D	13200		A26	13200	14000	f	0.94	No	b
Antimony	2/3	0.54	JD	0.87	J	A26	0.87	12.0	d	0.07	No	b
Arsenic	3/3	33.2	J	65.7	D	A26	65.7	9.79	a	6.71	Yes	a
Barium	3/3	96.6	J	122	D	A26	122	48.0	h	2.54	Yes	a
Cadmium	3/3	1.40	J	1.67	D	A26	1.67	0.99	a	1.69	Yes	a
Chromium	3/3	4.00	J	5.16	D	A26	5.16	43.4	a	0.12	No	b
Cobalt	3/3	12.1	J	14.6	D	A26	14.6	50.0	e	0.29	No	b
Copper	3/3	31.5	J	40.4	D	A26	40.4	31.6	a	1.28	Yes	a
Iron	3/3	25100	J	33200		A26	33200	20000	c	1.66	Yes	a
Lead	3/3	55.0	J	134		A26	134	35.8	a	3.74	Yes	a
Manganese	3/3	4620	D	5460	J	A26	5460	460	c	11.9	Yes	a
Mercury	1/3	0.01	JD	0.01	JD	A26	0.01	0.18	a	0.07	No	b
Molybdenum	1/2	1.92	D	1.92	D	A26	1.92	8.30	g	0.23	No	b
Nickel	3/3	8.10	J	9.92	D	A26	9.92	22.7	a	0.44	No	b
Selenium	1/3	1.70	J	1.70	J	A26	1.70	0.90	g	1.89	Yes	a
Silver	3/3	0.80	J	1.36	D	A26	1.36	1.00	b	1.36	Yes	a
Vanadium	3/3	18.2	J	26.0		A26	26.0	27.3	g	0.95	No	b
Zinc	3/3	309	J	421	D	A26	421	121	a	3.48	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

d. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ORNL Laboratory. ES/ER/TM-95/R4.

e. U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003, available at http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

f. Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, J.F. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius . J. Great Lakes Res. 22(3):602-623.

g. Thompson, P.A., J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monitor. Assess. 110:71-85

h. Los Alamos National Laboratory (LANL). ECORISK Database. Available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Table A10.27 Selection of Sediment COPECs for Community-level Benthic Macroinvertebrate Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05.

Contaminant of interest	FOD	Min. detection[a] (mg/kg)		Max. detection[b] (mg/kg)		Location of max	Concentration screening value[c]	No-effect ESV (mg/kg)	ESV source	HQ[d]	COPEC?	Reason code
Aluminum	4/4	4780	J	13100		A05	13100	14000	f	0.94	No	b
Antimony	4/4	0.64	JD	1.50	J	A05	1.50	12.0	d	0.13	No	b
Arsenic	4/4	47.1	D	74.6		A05	74.6	9.79	a	7.62	Yes	a
Barium	3/3	40.2	J	85.4		A05	85.4	48.0	h	1.78	Yes	a
Cadmium	4/4	7.10	J	11.0	D	A05	11.0	0.99	a	11.1	Yes	a
Chromium	4/4	2.20	J	3.39	D	A05	3.39	43.4	a	0.08	No	b
Cobalt	3/3	8.20		9.07	D	A05	9.07	50.0	e	0.18	No	b
Copper	4/4	28.5	J	44.3		A05	44.3	31.6	a	1.40	Yes	a
Iron	4/4	12900	J	24900		A05	24900	20000	c	1.25	Yes	a
Lead	4/4	120	J	290		A05	290	35.8	a	8.10	Yes	a
Manganese	4/4	1660	J	2920		A05	2920	460	c	6.35	Yes	a
Mercury	4/4	0.02	D	0.05	J-	A05	0.05	0.18	a	0.26	No	b
Molybdenum	2/2	6.50		6.88	D	A05	6.88	8.30	g	0.83	No	b
Nickel	4/4	4.10	J	4.92	D	A05	4.92	22.7	a	0.22	No	b
Selenium	1/4	1.70	J	1.70	J	A05	1.70	0.90	g	1.89	Yes	a
Silver	4/4	0.90	JD	2.02	D	A05	2.02	1.00	b	2.02	Yes	a
Vanadium	3/3	11.1		11.4	D	A05	11.4	27.3	g	0.42	No	b
Zinc	4/4	495	J	1180		A05	1180	121	a	9.75	Yes	a

mg/kg = milligram per kilogram dry-weight

COPEC = Contaminants of Potential Ecological Concern

FOD = Frequency of Detection

ESV = Ecological Screening Value

HQ = Hazard Quotient

Data Qualifier Definitions:

D = Sample diluted prior to chemical analysis; actual result reported

J = Estimated result

J- = Estimated result; result may be biased low

JD = Estimated result from a diluted sample

[a] These values represent the minimum detected concentrations

[b] These values represent the maximum detected concentrations. When not detected, reported values represent the Minimum Detection Limit

[c] When the maximum concentration is a Minimum Detection Limit value, then the reported values represents half of the Minimum Detection Limit

[d] The HQ is calculated by dividing a screening concentration by its ESV.

Reason codes:

a = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water ESV; HQ>1.00

b = The maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water ESV; HQ<1.00

ESV sources:

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

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Appendix 11

Surface Water Aquatic Community-level Receptor Exposure Point Concentration Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

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Table A11.1 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Pre-runoff Period							
pH	8/8	5.42	4.97	6.27	95% Student's-t	4.97	5.42
Aluminum	8/8	3516	5950	4627	95% Student's-t	4627	3516
Cadmium	8/8	1.05	2.00	1.46	95% Adjusted Gamma	1.60	1.05
Iron	8/8	4806	6830	5880	95% Student's-t	5880	4806
Mercury (TRM)	0/1	0.04	0.04	NA	NA	0.04	0.04
Mercury (DM)	0/1	0.04	0.04	NA	NA	0.04	0.04
Zinc	8/8	280	499	351	95% Student's-t	351	280
Runoff Period							
pH	15/15	7.06	6.49	7.41	95% Student's-t	6.49	7.06
Aluminum	13/13	1466	2800	2030	95% Adjusted Gamma	2030	1466
Cadmium	10/12	0.31	0.67	0.39	95% Student's-t	0.39	0.31
Iron	13/13	2887	6330	3822	95% Student's-t	3822	2887
Mercury (TRM)	1/1	0.01	0.01	NA	NA	0.01	0.01
Mercury (DM)	1/1	0.001	0.001	NA	NA	0.001	0.001
Zinc	11/13	60.7	184	95.5	95% Student's-t	95.5	60.7
Post-runoff Period							
pH	21/21	5.42	5.62	6.73	95% Student's-t	5.62	5.42
Aluminum	15/15	2330	3670	2743	95% Student's-t	2743	2330
Cadmium	16/16	0.59	0.91	0.67	95% Student's-t	0.67	0.59
Iron	15/15	3222	4870	3814	95% Student's-t	3814	3222
Mercury (TRM)	1/2	0.02	0.04	NA	NA	0.04	0.02
Mercury (DM)	0/2	0.02	0.04	NA	NA	0.04	0.02
Zinc	15/15	147	224	166	95% Student's-t	166	147

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.2 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Pre-runoff Period							
pH	3/3	4.66	4.36	5.47	95% Student's-t	4.36	4.66
Aluminum	3/3	4017	6570	7802	95% Student's-t	6570	4017
Cadmium	3/3	1.25	1.42	1.55	95% Student's-t	1.55	1.25
Copper	3/3	15.0	17.4	21.5	95% Student's-t	17.4	15.0
Iron	3/3	5613	8810	10312	95% Student's-t	8810	5613
Lead	3/3	6.65	8.62	11.1	95% Student's-t	8.6	6.65
Zinc	3/3	327	360	401	95% Student's-t	401	327
Runoff Period							
pH	5/5	5.40	4.65	7.65	95% Student's-t	4.65	5.40
Aluminum	6/6	1967	4570	3058	95% Student's-t	3058	1967
Cadmium	6/6	0.66	1.46	0.99	95% Student's-t	0.99	0.66
Copper	6/6	6.96	14.7	10.1	95% Student's-t	10.1	6.96
Iron	6/6	4038	6760	5702	95% Student's-t	5702	4038
Lead	6/6	1.93	4.55	3.10	95% Student's-t	3.10	1.93
Zinc	6/6	155	351	332	95% Student's-t	332	155
Post-runoff Period							
pH	4/4	4.73	4.41	5.25	95% Student's-t	4.41	4.73
Aluminum	4/4	5373	6830	7170	95% Student's-t	6830	5373
Cadmium	4/4	1.13	1.26	1.26	95% Student's-t	1.26	1.13
Copper	4/4	11.7	14.5	14.5	95% Student's-t	14.5	11.7
Iron	4/4	6903	9200	9427	95% Student's-t	9427	6903
Lead	4/4	3.24	5.17	5.01	95% Student's-t	5.01	3.24
Zinc	4/4	245	285	290	95% Student's-t	290	245

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.3 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Runoff Period							
pH	5/5	7.02	6.73	7.39	95% Student's-t	6.73	7.02
Aluminum	5/5	619	1700	1206	95% Student's-t	1696	580
Cadmium	5/5	0.49	0.62	0.57	95% Student's-t	0.55	0.47
Copper	5/5	9.81	14.1	12.4	95% Student's-t	12.0	9.94
Iron	5/5	1112	3530	NA	NA	3216	1032
Lead	5/5	4.63	5.99	5.76	95% Student's-t	5.75	4.80
Zinc	5/5	130	195	199	95% Student's-t	156	128
Post-runoff Period							
pH	4/4	6.53	6.05	7.34	95% Student's-t	6.05	6.53
Aluminum	4/4	715	1560	1539	95% Student's-t	1539	715
Cadmium	4/4	0.92	1.06	1.13	95% Student's-t	1.06	0.92
Copper	4/4	7.48	11.7	10.9	95% Student's-t	10.9	7.48
Iron	4/4	404	782	794	95% Student's-t	782	404
Lead	4/4	4.28	11.6	10.5	95% Student's-t	10.5	4.28
Zinc	4/4	282	375	374	95% Student's-t	374	282

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.4 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-04; Mineral Creek upstream of Mill Creek Monitoring Site M10A. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Runoff Period							
Aluminum	2/2	282	315	NA	NA	315	282
Beryllium	0/2	1.00	1.00	NA	NA	1.00	1.00
Cadmium	2/2	0.73	0.89	NA	NA	0.89	0.73
Copper	2/2	15.5	20.7	NA	NA	20.7	15.5
Lead	2/2	8.79	9.83	NA	NA	9.83	8.79
Zinc	2/2	214	270	NA	NA	270	214
Post-runoff Period							
Aluminum	2/2	165	172	NA	NA	172	165
Beryllium	0/2	1.00	1.00	NA	NA	1.00	1.00
Cadmium	2/2	1.97	2.53	NA	NA	2.53	1.97
Copper	2/2	13.7	16.3	NA	NA	16.3	13.7
Lead	2/2	27.4	43.9	NA	NA	43.9	27.4
Zinc	2/2	731	987	NA	NA	987	731

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.5 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Runoff Period							
Aluminum	2/2	505	546	581	95% Student's-t	546	505
Iron	3/3	313	364	NA	NA	394	313
Post-runoff Period							
Aluminum	2/2	613	628	NA	NA	628	613
Iron	2/2	864	1280	NA	NA	1280	864

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.6 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Runoff Period							
pH	2/2	6.08	5.89	NA	NA	5.89	6.08
Aluminum	2/2	2515	2830	NA	NA	2830	2515
Cadmium	2/2	0.24	0.27	NA	NA	0.27	0.24
Iron	2/2	6355	7670	NA	NA	7670	6355
Post-runoff Period							
pH	2/2	4.34	4.16	NA	NA	4.16	4.34
Aluminum	2/4	12800	15000	NA	NA	15000	12800
Cadmium	2/2	1.17	1.29	NA	NA	1.29	1
Iron	2/2	18750	20300	NA	NA	20300	18750

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.7 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Pre-runoff Period							
Aluminum	39/39	111	545	189	95% Chebyshev (Mean, Sd)	189	111
Cadmium	39/39	0.79	2.67	0.92	95% Student's-t	0.92	0.79
Copper	39/39	3.36	8.31	4.76	95% Chebyshev (Mean, Sd)	4.76	3.36
Iron	37/39	209	688	301	95% Chebyshev (Mean, Sd)	301	209
Zinc	39/39	314	482	329	95% Student's-t	329	314
Runoff Period							
Aluminum	18/18	337	955	476	95% Adjusted Gamma	476	337
Cadmium	18/18	0.89	1.14	0.94	95% Student's-t	0.94	0.89
Copper	18/18	7.68	15.2	8.97	95% Student's-t	8.97	7.68
Iron	17/18	327	1100	475	95% Adjusted Gamma	475	327
Zinc	18/18	306	409	322	95% Student's-t	322	306
Post-runoff Period							
Aluminum	10/11	92.2	208	158	95% Adjusted Gamma	158	92
Cadmium	11/11	0.59	0.88	0.68	95% Student's-t	0.68	0.59
Copper	11/11	1.89	2.59	2.18	95% Student's-t	2.18	1.89
Iron	3/11	103	250	203	95% Chebyshev (Mean, Sd)	203	103
Zinc	11/11	230	315	251	95% Student's-t	251	230

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.8 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Runoff Period							
Aluminum	3/3	141	217	287	95% Student's-t	217	141
Post-runoff Period							
Aluminum	2/3	26.6	38.6	51.6	95% Student's-t	38.6	26.5

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.9 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Pre-runoff Period							
pH	2/2	7.11	7.11	NA	NA	7.11	7.11
Aluminum	2/2	106	150	NA	NA	150	106
Cadmium	2/2	0.71	0.97	NA	NA	0.97	0.71
Copper	2/2	4.78	7.88	NA	NA	7.88	4.78
Zinc	2/2	333	401	NA	NA	401	333
Runoff Period							
pH	8/8	7.15	6.77	7.52	95% Student's-t	6.77	7.15
Aluminum	8/8	357	619	451	95% Student's-t	451	357
Cadmium	8/8	1.06	1.65	1.24	95% Student's-t	1.24	1.06
Copper	8/8	9.24	28.0	16.5	95% H-UCL	16.5	9.24
Zinc	8/8	341	517	396	95% Student's-t	396	341
Post-runoff Period							
pH	6/6	6.43	5.78	7.33	95% Student's-t	5.78	6.43
Aluminum	6/7	227	424	340	95% Student's-t	340	227
Cadmium	7/7	1.17	2.07	1.57	95% Student's-t	1.57	1.17
Copper	7/7	3.42	6.51	4.77	95% Student's-t	4.77	3.42
Zinc	7/7	367	553	451	95% Student's-t	451	367

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.10 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Pre-runoff Period							
Aluminum	2/2	505	834	NA	NA	834	505
Cadmium	2/2	1.76	2.70	NA	NA	2.70	1.76
Copper	2/2	12.0	17.9	NA	NA	17.9	12.0
Lead	0/2	0.05	0.05	NA	NA	0.05	0.05
Manganese	2/2	353	573	NA	NA	573	353
Zinc	2/2	573	828	NA	NA	828	573
Runoff Period							
Aluminum	9/9	506	905	618	95% Student's-t	618	506
Cadmium	9/9	1.59	1.95	1.70	95% Student's-t	1.70	1.59
Copper	9/9	14.2	33.5	24.4	95% Adjusted Gamma	24.4	14.2
Lead	9/9	1.01	1.63	1.26	95% Student's-t	1.26	1.01
Manganese	9/9	516	722	586	95% Student's-t	586	516
Zinc	9/9	471	552	510	95% Student's-t	510	471
Post-runoff Period							
Aluminum	6/7	467	916	703	95% Adjusted Gamma	703	467
Cadmium	7/7	2.01	2.47	2.30	95% Student's-t	2.30	2.01
Copper	7/7	5.74	7.67	7.00	95% Student's-t	7.00	5.74
Lead	5/7	0.18	0.61	0.55	95% Adjusted Gamma	0.55	0.18
Manganese	7/7	1382	1990	1646	95% Student's-t	1646	1382
Zinc	7/7	595	693	671	95% Student's-t	671	595

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.11 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Runoff Period							
Aluminum	2/2	212	213	NA	NA	213	212
Post-runoff Period							
Aluminum	4/4	511	821	872	95% Student's-t	821	511

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.12 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Runoff Period							
Aluminum	2/2	254	262	NA	NA	262	254
Cadmium	2/2	2.40	2.53	NA	NA	2.53	2.40
Copper	2/2	12.6	14.1	NA	NA	14.1	12.6
Zinc	2/2	837	880	NA	NA	880	837
Post-runoff Period							
Aluminum	3/4	54.8	83.6	92.9	95% Student's-t	83.6	54.8
Cadmium	4/4	0.50	0.75	0.75	95% Student's-t	0.75	0.50
Copper	4/4	3.82	6.01	6.26	95% Student's-t	6.01	3.82
Zinc	4/4	209	263	275	95% Student's-t	263	209

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.13 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Pre-runoff Period							
Aluminum	1/1	945	945	NA	NA	946	946
Cadmium	1/1	3.37	3.37	NA	NA	3.37	3.37
Copper	1/1	21.7	21.7	NA	NA	21.9	21.9
Iron	1/1	555	555	NA	NA	573	573
Lead	0/1	0.05	0.05	NA	NA	0.05	0.05
Zinc	1/1	950	950	NA	NA	950	950
Runoff Period							
Aluminum	5/5	519	1170	902	95% Student's-t	902	519
Cadmium	5/5	1.22	1.62	1.47	95% Student's-t	1.47	1.22
Copper	5/5	9.45	12.5	11.9	95% Student's-t	11.9	9.45
Iron	5/5	581	1180	992	95% Student's-t	992	581
Lead	5/5	1.18	3.87	8.58	95% Adjusted Gamma	3.87	1.18
Zinc	5/5	410	468	461	95% Student's-t	461	410
Post-runoff Period							
Aluminum	3/4	161	266	294	95% Student's-t	266	161
Cadmium	3/4	0.64	0.99	1.16	95% Student's-t	0.99	0.64
Copper	4/4	5.46	6.79	6.53	95% Student's-t	7.13	5.46
Iron	3/4	99.2	134	142	95% Student's-t	134	99.2
Lead	0/4	0.04	0.05	0.06	95% Student's-t	0.05	0.04
Zinc	4/4	252	307	321	95% Student's-t	307	252

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.14 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Pre-runoff Period							
pH	1/1	7.21	7.21	NA	NA	7.21	7.21
Aluminum	1/1	654	654	NA	NA	654	654
Beryllium	0/1	1.00	1.00	NA	NA	1.00	1.00
Cadmium	1/1	2.16	2.16	NA	NA	2.16	2.16
Copper	1/1	18.1	18.1	NA	NA	18.1	18.1
Lead	1/1	0.17	0.17	NA	NA	0.17	0.17
Manganese	1/1	593	593	NA	NA	593	593
Zinc	1/1	753	753	NA	NA	753	753
Runoff Period							
pH	7/7	6.75	6.34	7.36	95% Student's-t	6.34	6.75
Aluminum	7/7	957	1490	1249	95% Student's-t	1249	957
Beryllium	0/7	1.00	1.00	NA	NA	1.00	1.00
Cadmium	7/7	2.24	2.95	2.68	95% Student's-t	2.68	2.24
Copper	7/7	15.0	42.2	33.5	95% Adjusted Gamma	33.5	15.0
Lead	7/7	1.52	3.05	2.14	95% Student's-t	2.14	1.52
Manganese	7/7	1149	2310	1657	95% Student's-t	1657	1149
Zinc	7/7	601	850	742	95% Student's-t	742	601
Post-runoff Period							
pH	7/7	4.31	3.48	7.23	95% Student's-t	3.48	4.31
Aluminum	6/7	2505	5100	4205	95% Student's-t	4205	2505
Beryllium	4/7	3.21	6.55	7.73	95% Chebyshev (Mean, Sd	6.55	3.21
Cadmium	7/7	5.86	10.7	8.57	95% Student's-t	10.4	5.43
Copper	7/7	16.7	32.7	25.7	95% Student's-t	25.7	16.7
Lead	6/7	3.48	11.3	27.0	95% Adjusted Gamma	11.3	3.48
Manganese	7/7	6399	13600	21137	95% H-UCL	13600	6399
Zinc	7/7	1830	3800	2803	95% Adjusted Gamma	2803	1830

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.15 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-15; Upper West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Runoff Period							
pH	2/2	6.19	6.18	NA	NA	6.18	6.19
Aluminum	3/3	1250	1480	1665	95% Student's-t	1480	1250
Beryllium	0/3	1.00	1.00	NA	NA	1.00	1.00
Cadmium	3/3	2.77	3.02	3.15	95% Student's-t	3.02	2.77
Copper	3/3	14.1	16.2	17.2	95% Student's-t	16.2	14.1
Lead	3/3	3.05	3.67	3.97	95% Student's-t	3.97	3.05
Manganese	3/3	2557	3100	3422	95% Student's-t	3100	2557
Zinc	3/3	910	969	1033	95% Student's-t	1033	910
Post-runoff Period							
pH	3/3	5.37	5.13	5.96	95% Student's-t	5.13	5.37
Aluminum	3/3	6937	9050	8566	95% Student's-t	8566	6575
Beryllium	3/3	9.24	10.7	11.4	95% Student's-t	10.7	9.24
Cadmium	3/3	9.50	11.6	13.0	95% Student's-t	11.6	9.50
Copper	3/3	30.0	39.4	43.7	95% Student's-t	39.4	30.0
Lead	3/3	5.86	7.22	8.32	95% Student's-t	7.22	5.86
Manganese	3/3	15500	18000	19989	95% Student's-t	18000	15500
Zinc	3/3	3473	4560	5139	95% Student's-t	4560	3473

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.16 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Runoff Period							
pH	1/1	6.95	6.95	NA	NA	6.95	6.95
Aluminum	2/2	690	873	NA	NA	873	690
Cadmium	2/2	2.32	2.81	NA	NA	2.81	2.32
Copper	2/2	18.5	19.3	NA	NA	19.3	18.5
Lead	2/2	3.27	3.98	NA	NA	3.98	3.27
Manganese	2/2	1582	2320	NA	NA	2320	1582
Zinc	2/2	915	1110	NA	NA	1110	915
Post-runoff Period							
pH	4/4	6.04	5.87	6.32	95% Student's-t	5.87	6.04
Aluminum	4/4	921	1240	1202	95% Student's-t	1202	921
Cadmium	4/4	3.08	3.66	3.65	95% Student's-t	3.65	3.08
Copper	4/4	16.6	19.5	22.1	95% Student's-t	19.5	16.6
Lead	4/4	11.6	20.3	21.2	95% Student's-t	20.3	11.6
Manganese	4/4	1328	2240	2055	95% Student's-t	2055	1328
Zinc	4/4	1380	1710	1726	95% Student's-t	1710	1380

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.17 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-17; Mainstem West Fork Animas River to Confluence with Animas River in Animas Forks Monitoring Site A15. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Runoff Period							
pH	2/2	5.53	5.33	NA	NA	5.33	5.53
Aluminum	2/2	3070	3140	NA	NA	3140	3070
Beryllium	2/2	3.53	4.36	NA	NA	4.36	3.53
Cadmium	2/2	3.71	3.86	NA	NA	3.86	3.71
Copper	2/2	9.80	10.0	NA	NA	10.0	9.80
Lead	2/2	1.56	1.82	NA	NA	1.82	1.56
Manganese	2/2	5805	6980	NA	NA	6980	5805
Zinc	2/2	1230	1260	NA	NA	1260	1230
Post-runoff Period							
pH	4/4	5.29	5.17	5.50	95% Student's-t	5.17	5.29
Aluminum	4/4	9900	13100	15021	95% Student's-t	13100	9900
Beryllium	4/4	14.1	17.4	27.1	95% Chebyshev (Mean, Sd)	17.4	14.1
Cadmium	4/4	11.5	15.5	16.8	95% Student's-t	15.5	11.5
Copper	4/4	25.8	36.4	36.2	95% Student's-t	36.2	25.8
Lead	4/4	0.91	1.69	1.58	95% Student's-t	1.58	0.91
Manganese	4/4	22820	29700	34098	95% Student's-t	29700	22820
Zinc	4/4	3605	5100	5373	95% Student's-t	5100	3605

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.18 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-18; North Fork Animas River - Burrows Gulch to Animas Forks Monitoring Sites A08 and A09. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Runoff Period							
pH	4/4	5.38	4.80	7.60	95% Student's-t	4.80	5.38
Aluminum	5/5	1106	1470	1338	95% Student's-t	1338	1106
Beryllium	0/5	1.00	1.00	NA	NA	1.00	1.00
Cadmium	5/5	2.94	3.49	3.30	95% Student's-t	3.30	2.94
Copper	5/5	6.52	7.23	7.25	95% Student's-t	7.23	6.52
Lead	5/5	1.59	2.71	2.30	95% Student's-t	2.30	1.59
Manganese	5/5	440	544	524	95% Student's-t	524	440
Zinc	5/5	523	597	586	95% Student's-t	586	523
Post-runoff Period							
pH	7/7	5.02	4.74	5.28	95% Student's-t	4.74	5.02
Aluminum	7/7	3514	5230	4529	95% Student's-t	4529	3514
Beryllium	0/7	1.00	1.00	NA	NA	1.00	1.00
Cadmium	7/7	6.85	7.80	7.77	95% Student's-t	7.77	6.85
Copper	7/7	18.6	23.7	21.5	95% Student's-t	21.5	18.6
Lead	7/7	7.33	22.4	12.8	95% Student's-t	12.8	7.33
Manganese	7/7	1505	2060	1862	95% Student's-t	1862	1505
Zinc	7/7	1144	1380	1331	95% Student's-t	1331	1144

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.19 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Runoff Period							
pH	1/1	5.85	5.85	NA	NA	5.85	5.85
Aluminum	1/1	3470	3470	NA	NA	3470	3470
Beryllium	0/1	1.00	1.00	NA	NA	1.00	1.00
Cadmium	1/1	6.78	6.78	NA	NA	6.78	6.78
Copper	1/1	23.6	23.6	NA	NA	23.6	23.6
Lead	1/1	5.27	5.27	NA	NA	5.27	5.27
Manganese	1/1	1460	1460	NA	NA	1460	1460
Zinc	1/1	1200	1200	NA	NA	1200	1200
Post-runoff Period							
pH	4/4	4.57	4.37	4.81	95% Student's-t	4.37	4.57
Aluminum	4/4	9600	11900	13709	95% Student's-t	11900	9600
Beryllium	3/4	3.68	4.01	4.75	95% Student's-t	4.01	3.68
Cadmium	4/4	16.2	19.6	21.6	95% Student's-t	19.6	16.2
Copper	4/4	56.4	69.9	69.4	95% Student's-t	69.4	56.4
Lead	4/4	7.20	10.8	10.1	95% Student's-t	10.1	7.20
Manganese	4/4	4490	5980	6404	95% Student's-t	5980	4490
Zinc	4/4	2610	3240	3643	95% Student's-t	3240	2610

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.20 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-DR01; Upper Animas River Durango Reach. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Pre-runoff Period							
Aluminum	3/3	890	1700	2088	95% Student's-t	2088	890
Iron	3/3	1487	2900	NA	NA	2900	1487
Mercury (TRM)	0/3	0.04	0.04	NA	NA	0.04	0.04
Mercruy (DM)	0/3	0.04	0.04	NA	NA	0.04	0.04
Runoff Period							
Aluminum	2/2	2700	2800	NA	NA	2800	2700
Iron	2/2	4650	4700	NA	NA	4700	4650
Mercury (TRM)	2/2	0.01	0.01	NA	NA	0.01	0.01
Mercruy (DM)	2/2	0.001	0.001	NA	NA	0.001	0.001
Post-runoff Period							
Aluminum	7/7	279	429	378	95% Student's-t	378	279
Iron	7/7	370	550	474	95% Student's-t	474	370
Mercury (TRM)	4/7	0.02	0.04	0.02	95% Hall's Bootstrap	0.02	0.02
Mercruy (DM)	0/7	0.02	0.04	NA	NA	0.04	0.02

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.21 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in EU-DR02; Lower Animas River Durango Reach. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[c]	CTE
Pre-runoff Period							
pH	6/6	7.34	6.67	8.21	95% Student's-t	6.67	7.34
Aluminum	6/6	435	540	486	95% Student's-t	486	435
Cadmium	5/6	0.13	0.20	0.19	95% Student's-t	0.19	0.13
Iron	6/6	654	910	765	95% Student's-t	765	654
Mercury (TRM)	0/3	0.04	0.04	NA	NA	0.04	0.04
Mercruy (DM)	0/3	0.04	0.04	NA	NA	0.04	0.04
Runoff Period							
pH	8/8	6.79	6.00	7.69	95% Student's-t	6.00	6.79
Aluminum	7/7	1473	4100	3798	95% Adjusted Gamma	3798	1473
Cadmium	7/7	0.13	0.21	0.17	95% Student's-t	0.17	0.13
Iron	7/7	2525	7600	6923	95% Adjusted Gamma	6923	2525
Mercury (TRM)	2/2	0.01	0.02	NA	NA	0.02	0.01
Mercruy (DM)	2/2	0.001	0.002	NA	NA	0.002	0.001
Post-runoff Period							
pH	15/15	7.54	6.63	8.23	95% Student's-t	6.63	7.54
Aluminum	12/12	478	2700	1374	95% Chebyshev	1374	478
Cadmium	8/12	0.20	1.00	0.43	95% Adjusted Gamma	0.43	0.20
Iron	12/12	509	1800	1048	95% Chebyshev	1048	509
Mercury (TRM)	8/13	0.02	0.04	NA	NA	0.04	0.02
Mercruy (DM)	4/13	0.02	0.04	NA	NA	0.04	0.02

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured during each hydroperiod

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.22 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors Maggie Gulch Reference Exposure Unit Monitoring Site A43. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Runoff Period							
Aluminum	2/2	300	372	NA	NA	372	300
Post-runoff Period							
Aluminum	1/2	41.8	73.5	NA	NA	73.5	41.8

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.23 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Runoff Period							
Aluminum	1/1	117	117	NA	NA	117	117
Beryllium	0/1	1.00	1.00	NA	NA	1.00	1.00
Lead	1/1	0.83	0.83	NA	NA	0.83	0.83
Post-runoff Period							
Aluminum	1/1	265	265	NA	NA	265	265
Beryllium	0/1	1.00	1.00	NA	NA	1.00	1.00
Lead	1/1	0.25	0.25	NA	NA	0.25	0.25

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.24 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in Picayne Gulch Reference Exposure Unit Monitoring Site A26. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Runoff Period							
Aluminum	1/2	200	200	NA	NA	200	200
Post-runoff Period							
Aluminum	1/2	46.0	81.9	NA	NA	81.9	46.0

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A11.25 Surface Water Exposure Point Concentrations (EPCs) for Aquatic Community-level Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05. All concentrations in µg/L.

COPEC	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Surface water EPCs	
						RME[a]	CTE
Runoff Period							
Aluminum	3/3	415	767	936	95% Student's-t	767	415
Beryllium	0/3	1.00	1.00	NA	NA	1.00	1.00
Cadmium	3/3	1.56	1.84	1.98	95% Student's-t	1.84	1.56
Lead	3/3	0.62	0.75	0.82	95% Student's-t	0.75	0.62
Zinc	3/3	231	268	286	95% Student's-t	268	231
Post-runoff Period							
Aluminum	3/4	40.1	76.7	73.5	95% Student's-t	73.5	40.1
Beryllium	0/4	1.00	1.00	NA	NA	1.00	1.00
Cadmium	4/4	0.66	0.82	0.92	95% Student's-t	0.82	0.66
Lead	1/4	0.09	0.17	0.21	95% Student's-t	0.17	0.09
Zinc	4/4	116	142	158	95% Student's-t	142	116

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Appendix 12

Pore water Aquatic Community-level Receptor Exposure Point Concentration Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 12 Tables:

Table A12.1 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A. All concentrations in µg/L.

Table A12.2 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A. All concentrations in µg/L.

Table A12.3 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11. All concentrations in µg/L.

Table A12.4 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A. All concentrations in µg/L.

Table A12.5 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28. All concentrations in µg/L.

Table A12.6 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20. All concentrations in µg/L.

Table A12.7 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55. All concentrations in µg/L.

Table A12.8 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48. All concentrations in µg/L.

Table A12.9 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-09; Animas River from

Howardsville to Minnie Gulch Monitoring Sites A45 and A41A. All concentrations in µg/L.

Table A12.10 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35. All concentrations in µg/L.

Table A12.11 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36. All concentrations in µg/L.

Table A12.12 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37. All concentrations in µg/L.

Table A12.13 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34. All concentrations in µg/L.

Table A12.14 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14. All concentrations in µg/L.

Table A12.15 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10. All concentrations in µg/L.

Table A12.16 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20. All concentrations in µg/L.

Table A12.17 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15. All concentrations in µg/L.

Table A12.18 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-18; North Fork Animas River - Burrows Gulch to Animas Forks Monitoring Site A08 and A09. All concentrations in µg/L.

Table A12.19 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07. All concentrations in µg/L.

Table A12.20 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-DR01; James Ranch to 32nd Street Bridge. All concentrations in µg/L.

Table A12.21 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs. All concentrations in µg/L.

Table A12.22 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in Bear Creek Reference Exposure Unit Monitoring Site M30. All concentrations in µg/L.

Table A12.23 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08. All concentrations in µg/L.

Table A12.24 Pore water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05. All concentrations in µg/L.

Table A12.1 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A.
All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	1/1	5.82	5.82	NA	NA	5.82	5.82
Aluminum (TRM)	2/2	2525	3590	NA	NA	3590	2525
Cadmium (DM)	2/3	0.40	1.01	1.30	95% Student's-t	1.01	0.40
Iron (TRM)	2/2	6010	8070	NA	NA	8070	6010

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.2 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	2/2	4.05	3.76	NA	NA	3.76	4.05
Aluminum (TRM)	2/2	8037	15100	NA	NA	15100	8037
Cadmium (DM)	1/2	0.38	0.72	NA	NA	0.72	0.38
Copper (DM)	2/2	8.14	15.7	NA	NA	15.7	8.14
Iron (TRM)	2/2	39880	72000	NA	NA	72000	39880
Lead (DM)	1/2	42.8	85.6	NA	NA	85.6	42.8
Zinc (DM)	2/2	150	285	NA	NA	285	150

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.3 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	2/2	6.06	5.78	NA	NA	5.78	6.06
Aluminum (TRM)	2/2	5526	10600	NA	NA	10600	5526
Cadmium (DM)	2/2	0.94	1.06	NA	NA	1.06	0.94
Iron (TRM)	2/2	8477	16000	NA	NA	16000	8477
Zinc (DM)	2/2	347	376	NA	NA	376	347

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.4 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL[a]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[a]	CTE
Cadmium (DM)	1/1	1.65	1.65	NA	NA	1.65	1.65
Copper (DM)	1/1	10.0	9.99	NA	NA	9.99	10.0
Zinc (DM)	1/1	589	589	NA	NA	589	589

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.5 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs RME[c]	Pore water EPCs CTE
pH	1/1	4.01	4.01	NA	NA	4.01	4.01
Aluminum (TRM)	1/1	7950	7950	NA	NA	7950	7950
Cadmium (DM)	1/1	1.35	1.35	NA	NA	1.35	1.35
Iron (TRM)	1/1	27700	27700	NA	NA	27700	27700

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.6 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	1/1	3.94	3.94	NA	NA	3.94	3.94
Aluminum (TRM)	1/1	11700	11700	NA	NA	11700	11700
Cadmium (DM)	1/1	1.20	1.20	NA	NA	1.20	1.20
Iron (TRM)	1/1	35700	35700	NA	NA	35700	35700

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.7 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[a]	CTE
Aluminum (TRM)	3/3	1083	2050	2623	95% Student's-t	2050	1083
Cadmium (DM)	9/9	0.73	1.47	1.05	95% Student's-t	1.05	0.73
Copper (DM)	9/9	14.9	59.4	88.2	99% Chebyshev	59.4	14.9
Iron (TRM)	3/3	1366	2540	3292	95% Student's-t	2540	1366
Lead (DM)	5/9	4.89	33.3	32.9	95% Adjusted Gamm	32.9	4.89
Manganese (DM)	8/9	2494	13300	22030	95% Adjusted Gamm	13300	2494
Zinc (DM)	9/9	204	597	423	95% Adjusted Gamm	423	204

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.8 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-08; Cunningham Creek Monitoring Site A48. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[a]	CTE
Aluminum (TRM)	1/1	3850	3850	NA	NA	3850	3850
Iron (TRM)	1/1	4960	4960	NA	NA	4960	4960

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.9 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[a]	CTE
Aluminum (TRM)	3/3	1027	2260	2831	95% Student's-t	2260	1027
Cadmium (DM)	2/3	0.43	0.66	1.03	95% Student's-t	0.66	0.43
Iron (TRM)	3/3	1587	4120	5299	95% Student's-t	4120	1587
Zinc (DM)	3/3	296	476	563	95% Student's-t	476	296

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.10 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	2/2	6.35	6.07	NA	NA	6.07	6.35
Aluminum (TRM)	2/2	677	886	NA	NA	886	677
Cadmium (DM)	2/2	2.30	2.50	NA	NA	2.50	2.30
Manganese (DM)	2/2	1740	1840	NA	NA	1840	1740
Zinc (DM)	2/2	626	662	NA	NA	662	626

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.11 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[a]	CTE
Aluminum (TRM)	1/1	585	585	NA	NA	585	585
Iron (TRM)	1/1	1630	1630	NA	NA	1630	1630

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.12 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in U-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[a]	CTE
Aluminum (TRM)	1/1	223	223	NA	NA	223	223
Zinc (DM)	1/1	200	200	NA	NA	200	200

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.13 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-13; mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	1/1	6.50	6.50	NA	NA	6.50	6.50
Aluminum (TRM)	1/1	169	169	NA	NA	169	169

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.14 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	2/2	5.40	5.13	NA	NA	5.13	5.40
Aluminum (TRM)	2/2	16805	32300	NA	NA	32300	16805
Beryllium (TRM)	1/2	13.0	24.9	NA	NA	24.9	13.0
Cadmium (DM)	2/2	5.52	7.39	NA	NA	7.39	5.52
Copper (DM)	2/2	14.2	22.3	NA	NA	22.3	14.2
Iron (TRM)	1/2	3315	6580	NA	NA	6580	3315
Lead (DM)	2/2	4.43	8.55	NA	NA	8.55	4.43
Manganese (DM)	2/2	6285	9390	NA	NA	9390	6285
Zinc (DM)	2/2	1584	2200	NA	NA	2200	1584

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.15 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	1/1	5.46	5.46	NA	NA	5.46	5.46
Aluminum (TRM)	1/1	4830	4830	NA	NA	4830	4830
Beryllium (TRM)	1/1	2.01	2.01	NA	NA	2.01	2.01
Cadmium (DM)	1/1	2.28	2.28	NA	NA	2.28	2.28
Copper (DM)	1/1	8.11	8.11	NA	NA	8.11	8.11
Iron (TRM)	1/1	5670	5670	NA	NA	5670	5670
Lead (DM)	1/1	7.46	7.46	NA	NA	7.46	7.46
Zinc (DM)	1/1	779	779	NA	NA	779	779

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.16 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	1/1	6.09	6.09	NA	NA	6.09	6.09
Aluminum (TRM)	1/1	1320	1320	NA	NA	1320	1320
Cadmium (DM)	1/1	2.54	2.54	NA	NA	2.54	2.54
Copper (DM)	1/1	8.72	8.72	NA	NA	8.72	8.72
Lead (DM)	1/1	3.56	3.56	NA	NA	3.56	3.56
Zinc (DM)	1/1	1120	1120	NA	NA	1120	1120

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.17 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-17; West Fork Animas River from Placer Gulch up to its Source Monitoring Site A15. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[a]	CTE
Aluminum (TRM)	1/1	11900	11900	NA	NA	11900	11900
Beryllium (TRM)	1/1	16.3	16.3	NA	NA	16.3	16.3
Cadmium (DM)	1/1	10.8	10.8	NA	NA	10.8	10.8
Copper (DM)	1/1	30.2	30.2	NA	NA	30.2	30.2
Iron (TRM)	1/1	1790	1790	NA	NA	1790	1790
Manganese (DM)	1/1	23000	23000	NA	NA	23000	23000
Zinc (DM)	1/1	3380	3380	NA	NA	3380	3380

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.18 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-18; North Fork Animas River - Burrows Gulch to Animas Forks Monitoring site A08 and A09. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	2/2	4.83	4.74	NA	NA	4.74	4.83
Aluminum (TRM)	2/2	6845	10500	NA	NA	10500	6845
Cadmium (DM)	2/2	8.19	9.03	NA	NA	9.03	8.19
Copper (DM)	2/2	14.6	16.8	NA	NA	16.8	14.6
Iron (TRM)	1/2	1555	3060	NA	NA	3060	1555
Lead (DM)	2/2	7.18	14.0	NA	NA	14.0	7.18
Manganese (DM)	2/2	1500	1680	NA	NA	1680	1500
Zinc (DM)	2/2	1240	1300	NA	NA	1300	1240

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.19 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-19; Burrows Gulch Monitoring Site A07. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	1/1	4.63	4.63	NA	NA	4.63	4.63
Aluminum (TRM)	1/1	14200	14200	NA	NA	14200	14200
Beryllium (TRM)	1/1	3.70	3.70	NA	NA	3.70	3.70
Cadmium (DM)	1/1	16.9	16.9	NA	NA	16.9	16.9
Copper (DM)	1/1	52.1	52.1	NA	NA	52.1	52.1
Iron (TRM)	1/1	1480	1480	NA	NA	1480	1480
Lead (DM)	1/1	5.52	5.5	NA	NA	5.52	5.52
Manganese (DM)	1/1	4720	4720	NA	NA	4720	4720
Zinc (DM)	1/1	2940	2940	NA	NA	2940	2940

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.20 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-DR01; James Ranch to 32nd Street Bridge. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[a]	CTE
Copper (DM)	2/3	6.74	18.2	23.5	95% Student's-t	18.2	6.74
Manganese (DM)	3/3	4001	9300	12060	95% Student's-t	9300	4001

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.21 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean	Max detection or 1/2 MDL	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[a]	CTE
Manganese (DM)	2/2	3318	5870	NA	NA	5870	3318

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.22 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in Bear Creek Reference Exposure Unit Monitoring Site M30. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	1/1	6.30	6.30	NA	NA	6.30	6.30
Aluminum (TRM)	1/1	641	641	NA	NA	641	641

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.23 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	1/1	6.02	6.02	NA	NA	6.02	6.02
Aluminum (TRM)	1/1	211	211	NA	NA	211	211

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Table A12.24 Pore Water Exposure Point Concentrations (EPCs) for Community-level Benthic Macroinvertebrate Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05. All concentrations in µg/L.

COPEC (fraction)	Frequency of detection	Arithmetic mean[a]	Max detection or 1/2 MDL[b]	95% UCL of mean	UCL calculation method	Pore water EPCs	
						RME[c]	CTE
pH	1/1	5.78	5.78	NA	NA	5.78	5.78
Cadmium (DM)	1/1	0.66	0.66	NA	NA	0.66	0.66
Iron (TRM)	1/1	1780	1780	NA	NA	1780	1780

µg/L = microgram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

UCL = Upper Confidence Limit

MDL = Maximum Detection Limit

NA = Not Available

RME = Reasonable Maximum Exposure; represented by the 95% UCL.

TRM = Total Recoverable Metal

DM = Dissolved Metal

a = Average pH values represent the average concentration of hydronium ions converted back to standard pH units (see text for more details)

b = pH values represent the lowest value measured

c = If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit. RME values for pH represent the lowest pH values measured.

Appendix 13

Sediment Aquatic Community-level Receptor Exposure Point Concentration and Hazard Quotient Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 13 Tables:

Table A13.1 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A.

Table A13.2 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

Table A13.3 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

Table A13.4 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

Table A13.5 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

Table A13.6 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

Table A13.7 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

Table A13.8 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48.

Table A13.9 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

Table A13.10 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

Table A13.11 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

Table A13.12 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

Table A13.13 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-13; mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

Table A13.14 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

Table A13.15 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

Table A13.16 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

Table A13.17 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

Table A13.18 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-18; North Fork Animas River - Burrows Gulch to Animas Forks Monitoring Site A08 and A09.

Table A13.19 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07.

Table A13.20 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

Table A13.21 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs.

Table A13.22 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Bear Creek Reference Exposure Unit Monitoring Site M30.

Table A13.23 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Hermosa Creek Reference Exposure Unit Monitoring Site HC01.

Table A13.24 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Maggie Gulch Reference Exposure Unit Monitoring Site A43.

Table A13.25 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08.

Table A13.26 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Picayne Gulch Reference Exposure Unit Monitoring Site A26.

Table A13.27 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05.

Table A13.1 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A.

		Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
COPEC	FOD	UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	10/10	95% Student's-t	33201	26070	14000	60000	2.37	1.86	0.55	0.43
Arsenic	10/10	95% Adjusted Gamma	49.0	34.3	9.79	33.0	5.00	3.50	1.48	1.04
Barium	8/8	95% Student's-t	150	113	48.0	NA	3.12	2.36	-	-
Cadmium	10/10	95% Student's-t	2.04	1.53	0.99	4.98	2.06	1.55	0.41	0.31
Cobalt	8/8	95% Student's-t	34.6	23.9	50.0	NA	0.69	0.48	-	-
Copper	10/10	95% Student's-t	138	115	31.6	149	4.36	3.63	0.93	0.77
Iron	10/10	95% Student's-t	85943	71060	20000	40000	4.30	3.55	2.15	1.78
Lead	10/10	95% Student's-t	277	226	35.8	128	7.75	6.30	2.17	1.76
Manganese	10/10	95% Student's-t	1552	1241	460	1100	3.37	2.70	1.41	1.13
Mercury	10/10	95% H-UCL	0.23	0.09	0.18	1.06	1.27	0.52	0.22	0.09
Molybdenum	6/6	95% Student's-t	7.78	5.54	8.30	540	0.94	0.67	0.01	0.01
Selenium	7/10	95% Chebyshev	11.3	4.11	0.9	4.70	12.6	4.57	2.40	0.88
Silver	8/10	95% Adjusted Gamma	1.96	1.06	1.00	3.70	1.96	1.06	0.53	0.29
Vanadium	8/8	95% Student's-t	34.1	24.8	27.3	77.0	1.25	0.91	0.44	0.32
Zinc	10/10	95% Student's-t	693	513	121	459	5.73	4.24	1.51	1.12

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.2 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	4/4	Max value	62.9	47.3	9.79	33.0	6.42	4.83	1.91	1.43
Barium	2/2	Max value	56.7	51.9	48.0	NA	1.18	1.08	-	-
Cadmium	4/4	95% Student's-t	1.80	1.26	0.99	4.98	1.82	1.27	0.36	0.25
Copper	4/4	Max value	84.0	76.1	31.6	149	2.66	2.41	0.56	0.51
Iron	4/4	95% Student's-t	79393	62300	20000	40000	3.97	3.12	1.98	1.56
Lead	4/4	Max value	386	333	35.8	128	10.8	9.31	3.02	2.60
Manganese	4/4	95% Student's-t	1438	988	460	1100	3.13	2.15	1.31	0.90
Selenium	2/4	Max value	1.90	1.52	0.90	4.70	2.11	1.69	0.40	0.32
Zinc	4/4	95% Student's-t	1328	722	121	459	11.0	5.97	2.89	1.57

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.3 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

		Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
COPEC	FOD	UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	4/4	Max value	55.9	48.2	9.79	33.0	5.71	4.93	1.69	1.46
Barium	2/2	Max value	63.8	54.6	48.00	NA	1.33	1.14	-	-
Cadmium	4/4	95% Student's-t	10.9	5.55	0.99	4.98	11.0	5.61	2.18	1.12
Copper	4/4	95% Student's-t	185	117	31.6	149	5.84	3.71	1.24	0.79
Iron	4/4	95% Student's-t	36732	34175	20000	40000	1.84	1.71	0.92	0.85
Lead	4/4	95% Student's-t	778	456	35.8	128	21.7	12.7	6.08	3.56
Manganese	4/4	95% Student's-t	2285	1713	460	1100	4.97	3.72	2.08	1.56
Mercury	4/4	95% Student's-t	0.28	0.13	0.18	1.06	1.57	0.71	0.27	0.12
Selenium	3/4	Max value	1.40	0.96	0.90	4.70	1.56	1.06	0.30	0.20
Silver	4/4	Max value	1.34	0.96	1.00	3.70	1.34	0.96	0.36	0.26
Zinc	4/4	Max value	2920	1749	121	459	24.1	14.5	6.36	3.81

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.4 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	2/2	Max value	160	126	9.79	33.0	16.3	12.9	4.85	3.83
Cadmium	2/2	Max value	12.7	8.00	0.99	4.98	12.8	8.08	2.55	1.61
Copper	2/2	Max value	439	304	31.6	149	13.9	9.60	2.95	2.04
Iron	2/2	Max value	40500	37300	20000	40000	2.03	1.87	1.01	0.93
Lead	2/2	Max value	1890	1326	35.8	128	52.8	37.0	14.8	10.4
Manganese	2/2	Max value	2110	1565	460	1100	4.59	3.40	1.92	1.42
Mercury	2/2	Max value	0.31	0.17	0.18	1.06	1.69	0.92	0.29	0.16
Zinc	2/2	Max value	5900	5770	121	459	48.8	47.7	12.9	12.6

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

Table A13.5 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

		Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
COPEC	FOD	UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	2/2	Max value	14.5	12.5	9.79	33.0	1.48	1.28	0.44	0.38
Barium	1/1	Max value	57.4	57.4	48.0	NA	1.20	1.20	-	-
Cadmium	2/2	Max value	1.00	0.60	0.99	4.98	1.01	0.61	0.20	0.12
Iron	2/2	Max value	30200	29100	20000	40000	1.51	1.46	0.76	0.73
Lead	2/2	Max value	106	87.3	35.8	128	2.96	2.44	0.83	0.68
Manganese	2/2	Max value	1380	869	460	1100	3.00	1.89	1.25	0.79
Selenium	2/2	Max value	1.90	1.317	0.90	4.70	2.11	1.46	0.40	0.28
Zinc	2/2	Max value	386.00	255.00	121	459	3.19	2.11	0.84	0.56

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.6 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	2/2	Max value	14300	13450	14000	60000	1.02	0.96	0.24	0.22
Arsenic	2/2	Max value	16.9	15.2	9.79	33.0	1.73	1.55	0.51	0.46
Iron	2/2	Max value	131000	109150	20000	40000	6.55	5.46	3.28	2.73
Lead	2/2	Max value	100	83.6	35.8	128	2.79	2.34	0.78	0.65
Manganese	2/2	Max value	1170	924.0	460.0	1100	2.54	2.01	1.06	0.84
Selenium	1/2	Max value	1.50	1.37	0.90	4.70	1.67	1.53	0.32	0.29
Vanadium	1/1	Max value	23.5	23.5	27.3	77.0	0.86	0.86	0.31	0.31
Zinc	2/2	Max value	130	126	121	459	1.07	1.04	0.28	0.27

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.7 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

		Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
COPEC	FOD	UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	12/12	95% Student's-t	10865	9704	14000	60000	0.78	0.69	0.18	0.16
Arsenic	12/12	95% Student's-t	24.8	20.7	9.79	33.0	2.54	2.12	0.75	0.63
Barium	11/11	95% Student's-t	127	108	48.0	NA	2.64	2.24	-	-
Cadmium	12/12	95% Student's-t	12.0	9.68	0.99	4.98	12.1	9.78	2.41	1.94
Copper	12/12	95% Student's-t	315	267	31.6	149	9.96	8.46	2.11	1.79
Iron	12/12	95% Student's-t	29260	25900	20000	40000	1.46	1.30	0.73	0.65
Lead	12/12	95% Student's-t	1442	1232	35.8	128	40.3	34.4	11.3	9.63
Manganese	12/12	95% Student's-t	9481	7663	460	1100	20.6	16.7	8.62	6.97
Selenium	8/12	95% Student's-t	1.14	0.90	0.90	4.70	1.26	1.00	0.24	0.19
Silver	12/12	95% Student's-t	5.79	4.55	1.00	3.70	5.79	4.55	1.56	1.23
Zinc	12/12	95% Student's-t	3505	2695	121	459	29.0	22.3	7.64	5.87

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.8 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-08; Cunningham Creek Monitoring Site A48.

		Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
COPEC	FOD	UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	4/4	95% Student's-t	10.9	8.76	9.79	33.0	1.11	0.89	0.33	0.27
Barium	3/3	95% Student's-t	90.6	70.0	48.0	NA	1.89	1.46	-	-
Cadmium	4/4	95% Student's-t	2.61	2.05	0.99	4.98	2.63	2.07	0.52	0.41
Copper	4/4	95% Student's-t	94.1	65.3	31.6	149	2.98	2.07	0.63	0.44
Iron	4/4	95% Student's-t	26111	22120	20000	40000	1.31	1.11	0.65	0.55
Lead	4/4	95% Student's-t	562	411	35.8	128	15.7	11.5	4.39	3.21
Manganese	4/4	Max value	1240	1080	460	1100	2.70	2.35	1.13	0.98
Selenium	2/4	95% Student's-t	1.31	0.88	0.90	4.70	1.45	0.98	0.28	0.19
Silver	4/4	95% Student's-t	1.50	1.06	1.00	3.70	1.50	1.06	0.41	0.29
Zinc	4/4	95% Student's-t	486	429	121	459	4.02	3.54	1.06	0.93

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.9 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

		Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
COPEC	FOD	UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	8/8	95% Student's-t	12775	10421	14000	60000	0.91	0.74	0.21	0.17
Arsenic	8/8	95% Student's-t	34.8	28.6	9.79	33.0	3.55	2.92	1.05	0.87
Barium	6/6	95% Student's-t	121	94.9	48.0	NA	2.51	1.98	-	-
Cadmium	8/8	95% Student's-t	14.0	10.7	0.99	4.98	14.2	10.8	2.82	2.16
Copper	8/8	95% Student's-t	458	348	31.6	149	14.5	11.0	3.07	2.34
Iron	8/8	95% Student's-t	28074	25963	20000	40000	1.40	1.30	0.70	0.65
Lead	8/8	95% Student's-t	1940	1534	35.8	128	54.2	42.8	15.2	12.0
Manganese	8/8	95% Student's-t	12745	9781	460	1100	27.7	21.3	11.6	8.89
Mercury	6/8	95% Adjusted Gamma	0.15	0.06	0.18	1.06	0.84	0.32	0.14	0.05
Selenium	5/8	95% Student's-t	1.28	0.90	0.90	4.70	1.42	1.00	0.27	0.19
Silver	8/8	95% Student's-t	5.94	4.69	1.00	3.70	5.94	4.69	1.61	1.27
Zinc	8/8	95% Student's-t	3526	2472	121	459	29.1	20.4	7.68	5.39

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.10 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	8/8	95% Adjusted Gamma	17580	11994	14000	60000	1.26	0.86	0.29	0.20
Antimony	8/8	95% Student's-t	10.6	6.14	12.00	NA	0.89	0.51	-	-
Arsenic	8/8	95% Student's-t	49.7	44.1	9.79	33.0	5.08	4.50	1.51	1.34
Barium	6/6	95% Student's-t	125	102	48.0	NA	2.60	2.13	-	-
Cadmium	8/8	95% Adjusted Gamma	33.1	16.5	0.99	4.98	33.4	16.6	6.64	3.31
Copper	8/8	95% Student's-t	764	500	31.6	149	24.2	15.8	5.13	3.36
Iron	8/8	95% Student's-t	33442	29375	20000	40000	1.67	1.47	0.84	0.73
Lead	8/8	95% Student's-t	1907	1433	35.8	128	53.3	40.0	14.9	11.2
Manganese	8/8	95% Student's-t	18398	13678	460	1100	40.0	29.7	16.7	12.4
Molybdenum	4/4	Max value	14.6	10.7	8.30	540	1.76	1.29	0.03	0.02
Selenium	6/8	95% Adjusted Gamma	4.81	2.17	0.90	4.70	5.35	2.41	1.02	0.46
Silver	8/8	95% Adjusted Gamma	24.5	8.84	1.00	3.70	24.5	8.84	6.61	2.39
Zinc	8/8	95% Chebyshev	5966	3528	121	459	49.3	29.2	13.0	7.69

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.11 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

		Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
COPEC	FOD	UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	4/4	Max value	40.9	28.6	9.79	33.0	4.18	2.92	1.24	0.87
Barium	3/3	Max value	102	78.2	48.0	NA	2.13	1.63	-	-
Cadmium	4/4	Max value	1.56	1.17	0.99	4.98	1.58	1.18	0.31	0.23
Copper	4/4	95% Student's-t	110	91.2	31.6	149	3.49	2.89	0.74	0.61
Iron	4/4	95% Student's-t	57733	46450	20000	40000	2.89	2.32	1.44	1.16
Lead	4/4	Max value	317	207	35.8	128	8.85	5.78	2.48	1.62
Manganese	4/4	Max value	1410	1225	460	1100	3.07	2.66	1.28	1.11
Molybdenum	2/2	Max value	10.6	9.10	8.30	540	1.28	1.10	0.02	0.02
Selenium	3/4	Max value	2.60	1.63	0.90	4.70	2.89	1.81	0.55	0.35
Silver	4/4	Max value	1.54	1.16	1.00	3.70	1.54	1.16	0.42	0.31
Zinc	4/4	95% Student's-t	460	323	121	459	3.80	2.67	1.00	0.70

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.12 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

		Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
COPEC	FOD	UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	4/4	95% Student's-t	17391	12388	14000	60000	1.24	0.88	0.29	0.21
Arsenic	4/4	95% Student's-t	26.0	18.5	9.79	33.0	2.66	1.88	0.79	0.56
Barium	3/3	Max value	103	90.9	48.00	NA	2.15	1.89	-	-
Cadmium	4/4	95% Student's-t	14.7	10.9	0.99	4.98	14.8	11.0	2.95	2.19
Copper	4/4	95% Student's-t	318	238	31.6	149	10.1	7.54	2.13	1.60
Iron	4/4	95% Student's-t	39100	33125	20000	40000	1.96	1.66	0.98	0.83
Lead	4/4	95% Student's-t	693	541	35.8	128	19.3	15.1	5.41	4.23
Manganese	4/4	95% Student's-t	8530	7770	460	1100	18.5	16.9	7.75	7.06
Selenium	2/4	95% Student's-t	3.73	1.68	0.90	4.70	4.15	1.86	0.79	0.36
Silver	4/4	95% Student's-t	3.65	2.03	1.00	3.70	3.65	2.03	0.99	0.55
Zinc	4/4	95% Student's-t	4366	2955	121	459	36.1	24.4	9.51	6.44

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.13 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

		Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
COPEC	FOD	UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	4/4	95% Student's-t	36.2	25.0	9.79	33.0	3.70	2.55	1.10	0.76
Barium	3/3	Max value	81.0	77.8	48.0	NA	1.69	1.62	-	-
Cadmium	4/4	Max value	7.41	6.98	0.99	4.98	7.48	7.05	1.49	1.40
Copper	4/4	Max value	236	221	31.6	149	7.47	7.00	1.58	1.49
Iron	4/4	95% Student's-t	45981	42225	20000	40000	2.30	2.11	1.15	1.06
Lead	4/4	Max value	767	643	35.8	128	21.4	18.0	5.99	5.03
Manganese	4/4	Max value	5120	4048	460	1100	11.1	8.80	4.65	3.68
Mercury	4/4	95% Student's-t	0.50	0.24	0.18	1.06	2.79	1.35	0.47	0.23
Selenium	3/4	95% Student's-t	4.14	2.15	0.90	4.70	4.60	2.38	0.88	0.46
Silver	4/4	Max value	2.80	2.23	1.00	3.70	2.80	2.23	0.76	0.60
Zinc	4/4	Max value	2420	1940	121	459	20.0	16.0	5.27	4.23

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.14 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	8/8	95% Student's-t	19128	14883	14000	60000	1.37	1.06	0.32	0.25
Arsenic	8/8	95% Student's-t	58.6	46.2	9.79	33.0	5.99	4.72	1.78	1.40
Barium	6/6	95% Student's-t	79.4	60.6	48.0	NA	1.65	1.26	-	-
Cadmium	8/8	95% Student's-t	12.0	9.14	0.99	4.98	12.1	9.23	2.41	1.84
Copper	8/8	95% Student's-t	458	326	31.6	149	14.5	10.3	3.07	2.19
Iron	8/8	95% Student's-t	23436	21600	20000	40000	1.17	1.08	0.59	0.54
Lead	8/8	95% Student's-t	1307	997	35.8	128	36.5	27.9	10.2	7.79
Manganese	8/8	95% Student's-t	10438	8310	460	1100	22.7	18.1	9.49	7.55
Molybdenum	4/4	95% Student's-t	9.34	7.31	8.30	540	1.13	0.88	0.02	0.01
Selenium	6/8	95% Student's-t	1.22	0.90	0.90	4.70	1.36	1.00	0.26	0.19
Silver	8/8	95% Student's-t	5.02	3.67	1.00	3.70	5.02	3.67	1.36	0.99
Zinc	8/8	95% Student's-t	3458	2385	121	459	28.6	19.7	7.53	5.20

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.15 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	4/4	95% Student's-t	40218	20518	14000	60000	2.87	1.47	0.67	0.34
Arsenic	4/4	Max value	41.7	32.1	9.79	33.0	4.26	3.28	1.26	0.97
Barium	3/3	Max value	114	67.5	48.0	NA	2.38	1.41	-	-
Cadmium	4/4	Max value	10.4	6.52	0.99	4.98	10.5	6.58	2.09	1.31
Copper	4/4	Max value	477	304	31.6	149	15.1	9.6	3.20	2.04
Iron	4/4	Max value	28400	24025	20000	40000	1.42	1.20	0.71	0.60
Lead	4/4	Max value	2320	1546	35.8	128	64.8	43.2	18.1	12.1
Manganese	4/4	Max value	15600	9223	460	1100	33.9	20.1	14.2	8.38
Mercury	4/4	95% Student's-t	0.23	0.16	0.18	1.06	1.30	0.89	0.22	0.15
Molybdenum	2/2	Max value	8.79	7.00	8.30	540	1.06	0.84	0.02	0.01
Silver	4/4	Max value	6.19	3.51	1.00	3.70	6.19	3.51	1.67	0.95
Zinc	4/4	Max value	2770	1548	121	459	22.9	12.8	6.03	3.37

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.16 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Antimony	4/4	Max value	17.4	12.4	12.0	NA	1.45	1.03	-	-
Arsenic	4/4	Max value	66.4	53.6	9.79	33.0	6.78	5.47	2.01	1.62
Barium	3/3	Max value	392	212	48.0	NA	8.17	4.41	-	-
Cadmium	4/4	95% Student's-t	64.2	36.8	0.99	4.98	64.8	37.2	12.9	7.40
Cobalt	3/3	Max value	71.5	41.1	50.0	-	1.43	0.82	-	-
Copper	4/4	Max value	1700	1070	31.6	149	53.8	33.9	11.41	7.18
Iron	4/4	Max value	31300	27125	20000	40000	1.57	1.36	0.78	0.68
Lead	4/4	95% Student's-t	9009	6488	35.8	128	252	181	70.4	50.7
Manganese	4/4	95% Student's-t	58805	32150	460	1100	127.8	69.9	53.5	29.2
Mercury	4/4	Max value	0.98	0.68	0.18	1.06	5.42	3.76	0.92	0.64
Molybdenum	2/2	Max value	9.70	8.22	8.30	540	1.17	0.99	0.02	0.02
Selenium	2/4	95% Student's-t	4.20	1.88	0.90	4.70	4.67	2.08	0.89	0.40
Silver	4/4	95% Student's-t	22.2	12.4	1.00	3.70	22.2	12.4	6.01	3.36
Zinc	4/4	Max value	21500	8470	121	459	178	70.0	46.8	18.5

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.17 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	4/4	Max value	33000	25650	14000	60000	2.36	1.83	0.55	0.43
Arsenic	4/4	95% Student's-t	39.0	28.5	9.79	33.0	3.98	2.91	1.18	0.86
Barium	3/3	Max value	57.6	40.4	48.0	NA	1.20	0.84	-	-
Cadmium	3/4	Max value	2.70	1.83	0.99	4.98	2.73	1.85	0.54	0.37
Copper	4/4	Max value	277	193	31.6	149	8.77	6.11	1.86	1.30
Iron	4/4	95% Student's-t	45142	35250	20000	40000	2.26	1.76	1.13	0.88
Lead	4/4	Max value	339	242	35.8	128	9.47	6.75	2.65	1.89
Manganese	4/4	95% Student's-t	8537	5710	460	1100	18.6	12.4	7.76	5.19
Selenium	1/4	95% Student's-t	1.71	0.90	0.90	4.70	1.90	1.00	0.36	0.19
Silver	3/4	Max value	2.16	1.27	1.00	3.70	2.16	1.27	0.58	0.34
Vanadium	3/3	Max value	39.9	30.4	27.3	77.0	1.46	1.11	0.52	0.40
Zinc	4/4	Max value	834	686	121	459	6.89	5.67	1.82	1.49

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.18 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-18; North Fork Animas River - Burrows Gulch to Animas Forks Monitoring Site A08 and A09.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	8/8	95% Student's-t	22208	15799	14000	60000	1.59	1.13	0.37	0.26
Arsenic	8/8	95% Student's-t	57.1	41.1	9.79	33.0	5.83	4.20	1.73	1.24
Barium	6/6	95% Student's-t	62.8	39.9	48.0	NA	1.31	0.83	-	-
Cadmium	8/8	95% Student's-t	7.62	6.05	0.99	4.98	7.70	6.11	1.53	1.22
Copper	8/8	95% Student's-t	101	85.0	31.6	149	3.19	2.69	0.68	0.57
Iron	8/8	95% Student's-t	21164	16975	20000	40000	1.06	0.85	0.53	0.42
Lead	8/8	95% Student's-t	502	372	35.8	128	14.0	10.4	3.92	2.90
Manganese	8/8	95% Student's-t	4228	3340	460	1100	9.19	7.26	3.84	3.04
Molybdenum	4/4	Max value	9.74	8.37	8.30	540	1.17	1.01	0.02	0.02
Selenium	2/8	95% Adjusted Gamma	3.69	0.90	0.90	4.70	4.10	1.00	0.79	0.19
Silver	8/8	95% Student's-t	2.08	1.46	1.00	3.70	2.08	1.46	0.56	0.39
Zinc	8/8	95% Student's-t	1423	938	121	459	11.8	7.76	3.10	2.04

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.19 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-19; Burrows Gulch Monitoring Site A07.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	4/4	95% Student's-t	34730	23175	14000	60000	2.48	1.66	0.58	0.39
Arsenic	4/4	Max value	54.4	47.8	9.79	33.0	5.56	4.89	1.65	1.45
Barium	3/3	Max value	79.6	48.5	48.0	NA	1.66	1.01	-	-
Cadmium	4/4	Max value	7.70	7.02	0.99	4.98	7.78	7.09	1.55	1.41
Copper	4/4	Max value	224	204	31.6	149	7.09	6.46	1.50	1.37
Iron	4/4	95% Student's-t	35347	28900	20000	40000	1.77	1.45	0.88	0.72
Lead	4/4	95% Student's-t	571	448	35.8	128	16.0	12.5	4.46	3.50
Manganese	4/4	95% Student's-t	19911	11815	460	1100	43.3	25.7	18.1	10.7
Molybdenum	2/2	Max value	14.9	13.8	8.30	540	1.80	1.66	0.03	0.03
Selenium	1/4	95% Student's-t	1.28	0.61	0.90	4.70	1.42	0.68	0.27	0.13
Silver	4/4	95% Student's-t	1.99	1.37	1.00	3.70	1.99	1.37	0.54	0.37
Zinc	4/4	95% Student's-t	850	712	121	459	7.02	5.88	1.85	1.55

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.20 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	15/15	95% Student's-t	13.2	11.4	9.79	33.0	1.35	1.16	0.40	0.34
Barium	15/15	95% Student's-t	120	102	48.0	NA	2.49	2.12	-	-
Cadmium	15/15	95% Student's-t	2.78	2.22	0.99	4.98	2.81	2.24	0.56	0.45
Copper	15/15	95% Student's-t	94.2	79.3	31.6	149	2.98	2.51	0.63	0.53
Iron	15/15	95% Student's-t	22171	20080	20000	40000	1.11	1.00	0.55	0.50
Lead	15/15	95% Student's-t	242	202	35.8	128	6.75	5.64	1.89	1.58
Manganese	15/15	95% Student's-t	2395	1975	460	1100	5.21	4.29	2.18	1.80
Silver	15/15	95% Student's-t	1.58	1.21	1.00	3.70	1.58	1.21	0.43	0.33
Vanadium	15/15	95% Student's-t	21.3	18.8	27.3	77.0	0.78	0.69	0.28	0.24
Zinc	15/15	95% Student's-t	883	705	121	459	7.30	5.82	1.92	1.54

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.21 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	25/25	95% Student's-t	10.3	9.49	9.79	33.0	1.06	0.97	0.31	0.29
Barium	25/25	95% Student's-t	160	145	48.0	NA	3.33	3.02	-	-
Cadmium	25/25	95% Adjusted Gamma	2.77	2.30	0.99	4.98	2.80	2.33	0.56	0.46
Copper	25/25	95% Student's-t	82.4	72.2	31.6	149	2.61	2.29	0.55	0.48
Iron	25/25	95% Student's-t	20938	19732	20000	40000	1.05	0.99	0.52	0.49
Lead	25/25	95% Student's-t	190	168	35.8	128	5.32	4.68	1.49	1.31
Manganese	25/25	95% Student's-t	2140	1878	460	1100	4.65	4.08	1.95	1.71
Selenium	23/25	95% Chebyshev	2.74	1.13	0.90	4.70	3.05	1.26	0.58	0.24
Silver	24/25	95% Student's-t	1.11	0.95	1.00	3.70	1.11	0.95	0.30	0.26
Vanadium	25/25	95% Student's-t	23.4	20.8	27.3	77.0	0.86	0.76	0.30	0.27
Zinc	25/25	95% Student's-t	864	749	121	459	7.14	6.19	1.88	1.63

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.22 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in Bear Creek Reference Exposure Unit Monitoring Site M30.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	2/2	Max value	14.6	12.5	9.79	33.0	1.49	1.28	0.44	0.38
Barium	1/1	Max value	68.0	68.0	48.0	NA	1.42	1.42	-	-
Iron	2/2	Max value	20500	17750	20000	40000	1.03	0.89	0.51	0.44
Lead	2/2	Max value	65.2	53.5	35.8	128	1.82	1.49	0.51	0.42
Manganese	2/2	Max value	1390	1330	460	1100	3.02	2.89	1.26	1.21
Selenium	2/2	Max value	1.50	1.32	0.90	4.70	1.67	1.46	0.32	0.28
Zinc	2/2	Max value	263	257	121	459	2.17	2.12	0.57	0.56

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.23 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in Hermosa Creek Reference Exposure Unit Monitoring Site HC01.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Aluminum	1/1	Max value	17300	17300	14000	60000	1.24	1.24	0.29	0.29
Barium	1/1	Max value	107	107	48.0	NA	2.23	2.23	-	-
Iron	1/1	Max value	22000	22000	20000	40000	1.10	1.10	0.55	0.55
Selenium	1/1	Max value	2.40	2.40	0.90	4.70	2.67	2.67	0.51	0.51
Vanadium	1/1	Max value	29.9	29.9	27.3	77.0	1.10	1.10	0.39	0.39

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.24 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in Maggie Gulch Reference Exposure Unit Monitoring Site A43.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	3/3	Max value	12.5	9.40	9.79	33.0	1.28	0.96	0.38	0.28
Barium	3/3	Max value	140	110	48.0	NA	2.92	2.29	-	-
Copper	3/3	Max value	33.1	27.3	31.6	149	1.05	0.86	0.22	0.18
Iron	3/3	Max value	30500	24833	20000	40000	1.53	1.24	0.76	0.62
Lead	3/3	Max value	36.3	33.0	35.8	128	1.01	0.92	0.28	0.26
Manganese	3/3	Max value	1730	1420	460	1100	3.76	3.09	1.57	1.29
Mercury	2/3	Max value	0.22	0.09	0.18	1.06	1.20	0.48	0.20	0.08
Selenium	2/3	Max value	1.90	1.02	0.90	4.70	2.11	1.13	0.40	0.22
Zinc	3/3	Max value	168	137	121	459	1.39	1.13	0.37	0.30

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.25 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08.

		Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
COPEC	FOD	UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	1/1	Max value	10.0	10.0	9.79	33.0	1.02	1.02	0.30	0.30
Barium	1/1	Max value	62.1	62.1	48.0	NA	1.29	1.29	-	-
Cadmium	1/1	Max value	2.30	2.30	0.99	4.98	2.32	2.32	0.46	0.46
Lead	1/1	Max value	329	329	35.8	128	9.19	9.19	2.57	2.57
Manganese	1/1	Max value	1720	1720	460	1100	3.74	3.74	1.56	1.56
Selenium	1/1	Max value	1.20	1.20	0.90	4.70	1.33	1.33	0.26	0.26
Zinc	1/1	Max value	431	431	121	459	3.56	3.56	0.94	0.94

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.26 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in Picayne Gulch Reference Exposure Unit Monitoring Site A26.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	3/3	Max value	65.7	49.2	9.79	33.0	6.71	5.03	1.99	1.49
Barium	3/3	Max value	122	112	48.0	NA	2.54	2.33	-	-
Cadmium	3/3	Max value	1.67	1.56	0.99	4.98	1.69	1.57	0.34	0.31
Copper	3/3	Max value	40.4	36.2	31.6	149	1.28	1.15	0.27	0.24
Iron	3/3	Max value	33200	29600	20000	40000	1.66	1.48	0.83	0.74
Lead	3/3	Max value	134	85.1	35.8	128	3.74	2.38	1.05	0.66
Manganese	3/3	Max value	5460	4977	460	1100	11.9	10.8	4.96	4.52
Selenium	1/3	Max value	1.70	0.85	0.90	4.70	1.89	0.94	0.36	0.18
Silver	3/3	Max value	1.36	1.09	1.00	3.70	1.36	1.09	0.37	0.29
Zinc	3/3	Max value	421	383	121	459	3.48	3.17	0.92	0.83

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Table A13.27 Sediment Exposure Point Concentrations (EPCs) and Hazard Quotients (HQs) for Community-level Benthic Macroinvertebrates Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05.

COPEC	FOD	Metal concentration (mg/kg)			ESVs (mg/kg)		No-effect HQs		Low-effect HQs	
		UCL method	RME	CTE	No-effect	Low-effect	RME	CTE	RME	CTE
Arsenic	4/4	95% Student's-t	73.0	57.9	9.79	33.0	7.46	5.91	2.21	1.75
Barium	3/3	Max value	85.4	57.9	48.0	NA	1.78	1.21	-	-
Cadmium	4/4	95% Student's-t	10.8	8.93	0.99	4.98	10.9	9.02	2.17	1.79
Copper	4/4	95% Student's-t	43.6	35.7	31.6	149	1.38	1.13	0.29	0.24
Iron	4/4	95% Student's-t	24390	18425	20000	40000	1.22	0.92	0.61	0.46
Lead	4/4	Max value	290	208	35.8	128	8.10	5.80	2.27	1.62
Manganese	4/4	Max value	2920	2393	460	1100	6.35	5.20	2.65	2.18
Selenium	1/4	95% Student's-t	1.49	0.62	0.90	4.70	1.66	0.69	0.32	0.13
Silver	4/4	Max value	2.02	1.43	1.00	3.70	2.02	1.43	0.55	0.39
Zinc	4/4	Max value	1180	897	121	459	9.75	7.41	2.57	1.95

mg/kg = milligram per kilogram

COPEC = Contaminant of Potential Ecological Concern

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark)

FOD = Frequency of Detection

RME = Reasonable Maximum Exposure. If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit.

UCL = Upper Confidence Limit

NA = Not Available

Appendix 14

Surface Water, Sediment, and Dietary Item Wildlife Receptor Exposure Point Concentration Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

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Table A14.1 EU-01 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Mineral Creek from Animas River to South Fork Mineral Creek

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	5/23	95% Chebyshev	2.67	1.58	11/11	95% Adjusted Gamma	46.8	34.2	2/2	Max value	2.35	1.27
Cadmium	14/23	95% Chebyshev	0.74	0.52	11/11	95% Student's-t	2.04	1.58	2/2	Max value	1.05	0.58
Chromium	1/23	95% Student's-t	2.52	2.32	10/11	95% Chebyshev	6.45	3.67	2/2	Max value	5.24	2.87
Copper	23/23	95% Student's-t	11.3	9.8	11/11	95% Student's-t	140	118	2/2	Max value	80.6	46.0
Lead	22/22	95% Adjusted Gamma	14.9	9.96	11/11	95% Student's-t	276	229	2/2	Max value	75.0	38.3
Mercury	2/4	Max value	0.04	0.02	11/11	95% H-UCL	0.19	0.09	0/2	Half of max detection limit	0.05	0.04
Nickel	5/23	95% Student's-t	1.96	1.64	11/11	95% Student's-t	7.18	5.88	1/1	Max value	0.07	0.07
Selenium	0/23	Half of max detection limit	2.50	1.99	7/11	95% Chebyshev	10.5	3.85	2/2	Max value	1.71	1.06
Silver	0/23	Half of max detection limit	1.25	1.09	8/11	95% Adjusted Gamma	1.77	1.02	0/1	Half of max detection limit	0.03	0.03
Zinc	23/23	95% Student's-t	160	140	11/11	95% Student's-t	678	517	2/2	Max value	192	116

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.2 EU-02 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	1/13	95% Student's-t	1.77	1.44	4/4	Max Value	62.9	47.3	0/1	Half of max detection limit	0.32	0.32
Cadmium	11/13	95% Student's-t	1.10	0.90	4/4	95% Student's-t	1.80	1.26	0/1	Half of max detection limit	0.06	0.06
Chromium	0/13	Half of max detection limit	2.50	2.50	2/4	95% Student's-t	2.40	1.72	0/1	Half of max detection limit	0.63	0.63
Copper	13/13	95% Student's-t	17.1	15.6	4/4	Max Value	84.0	76.1	1/1	Max value	5.46	5.46
Lead	12/12	95% Adjusted Gamma	21.5	14.0	4/4	Max Value	386	333	1/1	Max value	8.20	8.20
Mercury	-	-	-	-	4/4	Max Value	0.08	0.05	0/1	Half of max detection limit	0.50	0.50
Nickel	0/13	Half of max detection limit	1.25	1.25	4/4	Max Value	3.43	2.85	0/1	Half of max detection limit	0.32	0.32
Selenium	0/13	Half of max detection limit	2.50	2.50	2/4	Max Value	1.90	1.52	0/1	Half of max detection limit	0.63	0.63
Silver	0/13	Half of max detection limit	1.25	1.25	0/4	Half of max detection limit	0.63	0.32	0/1	Half of max detection limit	0.32	0.32
Zinc	13/13	95% Student's-t	265	222	4/4	95% Student's-t	1328	722	1/1	Max value	23.6	23.6

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.3 EU-03 Surface Water, Sediment, and Invertebrate and Fish Tissue EPCs for Wildlife Receptors Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)				Fish tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	3/9	95% Chebyshev	6.26	2.64	4/4	Max Value	55.9	48.2	2/2	Max value	0.73	0.60	3/5	Max value	1.98	0.70
Cadmium	6/9	95% Student's-t	0.855	0.65	4/4	95% Student's-t	10.9	5.55	2/2	Max value	0.24	0.19	5/5	95% Student's-t	0.96	0.72
Chromium	0/9	Half of max detection limit	2.50	2.50	4/4	Max Value	3.90	2.53	2/2	Max value	0.57	0.55	5/5	Max value	5.40	3.68
Copper	9/9	95% Student's-t	23.0	18.0	4/4	95% Student's-t	185	117	2/2	Max value	18.9	16.5	5/5	95% Student's-t	14.5	10.5
Lead	9/9	95% Student's-t	48.0	30.9	4/4	95% Student's-t	778	456	2/2	Max value	28.5	18.3	5/5	Max value	27.5	10.3
Mercury	-	-	-	-	4/4	95% Student's-t	0.28	0.13	0/2	Half of max detection limit	0.05	0.05	3/5	95% Student's-t	0.15	0.10
Nickel	0/9	Half of max detection limit	1.25	1.25	4/4	95% Student's-t	5.85	4.25	2/2	Max value	0.11	0.11	0/5	Half of max detection limit	0.47	0.20
Selenium	0/9	Half of max detection limit	2.50	2.50	3/4	Max Value	1.40	0.96	2/2	Max value	0.31	0.31	4/5	95% Student's-t	4.06	3.23
Silver	0/9	Half of max detection limit	1.25	1.25	4/4	Max Value	1.34	0.96	0/2	Max value	0.03	0.03	0/5	Half of max detection limit	0.47	0.20
Zinc	9/9	95% Student's-t	258	209	4/4	Max Value	2920	1749	2/2	Max value	98.6	75.2	5/5	95% Student's-t	306	222

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.4 EU-04 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Mineral Creek Upstream of Mill Creek												
COPEC	**Surface water EPCs (µg/L TRM)**				**Sediment EPCs (mg/kg DW)**				**Invertebrate tissue EPCs (mg/kg DW)**			
	FOD	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**
Arsenic	0/4	Half of max detection limit	1.25	1.25	2/2	Max Value	160	126	1/1	Max value	2.55	2.55
Cadmium	4/4	95% Student's-t	2.39	1.38	2/2	Max Value	12.7	8.00	1/1	Max value	0.37	0.37
Chromium	0/4	Half of max detection limit	2.50	2.50	2/2	Max Value	2.43	1.87	1/1	Max value	0.44	0.44
Copper	4/4	Max value	30.8	22.4	2/2	Max Value	439	304	1/1	Max value	58.7	58.7
Lead	4/4	Max value	92.1	45.7	2/2	Max Value	1890	1326	1/1	Max value	166	166
Mercury	-	-	-	-	2/2	Max Value	0.31	0.17	0/1	Half of max detection limit	0.05	0.05
Nickel	0/4	Half of max detection limit	1.25	1.25	2/2	Max Value	8.89	5.55	1/1	Max value	0.20	0.20
Selenium	0/4	Half of max detection limit	2.50	2.50	1/2	Max Value	0.70	0.70	1/1	Max value	0.18	0.18
Silver	0/4	Half of max detection limit	1.25	1.25	1/2	Max Value	3.55	3.55	1/1	Max value	0.07	0.07
Zinc	4/4	95% Student's-t	870	467	2/2	Max Value	5900	5770	1/1	Max value	110	110

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.5 EU-05 Surface Water, Sediment, and Invertebrate and Fish Tissue EPCs for Wildlife Receptors Foraging in South Fork Mineral Creek

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)				Fish tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	0/5	Half of max detection limit	1.25	1.25	2/2	Max Value	14.5	12.5	2/2	Max value	0.35	0.35	5/5	95% Student's-t	1.23	0.85
Cadmium	0/5	Half of max detection limit	0.25	0.25	2/2	Max Value	1.00	0.60	2/2	Max value	0.32	0.21	5/5	95% Student's-t	0.72	0.55
Chromium	0/5	Half of max detection limit	2.50	2.50	2/2	Max Value	3.20	3.11	2/2	Max value	0.79	0.65	5/5	95% Student's-t	3.82	3.60
Copper	0/5	Half of max detection limit	1.25	1.25	2/2	Max Value	18.9	18.8	2/2	Max value	7.92	5.92	5/5	95% Student's-t	3.82	3.36
Lead	3/5	95% Student's-t	1.19	0.74	2/2	Max Value	106	87.3	2/2	Max value	1.62	1.16	3/5	95% Student's-t	3.15	1.56
Mercury	-	-	-	-	1/2	Max Value	0.09	0.05	0/2	Half of max detection limit	0.09	0.07	4/5	95% Student's-t	0.13	0.10
Nickel	0/5	Half of max detection limit	1.25	1.25	2/2	Max Value	11.6	8.45	2/2	Max value	0.88	0.57	0/5	95% Student's-t	0.14	0.13
Selenium	0/5	Half of max detection limit	2.50	2.50	2/2	Max Value	1.90	1.32	2/2	Max value	0.54	0.51	5/5	95% Student's-t	5.21	4.59
Silver	0/5	Half of max detection limit	1.25	1.25	1/2	Max Value	0.72	0.37	0/2	Half of max detection limit	0.06	0.04	0/5	Half of max detection limit	0.14	0.13
Zinc	5/5	95% Student's-t	22.8	19.6	2/2	Max Value	386	255	2/2	Max value	90.9	66.3	5/5	Max value	125	87

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.6 EU-06 Surface Water and Sediment EPCs for Wildlife Receptors Foraging in Middle Fork Mineral Creek								
COPEC	**Surface water EPCs (µg/L TRM)**				**Sediment EPCs (mg/kg DW)**			
	FOD	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**
Arsenic	0/4	Half of max detection limit	1.25	1.25	3/3	Max Value	16.9	13.9
Cadmium	2/4	95% Student's-t	1.40	0.72	3/3	Max Value	0.60	0.40
Chromium	0/4	Half of max detection limit	2.50	2.50	1/3	Max Value	1.60	1.37
Copper	2/4	Max value	6.04	3.45	3/3	Max Value	24.3	19.9
Lead	4/4	95% Student's-t	3.37	1.58	3/3	Max Value	100	83.6
Mercury	-	-	-	-	2/3	Max Value	0.01	0.01
Nickel	1/4	95% Student's-t	2.94	1.76	2/3	Max Value	1.77	1.17
Selenium	0/4	Half of max detection limit	2.50	2.50	1/3	Max Value	1.50	1.33
Silver	0/4	Half of max detection limit	1.25	1.25	0/3	Half of max detection limit	0.63	0.42
Zinc	4/4	95% Student's-t	181	94.5	3/3	Max Value	130	117

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.7 EU-07 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	1/68	95% Student's-t	1.31	1.27	12/12	95% Student's-t	24.8	20.7	5/5	Max value	18.6	4.14
Cadmium	58/68	95% Chebyshev	1.03	0.80	12/12	95% Student's-t	12.0	9.68	5/5	Max value	8.4	2.59
Chromium	0/68	Half of max detection limit	2.50	2.50	12/12	95% Student's-t	4.80	4.12	5/5	95% Student's-t	3.95	2.25
Copper	51/68	95% Chebyshev	12.92	8.51	12/12	95% Student's-t	315	267	5/5	Max value	143	46.5
Lead	66/66	95% Chebyshev	12.75	6.23	12/12	95% Student's-t	1442	1232	5/5	Max value	400	89.8
Mercury	-	-	-	-	9/11	95% Student's-t	0.11	0.07	1/5	Max value	0.05	0.04
Nickel	0/68	Half of max detection limit	1.25	1.25	12/12	95% Student's-t	8.03	6.96	3/4	95% Student's-t	0.50	0.32
Selenium	0/68	Half of max detection limit	2.50	2.46	8/12	95% Student's-t	1.14	0.90	5/5	95% Student's-t	1.72	1.15
Silver	0/68	Half of max detection limit	1.25	1.25	12/12	95% Student's-t	5.79	4.55	0/4	Half of max detection limit	0.14	0.11
Zinc	68/68	95% Student's-t	320	306	12/12	95% Student's-t	3505	2695	5/5	Max value	2140	708

µg/L = microgram per liter
mg/L = milligram per kilogram
COPEC = Contaminants of Potential Ecological Concern
TRM = Total Recoverable Metal
FOD = Frequency of Detection
UCL = Upper Confidence Level (95%)
RME = Reasonable Maximum Exposure; represented by the 95% UCL
CTE = Central Tendency Exposure
EPC = Exposure Point Concentration
DW = Dry-weight

Table A14.8 EU-08 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Cunningham Creek												
COPEC	**Surface water EPCs (µg/L TRM)**				**Sediment EPCs (mg/kg DW)**				**Invertebrate tissue EPCs (mg/kg DW)**			
	FOD	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**
Arsenic	0/6	Half of max detection limit	1.25	1.25	4/4	95% Student's-t	11.9	8.90	1/1	Max value	0.43	0.43
Cadmium	0/6	Half of max detection limit	0.25	0.25	4/4	Max value	2.87	2.17	1/1	Max value	1.34	1.34
Chromium	0/6	Half of max detection limit	2.50	2.50	4/4	95% Student's-t	4.08	3.36	1/1	Max value	0.53	0.53
Copper	0/6	Half of max detection limit	1.25	1.25	4/4	95% Student's-t	108.2	70.9	1/1	Max value	29.0	29.0
Lead	5/6	95% Student's-t	3.74	2.06	4/4	95% Student's-t	636	441	1/1	Max value	8.52	8.52
Mercury	-	-	-	-	2/4	95% Student's-t	0.04	0.02	0/1	Half of max detection limit	0.05	0.05
Nickel	0/6	Half of max detection limit	1.25	1.25	4/4	95% Student's-t	4.31	3.54	1/1	Max value	0.10	0.10
Selenium	0/6	Half of max detection limit	2.50	2.50	2/4	95% Student's-t	4.01	1.70	1/1	Max value	0.67	0.67
Silver	0/6	Half of max detection limit	1.25	1.25	4/4	Max value	1.64	1.18	1/1	Max value	0.28	0.28
Zinc	6/6	95% Student's-t	37.0	29.4	4/4	Max value	507	429	1/1	Max value	134	134

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.9 EU-09 Surface Water, Sediment, and Invertebrate and Fish Tissue EPCs for Wildlife Receptors Foraging in the Animas River from Howardsville to Minnie Gulch

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)				Fish tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	1/17	Max value	1.25	1.19	8/8	95% Student's-t	34.8	28.6	2/2	Max value	0.88	0.66	4/26	95% Student's-t	0.38	0.32
Cadmium	15/17	95% Student's-t	1.22	1.03	8/8	95% Student's-t	14.0	10.7	2/2	Max value	3.43	2.20	26/26	95% Student's-t	1.12	1.02
Chromium	0/17	Half of max detection limit	2.50	2.35	8/8	95% Student's-t	4.49	3.85	2/2	Max value	1.69	1.15	26/26	95% Student's-t	3.63	3.52
Copper	16/17	95% Adjusted Gamma	20.4	13.5	8/8	95% Student's-t	458	348	2/2	Max value	59.9	39.8	26/26	95% Student's-t	13.1	11.8
Lead	17/17	95% Chebyshev	12.2	5.49	8/8	95% Student's-t	1940	1534	2/2	Max value	22.1	16.3	25/26	95% Adjusted Gamma	4.98	3.86
Mercury	-	-	-	-	6/8	95% Adjusted Gamma	0.15	0.06	0/2	Half of max detection limit	0.08	0.06	19/23	95% Chebyshev	0.39	0.17
Nickel	1/17	Max value	1.25	1.24	8/8	95% Student's-t	9.87	7.96	2/2	Max value	0.51	0.38	20/26	95% Chebyshev	2.34	1.02
Selenium	0/17	Half of max detection limit	2.50	2.38	5/8	95% Student's-t	1.28	0.90	1/2	Max value	0.39	0.37	26/26	95% Student's-t	2.56	2.34
Silver	0/17	Half of max detection limit	1.25	1.18	8/8	95% Student's-t	5.94	4.69	1/2	Max value	0.20	0.15	0/26	95% Student's-t	0.23	0.22
Zinc	17/17	95% Student's-t	401	361	8/8	95% Student's-t	3526	2472	2/2	Max value	575	394	26/26	95% Student's-t	243	222

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.10 EU-10 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in the Animas River from Minnie Gulch to Eureka

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	1/18	Max value	1.25	1.20	8/8	95% Student's-t	49.7	44.1	1/1	Max value	0.90	0.90
Cadmium	18/18	95% Student's-t	2.01	1.79	8/8	95% Adjusted Gamma	33.1	16.5	1/1	Max value	1.12	1.12
Chromium	0/18	Half of max detection limit	2.50	2.36	8/8	95% Student's-t	4.85	4.51	1/1	Max value	0.58	0.58
Copper	18/18	95% H-UCL	41.0	29.0	8/8	95% Student's-t	764	500	1/1	Max value	30.7	30.7
Lead	18/18	95% Adjusted Gamma	9.67	6.17	8/8	95% Student's-t	1907	1433	1/1	Max value	10.5	10.5
Mercury	-	-	-	-	6/8	95% Adjusted Gamma	0.12	0.05	0/1	Half of max detection limit	0.05	0.05
Nickel	1/18	95% Student's-t	1.55	1.36	8/8	95% Student's-t	13.9	10.0	1/1	Max value	0.30	0.30
Selenium	0/18	Half of max detection limit	2.50	2.39	6/8	95% Student's-t	4.81	2.16	1/1	Max value	0.23	0.23
Silver	0/18	Half of max detection limit	1.25	1.18	8/8	95% Adjusted Gamma	24.5	8.84	1/1	Max value	0.11	0.11
Zinc	18/18	95% Student's-t	607	549	8/8	95% H-UCL	5966	3528	1/1	Max value	212	212

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.11 EU-11 Surface water, sediment, and invertebrate tissue EPCs for wildlife receptors foraging in upper south Fork Animas River up to confluence with Eureka Gulch

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	0/6	Half of max detection limit	1.25	1.25	4/4	Max Value	40.9	28.6	1/1	Max value	0.08	0.08
Cadmium	0/6	Half of max detection limit	0.25	0.25	4/4	Max Value	1.56	1.17	1/1	Max value	0.12	0.12
Chromium	0/6	Half of max detection limit	2.50	2.50	4/4	95% Student's-t	6.19	5.44	1/1	Max value	0.31	0.31
Copper	6/6	95% Student's-t	12.34	8.01	4/4	95% Student's-t	110	91.2	1/1	Max value	1.89	1.89
Lead	2/6	Max value	2.16	0.83	4/4	Max Value	317	207	1/1	Max value	0.33	0.33
Mercury	-	-	-	-	1/4	95% Student's-t	0.01	0.01	0/1	Half of max detection limit	0.05	0.05
Nickel	0/6	Half of max detection limit	1.25	1.25	4/4	Max Value	10.1	7.40	1/1	Max value	0.17	0.17
Selenium	0/6	Half of max detection limit	2.50	2.50	3/4	Max Value	2.60	1.63	1/1	Max value	0.48	0.48
Silver	0/6	Half of max detection limit	1.25	1.25	4/4	Max Value	1.54	1.16	0/1	Half of max detection limit	0.03	0.03
Zinc	6/6	95% Student's-t	83.2	57.6	4/4	95% Student's-t	460	323	1/1	Max value	46.8	46.8

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.12 EU-12 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Eureka Gulch Up to Confluence with Upper South Fork Animas River

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	0/6	Half of max detection limit	1.25	1.25	4/4	95% Student's-t	26.0	18.5	1/1	Max value	0.33	0.33
Cadmium	4/6	95% Student's-t	1.82	1.05	4/4	95% Student's-t	14.7	10.93	1/1	Max value	1.09	1.09
Chromium	0/6	Half of max detection limit	2.50	2.50	4/4	95% Student's-t	4.82	4.07	1/1	Max value	0.48	0.48
Copper	5/6	95% Student's-t	16.63	9.67	4/4	95% Student's-t	318	238	1/1	Max value	57.2	57.2
Lead	4/6	95% Student's-t	3.99	2.15	4/4	95% Student's-t	693	541	1/1	Max value	34.4	34.4
Mercury	-	-	-	-	3/4	Max Value	0.04	0.02	0/1	Half of max detection limit	0.05	0.05
Nickel	0/6	Half of max detection limit	1.25	1.25	4/4	Max Value	11.3	9.90	1/1	Max value	0.34	0.34
Selenium	0/6	Half of max detection limit	2.50	2.50	2/4	95% Student's-t	3.73	1.67	1/1	Max value	0.23	0.23
Silver	0/6	Half of max detection limit	1.25	1.25	4/4	95% Student's-t	3.65	2.03	1/1	Max value	0.19	0.19
Zinc	6/6	Max value	854	412	4/4	95% Student's-t	4366	2955	1/1	Max value	199	199

µg/L = microgram per liter
mg/L = milligram per kilogram
COPEC = Contaminants of Potential Ecological Concern
TRM = Total Recoverable Metal
FOD = Frequency of Detection
UCL = Upper Confidence Level (95%)
RME = Reasonable Maximum Exposure; represented by the 95% UCL
CTE = Central Tendency Exposure
EPC = Exposure Point Concentration
DW = Dry-weight

Table A14.13 EU-13 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	1/10	Max value	1.25	1.13	4/4	95% Student's-t	36.2	25.0	1/1	Max value	0.75	0.75
Cadmium	9/10	95% Student's-t	1.72	1.20	4/4	Max Value	7.41	6.98	1/1	Max value	1.62	1.62
Chromium	0/10	Half of max detection limit	2.50	2.25	4/4	95% Student's-t	6.38	5.66	1/1	Max value	0.72	0.72
Copper	10/10	95% Chebyshev	62.3	24.895	4/4	Max Value	236	221	1/1	Max value	31.5	31.5
Lead	6/10	95% Student's-t	3.63	2.19	4/4	Max Value	767	643	1/1	Max value	7.64	7.64
Mercury	-	-	-	-	4/4	95% Student's-t	0.50	0.24	0/1	Half of max detection limit	0.10	0.10
Nickel	1/10	Max value	1.25	1.24	4/4	Max Value	12.5	10.4	1/1	Max value	0.62	0.62
Selenium	0/10	Half of max detection limit	2.50	2.29	3/4	95% Student's-t	4.14	2.15	1/1	Max value	0.32	0.32
Silver	0/10	Half of max detection limit	1.25	1.13	4/4	Max Value	2.80	2.23	0/1	Half of max detection limit	0.06	0.06
Zinc	10/10	95% Student's-t	537	413	4/4	Max Value	2420	1940	1/1	Max value	345	345

µg/L = microgram per liter
mg/L = milligram per kilogram
COPEC = Contaminants of Potential Ecological Concern
TRM = Total Recoverable Metal
FOD = Frequency of Detection
UCL = Upper Confidence Level (95%)
RME = Reasonable Maximum Exposure; represented by the 95% UCL
CTE = Central Tendency Exposure
EPC = Exposure Point Concentration
DW = Dry-weight

Table A14.14 EU-14 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in the Animas River from Eureka to Animas Forks												
COPEC	**Surface water EPCs (µg/L TRM)**				**Sediment EPCs (mg/kg DW)**				**Invertebrate tissue EPCs (mg/kg DW)**			
	FOD	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**
Arsenic	1/15	Max value	1.25	1.20	8/8	95% Student's-t	58.6	46.2	1/1	Max value	0.21	0.21
Cadmium	15/15	95% Chebyshev	7.36	3.99	8/8	95% Student's-t	12.0	9.14	1/1	Max value	0.77	0.77
Chromium	1/15	95% Student's-t	3.07	2.71	8/8	95% Student's-t	4.32	3.86	1/1	Max value	0.41	0.41
Copper	15/15	95% H-UCL	55.4	39.3	8/8	95% Student's-t	458	326	1/1	Max value	26.2	26.2
Lead	15/15	95% Adjusted Gamma	15.8	9.95	8/8	95% Student's-t	1307	997	1/1	Max value	2.96	2.96
Mercury	-	-	-	-	7/8	95% Student's-t	0.09	0.06	0/1	Half of max detection limit	0.11	0.11
Nickel	4/15	95% Chebyshev	7.01	2.98	8/8	95% Student's-t	8.51	6.80	0/1	Half of max detection limit	0.07	0.07
Selenium	0/15	Half of max detection limit	2.50	2.36	6/8	95% Student's-t	1.22	0.90	0/1	Half of max detection limit	0.13	0.13
Silver	0/15	Half of max detection limit	1.25	1.17	8/8	95% Student's-t	5.02	3.67	0/1	Half of max detection limit	0.07	0.07
Zinc	15/15	95% H-UCL	1675	1157	8/8	95% Student's-t	3458	2385	1/1	Max value	82.5	82.5

µg/L = microgram per liter
mg/L = milligram per kilogram
COPEC = Contaminants of Potential Ecological Concern
TRM = Total Recoverable Metal
FOD = Frequency of Detection
UCL = Upper Confidence Level (95%)
RME = Reasonable Maximum Exposure; represented by the 95% UCL
CTE = Central Tendency Exposure
EPC = Exposure Point Concentration
DW = Dry-weight

Table A14.15 EU-15 Surface Water and Sediment EPCs for Wildlife Receptors Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	0/6	Half of max detection limit	1.25	1.25	4/4	Max Value	41.7	32.1
Cadmium	6/6	95% Student's-t	9.11	5.94	4/4	Max Value	10.40	6.52
Chromium	0/6	Half of max detection limit	2.50	2.50	4/4	Max Value	4.81	3.73
Copper	6/6	95% Student's-t	36.2	28.4	4/4	Max Value	477	304
Lead	6/6	Max value	37.3	15.6	4/4	Max Value	2320	1546
Mercury	-	-	-	-	4/4	95% Student's-t	0.23	0.16
Nickel	3/6	95% Student's-t	7.64	4.60	4/4	Max Value	7.30	5.14
Selenium	0/6	Half of max detection limit	2.50	2.50	1/4	95% Student's-t	0.84	0.55
Silver	0/6	Half of max detection limit	1.25	1.25	4/4	Max Value	6.19	3.51
Zinc	6/6	95% Student's-t	3297	2126	4/4	Max Value	2770	1548

µg/L = microgram per liter
mg/L = milligram per kilogram
COPEC = Contaminants of Potential Ecological Concern
TRM = Total Recoverable Metal
FOD = Frequency of Detection
UCL = Upper Confidence Level (95%)
RME = Reasonable Maximum Exposure; represented by the 95% UCL
CTE = Central Tendency Exposure
EPC = Exposure Point Concentration
DW = Dry-weight

Table A14.16 EU-16 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Placer Gulch to Confluence with Upper West Fork Animas River

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	0/6	Half of max detection limit	1.25	1.25	4/4	Max Value	66.4	53.6	0/1	Half of max detection limit	0.48	0.48
Cadmium	6/6	Max value	3.25	2.90	4/4	95% Student's-t	64.2	36.8	1/1	Max value	0.34	0.34
Chromium	0/6	Half of max detection limit	2.50	2.50	4/4	95% Student's-t	4.33	3.57	0/1	Half of max detection limit	0.96	0.96
Copper	6/6	95% Student's-t	30.9	24.5	4/4	Max Value	1700	1070	1/1	Max value	19.8	19.8
Lead	6/6	95% Student's-t	21.2	16.6	4/4	95% Student's-t	9009	6488	1/1	Max value	15.1	15.1
Mercury	-	-	-	-	4/4	Max Value	0.98	0.68	0/1	Half of max detection limit	0.76	0.76
Nickel	3/6	95% Student's-t	3.12	2.20	4/4	95% Student's-t	17.0	9.53	0/1	Half of max detection limit	0.48	0.48
Selenium	0/6	Half of max detection limit	2.50	2.50	2/4	95% Student's-t	4.20	1.88	0/1	Half of max detection limit	0.96	0.96
Silver	0/6	Half of max detection limit	1.25	1.25	4/4	95% Student's-t	22.2	12.4	0/1	Half of max detection limit	0.48	0.48
Zinc	6/6	95% Student's-t	1452	1182	4/4	Max Value	21500	8470	1/1	Max value	51.8	51.8

µg/L = microgram per liter
mg/L = milligram per kilogram
COPEC = Contaminants of Potential Ecological Concern
TRM = Total Recoverable Metal
FOD = Frequency of Detection
UCL = Upper Confidence Level (95%)
RME = Reasonable Maximum Exposure; represented by the 95% UCL
CTE = Central Tendency Exposure
EPC = Exposure Point Concentration
DW = Dry-weight

Table A14.17 EU-17 Surface Water and Sediment EPCs for Wildlife Receptors Foraging in Upper West Fork Animas River from Placer Gulch Up to its Source

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	0/6	Half of max detection limit	1.25	1.25	4/4	95% Student's-t	39.0	28.5
Cadmium	6/6	95% Student's-t	12.7	8.64	3/4	Max Value	2.70	1.83
Chromium	0/6	Half of max detection limit	2.50	2.50	4/4	95% Student's-t	8.52	5.57
Copper	6/6	95% Student's-t	35.5	26.0	4/4	Max Value	277	193
Lead	6/6	95% Student's-t	6.16	3.58	4/4	Max Value	339	242
Mercury	-	-	-	-	4/4	Max Value	0.04	0.03
Nickel	6/6	95% Student's-t	13.37	8.69	4/4	95% Student's-t	12.3	7.36
Selenium	0/6	Half of max detection limit	2.50	2.50	1/4	95% Student's-t	1.71	0.90
Silver	0/6	Half of max detection limit	1.25	1.25	3/4	Max Value	2.16	1.27
Zinc	6/6	95% Student's-t	3932	2640	4/4	Max Value	834	686

µg/L = microgram per liter
mg/L = milligram per kilogram
COPEC = Contaminants of Potential Ecological Concern
TRM = Total Recoverable Metal
FOD = Frequency of Detection
UCL = Upper Confidence Level (95%)
RME = Reasonable Maximum Exposure; represented by the 95% UCL
CTE = Central Tendency Exposure
EPC = Exposure Point Concentration
DW = Dry-weight

Table A14.18 EU-18 Surface Water and Sediment EPCs for Wildlife Receptors Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	0/12	Half of max detection limit	1.25	1.25	8/8	95% Student's-t	57.1	41.1
Cadmium	12/12	95% Student's-t	6.24	5.10	8/8	95% Student's-t	7.62	6.05
Chromium	0/12	Half of max detection limit	2.50	2.50	8/8	95% Student's-t	3.27	2.67
Copper	12/12	95% Student's-t	19.9	16.9	8/8	95% Student's-t	101	85.0
Lead	12/12	95% Adjusted Gamma	12.7	7.75	8/8	95% Student's-t	502	372
Mercury	-	-	-	-	6/8	95% Adjusted Gamma	0.07	0.03
Nickel	6/12	95% Chebyshev	3.75	2.31	8/8	95% Student's-t	5.29	4.34
Selenium	0/12	Half of max detection limit	2.50	2.50	2/8	95% Adjusted Gamma	3.68	0.90
Silver	0/12	Half of max detection limit	1.25	1.25	8/8	95% Student's-t	2.08	1.46
Zinc	12/12	95% Student's-t	1054	864	8/8	95% Student's-t	1423	938

µg/L = microgram per liter
mg/L = milligram per kilogram
COPEC = Contaminants of Potential Ecological Concern
TRM = Total Recoverable Metal
FOD = Frequency of Detection
UCL = Upper Confidence Level (95%)
RME = Reasonable Maximum Exposure; represented by the 95% UCL
CTE = Central Tendency Exposure
EPC = Exposure Point Concentration
DW = Dry-weight

Table A14.19 EU-19 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Burrows Gulch												
COPEC	**Surface water EPCs (µg/L TRM)**				**Sediment EPCs (mg/kg DW)**				**Invertebrate tissue EPCs (mg/kg DW)**			
	FOD	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**
Arsenic	0/5	Half of max detection limit	1.25	1.25	4/4	Max Value	54.4	47.8	1/1	Max value	1.12	1.12
Cadmium	5/5	Max value	18.6	14.0	4/4	Max Value	7.7	7.02	1/1	Max value	0.31	0.31
Chromium	0/5	Half of max detection limit	2.50	2.50	4/4	Max Value	4.21	3.19	0/1	Half of max detection limit	0.30	0.30
Copper	5/5	Max value	65.6	50.7	4/4	Max Value	224	204	1/1	Max value	15.9	15.9
Lead	5/5	95% Student's-t	9.55	7.37	4/4	95% Student's-t	571	448	1/1	Max value	13.3	13.3
Mercury	-	-	-	-	4/4	95% Student's-t	0.04	0.02	0/1	Half of max detection limit	0.24	0.24
Nickel	5/5	Max value	11.8	8.18	4/4	95% Student's-t	6.95	5.76	0/1	Half of max detection limit	0.15	0.15
Selenium	0/5	Half of max detection limit	2.50	2.50	1/4	95% Student's-t	1.28	0.61	0/1	Half of max detection limit	0.30	0.30
Silver	0/5	Half of max detection limit	1.25	1.25	4/4	95% Student's-t	1.99	1.37	1/1	Max value	0.31	0.31
Zinc	5/5	Max value	2970	2234	4/4	95% Student's-t	850	712	1/1	Max value	38.5	38.5

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.20 EU-DR01 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in the Animas River, Durango Reach from 32nd St.												
COPEC	**Surface water EPCs (µg/L TRM)**				**Sediment EPCs (mg/kg DW)**				**Invertebrate tissue EPCs (mg/kg DW)**			
	FOD	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**
Arsenic	3/12	95% Chebyshev	2.47	0.99	15/15	95% Student's-t	13.2	11.4	2/3	Max value	3.93	2.29
Cadmium	9/12	95% Student's-t	0.51	0.38	15/15	95% Student's-t	2.78	2.22	2/3	Max value	2.01	1.53
Chromium	2/12	95% Chebyshev	1.97	0.98	15/15	95% Adjusted Gamma	8.18	6.93	2/3	Max value	84	31.3
Copper	12/12	95% H-UCL	15.9	7.63	15/15	95% Student's-t	94.2	79.3	3/3	Max value	66.6	45.1
Lead	12/12	95% Chebyshev	73.9	12.8	15/15	95% Student's-t	242	202	3/3	Max value	36.7	17.5
Mercury	6/11	Max value	0.04	0.02	7/15	95% Student's-t	0.02	0.01	0/3	Half of max detection limit	0.79	0.30
Nickel	10/12	95% Student's-t	2.40	1.99	15/15	95% Student's-t	9.59	8.63	2/3	Max value	42.0	15.8
Selenium	0/12	95% Chebyshev	1.74	0.66	13/15	95% Chebyshev	4.80	1.95	1/3	Max value	7.85	3.27
Silver	3/12	95% Chebyshev	0.87	0.30	15/15	95% Student's-t	1.58	1.21	0/3	Half of max detection limit	3.9	1.50
Zinc	12/12	95% Student's-t	150	121	15/15	95% Student's-t	883	705	3/3	Max value	516	431

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.21 EU-DR02 Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	13/25	95% Chebyshev	1.95	0.97	25/25	95% Student's-t	10.3	9.49	1/1	Max value	1.74	1.74
Cadmium	20/25	95% Chebyshev	0.51	0.30	25/25	95% Adjusted Gamma	2.77	2.30	1/1	Max value	0.54	0.54
Chromium	2/25	95% Chebyshev	1.28	0.71	25/25	95% Adjusted Gamma	8.76	7.64	1/1	Max value	2.50	2.50
Copper	25/25	95% H-UCL	8.69	6.70	25/25	95% Student's-t	82.4	72.2	1/1	Max value	28.0	28.0
Lead	25/25	95% Chebyshev	27.8	9.84	25/25	95% Student's-t	190	168	1/1	Max value	6.78	6.78
Mercury	10/16	Max value	0.04	0.02	16/17	95% Adjusted Gamma	0.04	0.03	0/1	Half of max detection limit	0.03	0.03
Nickel	15/25	95% Student's-t	1.88	1.56	25/25	95% Student's-t	11.5	10.1	1/1	Max value	2.37	2.37
Selenium	8/25	95% Chebyshev	0.99	0.45	23/25	95% Chebyshev	2.74	1.13	1/1	Max value	0.92	0.92
Silver	5/25	95% Chebyshev	0.47	0.17	24/25	95% Student's-t	1.11	0.95	0/1	Half of max detection limit	0.15	0.15
Zinc	25/25	95% Chebyshev	129	83.0	25/25	95% Student's-t	864	749	1/1	Max value	412	412

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.22 Reference Exposure Unit Bear Creek Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Bear Creek												
COPEC	**Surface water EPCs (µg/L TRM)**				**Sediment EPCs (mg/kg DW)**				**Invertebrate tissue EPCs (mg/kg DW)**			
	FOD	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**
Arsenic	0/2	Half of max detection limit	1.25	1.25	2/2	Max Value	14.6	12.5	1/1	Max value	0.29	0.29
Cadmium	0/2	Half of max detection limit	0.25	0.25	2/2	Max Value	0.95	0.82	1/1	Max value	0.29	0.29
Chromium	0/2	Half of max detection limit	2.50	2.50	2/2	Max Value	3.83	3.82	1/1	Max value	0.46	0.46
Copper	0/2	Half of max detection limit	1.25	1.25	2/2	Max Value	25.9	23.6	1/1	Max value	5.16	5.16
Lead	0/2	Half of max detection limit	0.25	0.25	2/2	Max Value	65.2	53.5	1/1	Max value	0.20	0.20
Mercury	-	-	-	-	1/2	Max Value	0.01	0.01	0/1	Half of max detection limit	0.05	0.05
Nickel	0/2	Half of max detection limit	1.25	1.25	2/2	Max Value	7.20	6.93	1/1	Max value	0.25	0.25
Selenium	0/2	Half of max detection limit	2.50	2.50	2/2	Max Value	1.50	1.32	1/1	Max value	1.10	1.10
Silver	0/2	Half of max detection limit	1.25	1.25	0/2	Half of max detection limit	0.12	0.07	0/1	Half of max detection limit	0.03	0.03
Zinc	0/2	Half of max detection limit	5.00	5.00	2/2	Max Value	263	257	1/1	Max value	62.4	62.4

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.23 Reference Exposure Unit Hermosa Creek Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Hermosa Creek												
COPEC	**Surface water EPCs (µg/L TRM)**				**Sediment EPCs (mg/kg DW)**				**Invertebrate tissue EPCs (mg/kg DW)**			
	FOD	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**
Arsenic	0/1	Half of max detection limit	1.25	1.25	1/1	Max Value	1.10	1.10	1/1	Max value	0.14	0.14
Cadmium	0/1	Half of max detection limit	0.25	0.25	0/1	Half of max detection limit	0.03	0.03	1/1	Max value	0.03	0.03
Chromium	0/1	Half of max detection limit	2.50	2.50	1/1	Max Value	23.0	23.0	1/1	Max value	0.56	0.56
Copper	0/1	Half of max detection limit	1.25	1.25	1/1	Max Value	11.5	11.5	1/1	Max value	3.78	3.78
Lead	0/1	Half of max detection limit	0.25	0.25	1/1	Max Value	11.7	11.7	1/1	Max value	0.08	0.08
Mercury	-	-	-	-	0/1	Half of max detection limit	0.003	0.003	1/1	Max value	0.11	0.11
Nickel	0/1	Half of max detection limit	1.25	1.25	1/1	Max Value	15.0	15.0	1/1	Max value	0.12	0.12
Selenium	0/1	Half of max detection limit	2.50	2.50	1/1	Max Value	2.40	2.40	1/1	Max value	0.86	0.86
Silver	0/1	Half of max detection limit	1.25	1.25	0/1	Half of max detection limit	0.02	0.02	0/1	Half of max detection limit	0.03	0.03
Zinc	0/1	Half of max detection limit	5.00	5.00	1/1	Max Value	65.9	65.9	1/1	Max value	47.8	47.8

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.24 Reference Exposure Unit Mill Creek Surface Water, Sediment, and Invertebrate and Fish Tissue EPCs for Wildlife Receptors Foraging in Mill Creek																
COPEC	**Surface water EPCs (µg/L TRM)**				**Sediment EPCs (mg/kg DW)**				**Invertebrate tissue EPCs (mg/kg DW)**				**Fish tissue EPCs (mg/kg DW)**			
	FOD	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**
Arsenic	0/2	Half of max detection limit	1.25	1.25	1/1	Max Value	10.0	10.0	1/1	Max value	0.31	0.31	4/6	95% Student's-t	0.47	0.34
Cadmium	0/2	Half of max detection limit	0.25	0.25	1/1	Max Value	2.30	2.30	1/1	Max value	0.26	0.26	5/6	95% Student's-t	0.56	0.43
Chromium	0/2	Half of max detection limit	2.50	2.50	1/1	Max Value	0.87	0.87	1/1	Max value	0.49	0.49	6/6	95% Student's-t	3.79	3.51
Copper	0/2	Half of max detection limit	1.25	1.25	1/1	Max Value	15.7	15.7	1/1	Max value	5.18	5.18	6/6	95% Student's-t	4.52	3.23
Lead	2/2	Max value	1.74	1.26	1/1	Max Value	329	329	1/1	Max value	4.42	4.42	5/6	95% Student's-t	8.12	4.95
Mercury	-	-	-	-	0/1	Half of max detection limit	0.002	0.002	0/1	Half of max detection limit	0.05	0.05	1/6	95% H-UCL	0.09	0.06
Nickel	0/2	Half of max detection limit	1.25	1.25	1/1	Max Value	2.70	2.70	1/1	Max value	0.15	0.15	0/6	95% Student's-t	0.20	0.15
Selenium	0/2	Half of max detection limit	2.50	2.50	1/1	Max Value	1.20	1.20	1/1	Max value	0.34	0.34	6/6	95% Student's-t	3.98	3.38
Silver	0/2	Half of max detection limit	1.25	1.25	0/1	Half of max detection limit	0.02	0.02	0/1	Half of max detection limit	0.03	0.03	0/6	95% Student's-t	0.20	0.15
Zinc	2/2	Max value	42.1	30.7	1/1	Max Value	431	431	1/1	Max value	56.1	56.1	6/6	95% Student's-t	171	117

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.25 Reference Exposure Unit Maggie Gulch Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Maggie Gulch												
COPEC	**Surface water EPCs (µg/L TRM)**				**Sediment EPCs (mg/kg DW)**				**Invertebrate tissue EPCs (mg/kg DW)**			
	FOD	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**
Arsenic	0/4	Half of max detection limit	1.25	1.25	3/3	Max Value	12.5	9.40	1/1	Max value	0.23	0.23
Cadmium	0/4	Half of max detection limit	0.25	0.25	2/3	Max Value	0.79	0.45	1/1	Max value	0.22	0.22
Chromium	0/4	Half of max detection limit	2.50	2.50	3/3	Max Value	3.20	2.80	1/1	Max value	0.50	0.50
Copper	0/4	Half of max detection limit	1.25	1.25	3/3	Max Value	33.1	27.3	1/1	Max value	4.27	4.27
Lead	1/4	95% Student's-t	0.47	0.32	3/3	Max Value	36.3	33.0	1/1	Max value	0.54	0.54
Mercury	-	-	-	-	2/3	Max Value	0.22	0.09	0/1	Half of max detection limit	0.05	0.05
Nickel	0/4	Half of max detection limit	1.25	1.25	3/3	Max Value	6.70	6.25	1/1	Max value	0.11	0.11
Selenium	0/4	Half of max detection limit	2.50	2.50	2/3	95% Student's-t	2.31	1.02	1/1	Max value	0.90	0.90
Silver	0/4	Half of max detection limit	1.25	1.25	1/3	Max Value	0.70	0.32	0/1	Half of max detection limit	0.03	0.03
Zinc	0/4	Half of max detection limit	5.00	5.00	3/3	Max Value	168	137	1/1	Max value	71.3	71.3

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Table A14.26 Reference Exposure Unit Picayne Gulch Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in Picayne Gulch												
COPEC	**Surface water EPCs (µg/L TRM)**				**Sediment EPCs (mg/kg DW)**				**Invertebrate tissue EPCs (mg/kg DW)**			
	FOD	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**	**FOD**	**UCL method**	**RME**	**CTE**
Arsenic	0/3	Half of max detection limit	1.25	1.25	3/3	Max Value	65.7	49.2	1/1	Max value	1.26	1.26
Cadmium	0/3	Half of max detection limit	0.25	0.25	3/3	Max Value	1.67	1.56	1/1	Max value	0.18	0.18
Chromium	0/3	Half of max detection limit	2.50	2.50	3/3	Max Value	5.16	4.75	1/1	Max value	0.55	0.55
Copper	0/3	Half of max detection limit	1.25	1.25	3/3	Max Value	40.4	36.2	1/1	Max value	3.43	3.43
Lead	1/3	Max value	0.78	0.43	3/3	Max Value	134	85	1/1	Max value	1.02	1.02
Mercury	-	-	-	-	1/3	Max Value	0.01	0.01	0/1	Half of max detection limit	0.04	0.04
Nickel	0/3	Half of max detection limit	1.25	1.25	3/3	Max Value	9.9	8.87	1/1	Max value	0.24	0.24
Selenium	0/3	Half of max detection limit	2.50	2.50	1/3	Max Value	1.70	0.85	1/1	Max value	0.54	0.54
Silver	0/3	Half of max detection limit	1.25	1.25	3/3	Max Value	1.36	1.09	1/1	Max value	0.06	0.06
Zinc	2/3	Max value	40.7	19.3	3/3	Max Value	421	383	1/1	Max value	71.8	71.8

µg/L = microgram per liter
mg/L = milligram per kilogram
COPEC = Contaminants of Potential Ecological Concern
TRM = Total Recoverable Metal
FOD = Frequency of Detection
UCL = Upper Confidence Level (95%)
RME = Reasonable Maximum Exposure; represented by the 95% UCL
CTE = Central Tendency Exposure
EPC = Exposure Point Concentration
DW = Dry-weight

Table A14.27 Reference Exposure Unit North Fork Animas River Surface Water, Sediment, and Invertebrate Tissue EPCs for Wildlife Receptors Foraging in North Fork Animas River Above Burrows Gulch

COPEC	Surface water EPCs (µg/L TRM)				Sediment EPCs (mg/kg DW)				Invertebrate tissue EPCs (mg/kg DW)			
	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE	FOD	UCL method	RME	CTE
Arsenic	0/7	Half of max detection limit	1.25	1.25	4/4	95% Student's-t	73.0	57.9	1/1	Max value	2.07	2.07
Cadmium	6/7	95% Student's-t	1.44	1.05	4/4	95% Student's-t	10.8	8.93	1/1	Max value	1.52	1.52
Chromium	0/7	Half of max detection limit	2.50	2.50	4/4	95% Student's-t	3.23	2.60	1/1	Max value	0.67	0.67
Copper	1/7	95% Student's-t	2.02	1.51	4/4	95% Student's-t	43.6	35.7	1/1	Max value	5.46	5.46
Lead	4/7	95% Student's-t	4.51	2.32	4/4	Max Value	290	208	1/1	Max value	5.97	5.97
Mercury	-	-	-	-	4/4	95% Student's-t	0.04	0.03	0/1	Half of max detection limit	0.05	0.05
Nickel	0/7	Half of max detection limit	1.25	1.25	4/4	Max Value	4.92	4.66	1/1	Max value	0.27	0.27
Selenium	0/7	Half of max detection limit	2.50	2.50	1/4	95% Student's-t	1.49	0.62	1/1	Max value	0.42	0.42
Silver	0/7	Half of max detection limit	1.25	1.25	4/4	Max Value	2.02	1.43	1/1	Max value	0.09	0.09
Zinc	7/7	95% Student's-t	218	166	4/4	Max Value	1180	897	1/1	Max value	185	185

µg/L = microgram per liter

mg/L = milligram per kilogram

COPEC = Contaminants of Potential Ecological Concern

TRM = Total Recoverable Metal

FOD = Frequency of Detection

UCL = Upper Confidence Level (95%)

RME = Reasonable Maximum Exposure; represented by the 95% UCL

CTE = Central Tendency Exposure

EPC = Exposure Point Concentration

DW = Dry-weight

Appendix 15

Wildlife Receptor Estimated Daily Dose Derivation Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 15 Tables:

Table A15.1 EU-01 Estimated Daily Doses (EDDs) for American Dipper Foraging in Mineral Creek from Animas River to South Fork Mineral Creek

Table A15.2 EU-02 Estimated Daily Doses (EDDs) for American Dipper Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

Table A15.3 EU-03 Estimated Daily Doses (EDDs) for American Dipper Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

Table A15.4 EU-04 Estimated Daily Doses (EDDs) for American Dipper Foraging in Mineral Creek Upstream of Mill Creek

Table A15.5 EU-05 Estimated Daily Doses (EDDs) for American Dipper Foraging in South Fork Mineral Creek

Table A15.6 EU-06 Estimated Daily Doses (EDDs) for American Dipper Foraging in Middle Fork Mineral Creek

Table A15.7 EU-07 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

Table A15.8 EU-08 Estimated Daily Doses (EDDs) for American Dipper Foraging in Cunningham Creek

Table A15.9 EU-09 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River from Howardsville to Minnie Gulch

Table A15.10 EU-10 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River from Minnie Gulch to Eureka

Table A15.11 EU-11 Estimated Daily Doses (EDDs) for American Dipper Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

Table A15.12 EU-12 Estimated Daily Doses (EDDs) for American Dipper Foraging in Eureka Gulch Up to Confluence with Upper South Fork

Table A15.13 EU-13 Estimated Daily Doses (EDDs) for American Dipper Foraging in Mainstem South Fork Animas River Up to Confluence

Table A15.14 EU-14 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River from Eureka to Animas Forks

Table A15.15 EU-15 Estimated Daily Doses (EDDs) for American Dipper Foraging in lower West Fork Animas River to Confluence with Placer Gulch

Table A15.16 EU-16 Estimated Daily Doses (EDDs) for the American Dipper Foraging in Placer Gulch to Confluence with Upper West Fork

Table A15.17 EU-17 Estimated Daily Doses (EDDs) for American Dipper Foraging in Upper West Fork Animas River from Placer Gulch Up to its Source

Table A15.18 EU-18 Estimated Daily Doses (EDDs) for American Dipper Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

Table A15.19 EU-19 Estimated Daily Doses (EDDs) for American Dipper Foraging in Burrows Gulch

Table A15.20 EU-DR01 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

Table A15.21 EU-DR02 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

Table A15.22 Reference Exposure Unit Bear Creek Estimated Daily Doses (EDDs) for American Dipper Foraging in Bear Creek

Table A15.23 Reference Exposure Unit Hermosa Creek Estimated Daily Doses (EDDs) for American Dipper Foraging in Hermosa Creek

Table A15.24 Reference Exposure Unit Mill Creek Estimated Daily Doses (EDDs) for American Dipper Foraging in Mill Creek

Table A15.25 Reference Exposure Unit Maggie Gulch Estimated Daily Doses (EDDs) for American Dipper Foraging in Maggie Gulch

Table A15.26 Reference Exposure Unit Picayne Gulch Estimated Daily Doses (EDDs) for American Dipper Foraging in Picayne Gulch

Table A15.27 Reference Exposure Unit North Fork Animas River Estimated Daily Doses (EDDs) for American Dipper Foraging in North Fork Animas River Above Burrows Creek

Table A15.28 EU-01 Estimated Daily Doses (EDDs) for Mallard Foraging in Mineral Creek from Animas River to South Fork

Table A15.29 EU-02 Estimated Daily Doses (EDDs) for Mallard Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

Table A15.30 EU-03 Estimated Daily Doses (EDDs) for Mallard Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

Table A15.31 EU-04 Estimated Daily Doses (EDDs) for Mallard Foraging in Mineral Creek Upstream of Mill Creek

Table A15.32 EU-05 Estimated Daily Doses (EDDs) for Mallard Foraging in South Fork Mineral Creek

Table A15.33 EU-06 Estimated Daily Doses (EDDs) for Mallard Foraging in Middle Fork Mineral Creek

Table A15.34 EU-07 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

Table A15.35 EU-08 Estimated Daily Doses (EDDs) for Mallard Foraging in Cunningham Creek

Table A15.36 EU-09 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River from Howardsville to Minnie Gulch

Table A15.37 EU-10 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River from Minnie Gulch to Eureka

Table A15.38 EU-11 Estimated Daily Doses (EDDs) for Mallard Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

Table A15.39 EU-12 Estimated Daily Doses (EDDs) for Mallard Foraging in Eureka Gulch Up to Confluence with Upper South Fork

Table A15.40 EU-13 Estimated Daily Doses (EDDs) for Mallard Foraging in Mainstem South Fork Animas River Up to Confluence

Table A15.41 EU-14 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River from Eureka to Animas Forks

Table A15.42 EU-15 Estimated Daily Doses (EDDs) for Mallard Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

Table A15.43 EU-16 Estimated Daily Doses (EDDs) for Mallard Foraging in Placer Gulch to Confluence with Upper West Fork

Table A15.44 EU-17 Estimated Daily Doses (EDDs) for Mallard Foraging in Mainstem West Fork Animas River from Placer Gulch Up to its Source

Table A15.45 EU-18 Estimated Daily Doses (EDDs) for Mallard Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

Table A15.46 EU-19 Estimated Daily Doses (EDDs) for Mallard Foraging in Burrows Gulch

Table A15.47 EU-DR01 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

Table A15.48 EU-DR02 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

Table A15.49 Reference Exposure Unit Bear Creek Estimated Daily Doses (EDDs) for Mallard Foraging in Bear Creek

Table A15.50 Reference Exposure Unit Hermosa Creek Estimated Daily Doses (EDDs) for Mallard Foraging in Hermosa Creek

Table A15.51 Reference Exposure Unit Mill Creek Estimated Daily Doses (EDDs) for Mallard Foraging in Mill Creek

Table A15.52 Reference Exposure Unit Maggie Gulch Estimated Daily Doses (EDDs) for Mallard Foraging in Maggie Gulch

Table A15.53 Reference Exposure Unit Picayne Gulch Estimated Daily Doses (EDDs) for Mallard Foraging in Picayne Gulch

Table A15.54 Reference Exposure Unit North Fork Animas River Estimated Daily Doses (EDDs) for Mallard Foraging in North Fork Animas River above Burrows Gulch

Table A15.55 EU-01 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Mineral Creek from Animas River to South Fork

Table A15.56 EU-02 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

Table A15.57 EU-03 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

Table A15.58 EU-04 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Mineral Creek Upstream of Mill Creek

Table A15.59 EU-05 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in South Fork Mineral Creek

Table A15.60 EU-06 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Middle Fork Mineral Creek

Table A15.61 EU-07 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

Table A15.62 EU-08 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Cunningham Creek

Table A15.63 EU-09 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in the Animas River from Howardsville to Minnie Gulch

Table A15.64 EU-10 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in the Animas River from Minnie Gulch to Eureka

Table A15.65 EU-11 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

Table A15.66 EU-12 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Eureka Gulch Up to Confluence with Upper South Fork

Table A15.67 EU-13 Estimated Daily Doses (EDDs) for the Belted Kingfisher Foraging in Mainstem South Fork Animas River Up to Confluence

Table A15.68 EU-14 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in the Animas River from Eureka to Animas Forks

Table A15.69 EU-15 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in lower West Fork Animas River to Confluence with Placer Gulch

Table A15.70 EU-16 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Placer Gulch to Confluence with Upper West Fork

Table A15.71 EU-17 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Mainstem West Fork Animas River from Placer Gulch Up to its Source

Table A15.72 EU-18 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

Table A15.73 EU-19 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Burrows Gulch

Table A15.74 EU-DR01 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

Table A15.75 EU-DR02 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

Table A15.76 Reference Exposure Unit Bear Creek Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Bear Creek

Table A15.77 Reference Exposure Unit Hermosa Creek Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Hermosa Creek

Table A15.78 Reference Exposure Unit Mill Creek Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Mill Creek

Table A15.79 Reference Exposure Unit Maggie Gulch Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Maggie Gulch

Table A15.80 Reference Exposure Unit Picayne Gulch Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Picayne Gulch

Table A15.81 Reference Exposure Unit North Fork Animas River Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in North Fork Animas River Above Burrows Gulch

Table A15.82 EU-01 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mineral Creek from Animas River to South Fork

Table A15.83 EU-02 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

Table A15.84 EU-03 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

Table A15.85 EU-04 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mineral Creek Upstream of Mill Creek

Table A15.86 EU-05 Estimated Daily Doses (EDDs) for Muskrat Foraging in South Fork Mineral Creek

Table A15.87 EU-06 Estimated Daily Doses (EDDs) for Muskrat Foraging in Middle Fork Mineral Creek

Table A15.88 EU-07 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

Table A15.89 EU-08 Estimated Daily Doses (EDDs) for Mallard Foraging in Cunningham Creek

Table A15.90 EU-09 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River from Howardsville to Minnie Gulch

Table A15.91 EU-10 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River from Minnie Gulch to Eureka

Table A15.92 EU-11 Estimated Daily Doses (EDDs) for Muskrat Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

Table A15.93 EU-12 Estimated Daily Doses (EDDs) for Muskrat Foraging in Eureka Gulch Up to Confluence with Upper South Fork

Table A15.94 EU-13 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mainstem South Fork Animas River Up to Confluence

Table A15.95 EU-14 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River from Eureka to Animas Forks

Table A15.96 EU-15 Estimated Daily Doses (EDDs) for Muskrat Foraging in lower West Fork Animas River to Confluence with Placer Gulch

Table A15.97 EU-16 Estimated Daily Doses (EDDs) for Muskrat Foraging in Placer Gulch to Confluence with Upper West Fork

Table A15.98 EU-17 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mainstem West Fork Animas River from Placer Gulch Up to its Source

Table A15.99 EU-18 Estimated Daily Doses (EDDs) for Muskrat Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

Table A15.100 EU-19 Estimated Daily Doses (EDDs) for Muskrat Foraging in Burrows Gulch

Table A15.101 EU-DR01 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

Table A15.102 EU-DR02 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

Table A15.103 Reference Exposure Unit Bear Creek Estimated Daily Doses (EDDs) for Muskrat Foraging in Bear Creek

Table A15.104 Reference Exposure Unit Hermosa Creek Estimated Daily Doses (EDDs) for Muskrat Foraging in Hermosa Creek

Table A15.105 Reference Exposure Unit Mill Creek Estimated Daily Doses (EDDs) for Muskrat Foraging in Mill Creek

Table A15.106 Reference Exposure Unit Maggie Gulch Estimated Daily Doses (EDDs) for Muskrat Foraging in Maggie Gulch

Table A15.107 Reference Exposure Unit Picayne Gulch Estimated Daily Doses (EDDs) for Muskrat Foraging in Picayne Gulch

Table A15.108 Reference Exposure Unit North Fork Animas River Estimated Daily Doses (EDDs) for Muskrat Foraging in North Fork Animas River above Burrows Gulch

Table A15.109 EU-01 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mineral Creek from Animas River to South Fork

Table A15.110 EU-02 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

Table A15.111 EU-03 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

Table A15.112 EU-04 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mineral Creek Upstream of Mill Creek

Table A15.113 EU-05 Estimated Daily Doses (EDDs) for Raccoon Foraging in South Fork Mineral Creek

Table A15.114 EU-06 Estimated Daily Doses (EDDs) for Raccoon Foraging in Middle Fork Mineral Creek

Table A15.115 EU-07 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

Table A15.116 EU-08 Estimated Daily Doses (EDDs) for Raccoon Foraging in Cunningham Creek

Table A15.117 EU-09 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River from Howardsville to Minnie Gulch

Table A15.118 EU-10 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River from Minnie Gulch to Eureka

Table A15.119 EU-11 Estimated Daily Doses (EDDs) for Raccoon Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

Table A15.120 EU-12 Estimated Daily Doses (EDDs) for Raccoon Foraging in Eureka Gulch Up to Confluence with Upper South Fork

Table A15.121 EU-13 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mainstem South Fork Animas River Up to Confluence

Table A15.122 EU-14 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River from Eureka to Animas Forks

Table A15.123 EU-15 Estimated Daily Doses (EDDs) for Raccoon Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

Table A15.124 EU-16 Estimated Daily Doses (EDDs) for Raccoon Foraging in Placer Gulch to Confluence with Upper West Fork

Table A15.125 EU-17 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mainstem West Fork Animas River from Placer Gulch Up to its Source

Table A15.126 EU-18 Estimated Daily Doses (EDDs) for Raccoon Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

Table A15.127 EU-19 Estimated Daily Doses (EDDs) for Raccoon Foraging in Burrows Gulch

Table A15.128 EU-DR01 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

Table A15.129 EU-DR02 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

Table A15.130 Reference Exposure Unit Bear Creek Estimated Daily Doses (EDDs) for Raccoon Foraging in Bear Creek

Table A15.131 Reference Exposure Unit Hermosa Creek Estimated Daily Doses (EDDs) for Raccoon Foraging in Hermosa Creek

Table A15.132 Reference Exposure Unit Mill Creek Estimated Daily Doses (EDDs) for Raccoon Foraging in Mill Creek

Table A15.133 Reference Exposure Unit Maggie Gulch Estimated Daily Doses (EDDs) for Raccoon Foraging in Maggie Gulch

Table A15.134 Reference Exposure Unit Picayne Gulch Estimated Daily Doses (EDDs) for Raccoon Foraging in Picayne Gulch

Table A15.135 Reference Exposure Unit North Fork Animas River Estimated Daily Doses (EDDs) for Raccoon Foraging in North Fork Animas River Above Burrows Gulch

Table A15.1 EU-01 Estimated Daily Doses (EDDs) for American Dipper Foraging in Mineral Creek from Animas River to South Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	46.8	2.67E-03	Measured	2.35	4.14E-01	8.24E-01	4.13E-04	1.24E+00	34.2	1.58E-03	Measured	1.27	2.23E-01	6.03E-01	2.45E-04	8.26E-01
Cadmium	2.04	7.37E-04	Measured	1.05	1.85E-01	3.60E-02	1.14E-04	2.21E-01	1.58	5.17E-04	Measured	0.58	1.02E-01	2.78E-02	8.01E-05	1.30E-01
Chromium	6.45	2.52E-03	Measured	5.24	9.22E-01	1.14E-01	3.91E-04	1.04E+00	3.67	2.32E-03	Measured	2.87	5.05E-01	6.46E-02	3.59E-04	5.70E-01
Copper	140	1.13E-02	Measured	80.6	1.42E+01	2.46E+00	1.75E-03	1.67E+01	118	9.75E-03	Measured	46.0	8.10E+00	2.08E+00	1.51E-03	1.02E+01
Lead	276	1.49E-02	Measured	75.0	1.32E+01	4.85E+00	2.31E-03	1.81E+01	229	9.96E-03	Measured	38.3	6.75E+00	4.03E+00	1.54E-03	1.08E+01
Mercury (inorganic)	0.19	4.00E-05	Measured	0.05	8.72E-03	3.26E-03	6.20E-06	1.20E-02	0.09	2.20E-05	Measured	0.04	6.56E-03	1.58E-03	3.41E-06	8.14E-03
Nickel	7.18	1.96E-03	Measured	0.07	1.31E-02	1.26E-01	3.04E-04	1.40E-01	5.88	1.64E-03	Measured	0.07	1.31E-02	1.03E-01	2.54E-04	1.17E-01
Selenium	10.5	2.50E-03	Measured	1.71	3.01E-01	1.84E-01	3.88E-04	4.85E-01	3.85	1.99E-03	Measured	1.06	1.86E-01	6.78E-02	3.09E-04	2.54E-01
Silver	1.77	1.25E-03	Measured	0.03	5.50E-03	3.11E-02	1.94E-04	3.68E-02	1.02	1.09E-03	Measured	0.03	5.50E-03	1.79E-02	1.69E-04	2.36E-02
Zinc	678	1.60E-01	Measured	192	3.38E+01	1.19E+01	2.49E-02	4.58E+01	517	1.40E-01	Measured	116	2.04E+01	9.09E+00	2.18E-02	2.96E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, DW)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, DW)	0.0176	

Table A15.2 EU-02 Estimated Daily Doses (EDDs) for American Dipper Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	62.9	1.77E-03	Measured	0.32	5.54E-02	1.11E+00	2.74E-04	1.16E+00	47.3	1.44E-03	Measured	0.32	5.54E-02	8.33E-01	2.23E-04	8.89E-01
Cadmium	1.80	1.10E-03	Measured	0.06	1.11E-02	3.17E-02	1.71E-04	4.29E-02	1.26	9.00E-04	Measured	0.06	1.11E-02	2.22E-02	1.39E-04	3.34E-02
Chromium	2.40	2.50E-03	Measured	0.63	1.11E-01	4.22E-02	3.88E-04	1.53E-01	1.72	2.50E-03	Measured	0.63	1.11E-01	3.03E-02	3.88E-04	1.42E-01
Copper	84.0	1.71E-02	Measured	5.46	9.61E-01	1.48E+00	2.65E-03	2.44E+00	76.1	1.56E-02	Measured	5.46	9.61E-01	1.34E+00	2.41E-03	2.30E+00
Lead	386	2.15E-02	Measured	8.20	1.44E+00	6.79E+00	3.34E-03	8.24E+00	333	1.40E-02	Measured	8.20	1.44E+00	5.87E+00	2.17E-03	7.31E+00
Mercury (inorganic)	0.08	-	Measured	0.50	8.79E-02	1.48E-03	-	8.94E-02	0.05	-	Measured	0.50	8.79E-02	9.03E-04	-	8.88E-02
Nickel	3.43	1.25E-03	Measured	0.32	5.54E-02	6.04E-02	1.94E-04	1.16E-01	2.85	1.25E-03	Measured	0.32	5.54E-02	5.02E-02	1.94E-04	1.06E-01
Selenium	1.90	2.50E-03	Measured	0.63	1.11E-01	3.34E-02	3.88E-04	1.45E-01	1.52	2.50E-03	Measured	0.63	1.11E-01	2.68E-02	3.88E-04	1.38E-01
Silver	0.63	1.25E-03	Measured	0.32	5.54E-02	1.10E-02	1.94E-04	6.66E-02	0.32	1.25E-03	Measured	0.32	5.54E-02	5.67E-03	1.94E-04	6.13E-02
Zinc	1328	2.65E-01	Measured	23.6	4.15E+00	2.34E+01	4.10E-02	2.76E+01	722	2.22E-01	Measured	23.6	4.15E+00	1.27E+01	3.44E-02	1.69E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, DW)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, DW)	0.0176	

Table A15.3 EU-03 Estimated Daily Doses (EDDs) for American Dipper Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	55.9	6.26E-03	Measured	0.73	1.28E-01	9.84E-01	9.70E-04	1.11E+00	48.2	2.64E-03	Measured	0.60	1.06E-01	8.49E-01	4.09E-04	9.55E-01
Cadmium	10.9	8.55E-04	Measured	0.24	4.17E-02	1.91E-01	1.33E-04	2.33E-01	5.55	6.54E-04	Measured	0.19	3.34E-02	9.77E-02	1.01E-04	1.31E-01
Chromium	3.90	2.50E-03	Measured	0.57	9.94E-02	6.86E-02	3.88E-04	1.68E-01	2.53	2.50E-03	Measured	0.55	9.71E-02	4.45E-02	3.88E-04	1.42E-01
Copper	185	2.30E-02	Measured	18.9	3.33E+00	3.25E+00	3.57E-03	6.58E+00	117	1.80E-02	Measured	16.5	2.90E+00	2.06E+00	2.80E-03	4.97E+00
Lead	778	4.80E-02	Measured	28.5	5.02E+00	1.37E+01	7.44E-03	1.87E+01	456	3.09E-02	Measured	18.3	3.21E+00	8.03E+00	4.79E-03	1.12E+01
Mercury (inorganic)	0.28	-	Measured	0.05	8.38E-03	4.96E-03	-	1.33E-02	0.13	-	Measured	0.05	8.20E-03	2.24E-03	-	1.04E-02
Nickel	5.85	1.25E-03	Measured	0.11	1.97E-02	1.03E-01	1.94E-04	1.23E-01	4.25	1.25E-03	Measured	0.11	1.89E-02	7.47E-02	1.94E-04	9.38E-02
Selenium	1.40	2.50E-03	Measured	0.31	5.44E-02	2.46E-02	3.88E-04	7.94E-02	0.96	2.50E-03	Measured	0.31	5.38E-02	1.69E-02	3.88E-04	7.10E-02
Silver	1.34	1.25E-03	Measured	0.03	5.36E-03	2.36E-02	1.94E-04	2.91E-02	0.96	1.25E-03	Measured	0.03	5.21E-03	1.68E-02	1.94E-04	2.22E-02
Zinc	2920	2.58E-01	Measured	98.6	1.74E+01	5.14E+01	4.01E-02	6.88E+01	1749	2.09E-01	Measured	75.2	1.32E+01	3.08E+01	3.23E-02	4.40E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.4 EU-04 Estimated Daily Doses (EDDs) for American Dipper Foraging in Mineral Creek Upstream of Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Invert tissue concentration (C_{invert})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Invert tissue concentration (C_{invert})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	160	1.25E-03	Measured	2.55	4.49E-01	2.82E+00	1.94E-04	3.26E+00	126	1.25E-03	Measured	2.55	4.49E-01	2.22E+00	1.94E-04	2.67E+00
Cadmium	12.7	2.39E-03	Measured	0.37	6.44E-02	2.24E-01	3.71E-04	2.88E-01	8.00	1.38E-03	Measured	0.37	6.44E-02	1.41E-01	2.14E-04	2.05E-01
Chromium	2.43	2.50E-03	Measured	0.44	7.69E-02	4.28E-02	3.88E-04	1.20E-01	1.87	2.50E-03	Measured	0.44	7.69E-02	3.29E-02	3.88E-04	1.10E-01
Copper	439	3.08E-02	Measured	58.7	1.03E+01	7.73E+00	4.77E-03	1.81E+01	304	2.24E-02	Measured	58.7	1.03E+01	5.34E+00	3.48E-03	1.57E+01
Lead	1890	9.21E-02	Measured	166	2.92E+01	3.33E+01	1.43E-02	6.25E+01	1326	4.57E-02	Measured	166	2.92E+01	2.33E+01	7.08E-03	5.26E+01
Mercury (inorganic)	0.31	-	Measured	0.05	9.42E-03	5.37E-03	-	1.48E-02	0.17	-	Measured	0.05	9.42E-03	2.90E-03	-	1.23E-02
Nickel	8.89	1.25E-03	Measured	0.20	3.59E-02	1.56E-01	1.94E-04	1.93E-01	5.55	1.25E-03	Measured	0.20	3.59E-02	9.77E-02	1.94E-04	1.34E-01
Selenium	0.70	2.50E-03	Measured	0.18	3.12E-02	1.23E-02	3.88E-04	4.39E-02	0.70	2.50E-03	Measured	0.18	3.12E-02	1.23E-02	3.88E-04	4.39E-02
Silver	3.55	1.25E-03	Measured	0.07	1.20E-02	6.25E-02	1.94E-04	7.46E-02	3.55	1.25E-03	Measured	0.07	1.20E-02	6.25E-02	1.94E-04	7.46E-02
Zinc	5900	8.70E-01	Measured	110	1.94E+01	1.04E+02	1.35E-01	1.23E+02	5770	4.67E-01	Measured	110	1.94E+01	1.02E+02	7.24E-02	1.21E+02

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.176	100% invertebrates
IR_{water} (L/kg BW-day)	0.155	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.0176	

Table A15.5 EU-05 Estimated Daily Doses (EDDs) for American Dipper Foraging in South Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	14.5	1.25E-03	Measured	0.35	6.23E-02	2.55E-01	1.94E-04	3.18E-01	12.5	1.25E-03	Measured	0.35	6.12E-02	2.20E-01	1.94E-04	2.81E-01
Cadmium	1.00	2.50E-04	Measured	0.32	5.56E-02	1.76E-02	3.88E-05	7.33E-02	0.60	2.50E-04	Measured	0.21	3.76E-02	1.06E-02	3.88E-05	4.82E-02
Chromium	3.20	2.50E-03	Measured	0.79	1.38E-01	5.63E-02	3.88E-04	1.95E-01	3.11	2.50E-03	Measured	0.65	1.14E-01	5.47E-02	3.88E-04	1.70E-01
Copper	18.9	1.25E-03	Measured	7.92	1.39E+00	3.33E-01	1.94E-04	1.73E+00	18.8	1.25E-03	Measured	5.92	1.04E+00	3.31E-01	1.94E-04	1.37E+00
Lead	106	1.19E-03	Measured	1.62	2.85E-01	1.87E+00	1.84E-04	2.15E+00	87.3	7.41E-04	Measured	1.16	2.04E-01	1.54E+00	1.15E-04	1.74E+00
Mercury (inorganic)	0.09	-	Measured	0.09	1.57E-02	1.50E-03	-	1.72E-02	0.05	-	Measured	0.07	1.19E-02	7.92E-04	-	1.27E-02
Nickel	11.6	1.25E-03	Measured	0.88	1.55E-01	2.04E-01	1.94E-04	3.59E-01	8.45	1.25E-03	Measured	0.57	1.01E-01	1.49E-01	1.94E-04	2.50E-01
Selenium	1.90	2.50E-03	Measured	0.54	9.49E-02	3.34E-02	3.88E-04	1.29E-01	1.32	2.50E-03	Measured	0.51	9.04E-02	2.32E-02	3.88E-04	1.14E-01
Silver	0.72	1.25E-03	Measured	0.06	9.86E-03	1.26E-02	1.94E-04	2.27E-02	0.37	1.25E-03	Measured	0.04	7.49E-03	6.48E-03	1.94E-04	1.42E-02
Zinc	386	2.28E-02	Measured	90.9	1.60E+01	6.79E+00	3.53E-03	2.28E+01	255	1.96E-02	Measured	66.3	1.17E+01	4.49E+00	3.04E-03	1.62E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.6 EU-06 Estimated Daily Doses (EDDs) for American Dipper Foraging in Middle Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	16.9	1.25E-03	Ref. Eq.	4.30	7.57E-01	2.97E-01	1.94E-04	1.06E+00	13.9	1.25E-03	Ref. Eq.	3.71	6.52E-01	2.44E-01	1.94E-04	8.97E-01
Cadmium	0.60	1.40E-03	Ref. Eq.	0.37	6.58E-02	1.06E-02	2.17E-04	7.66E-02	0.40	7.21E-04	Ref. Eq.	0.30	5.36E-02	7.09E-03	1.12E-04	6.08E-02
Chromium	1.60	2.50E-03	Ref. Eq.	1.92	3.38E-01	2.82E-02	3.88E-04	3.67E-01	1.37	2.50E-03	Ref. Eq.	1.81	3.19E-01	2.41E-02	3.88E-04	3.44E-01
Copper	24.3	6.04E-03	Ref. Factor	20.0	3.52E+00	4.28E-01	9.36E-04	3.95E+00	19.9	3.45E-03	Ref. Factor	16.4	2.88E+00	3.50E-01	5.34E-04	3.23E+00
Lead	100	3.37E-03	Ref. Eq.	6.18	1.09E+00	1.76E+00	5.22E-04	2.85E+00	83.6	1.58E-03	Ref. Eq.	5.50	9.68E-01	1.47E+00	2.45E-04	2.44E+00
Mercury (inorganic)	0.01	-	Site-sp. Eq.	0.14	2.55E-02	2.11E-04	-	2.57E-02	0.01	-	Site-sp. Eq.	0.14	2.47E-02	1.49E-04	-	2.49E-02
Nickel	1.77	2.94E-03	Ref. Eq.	0.54	9.50E-02	3.12E-02	4.56E-04	1.27E-01	1.17	1.76E-03	Ref. Eq.	0.40	7.11E-02	2.05E-02	2.72E-04	9.18E-02
Selenium	1.50	2.50E-03	Ref. Factor	1.50	2.64E-01	2.64E-02	3.88E-04	2.91E-01	1.33	2.50E-03	Ref. Factor	1.33	2.35E-01	2.35E-02	3.88E-04	2.59E-01
Silver	0.63	1.25E-03	Ref. Factor	0.11	1.98E-02	1.10E-02	1.94E-04	3.10E-02	0.42	1.25E-03	Ref. Factor	0.08	1.34E-02	7.44E-03	1.94E-04	2.10E-02
Zinc	130	1.81E-01	Site-sp. Eq.	53.7	9.45E+00	2.29E+00	2.81E-02	1.18E+01	117	9.45E-02	Site-sp. Eq.	50.9	8.96E+00	2.05E+00	1.46E-02	1.10E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-invertebrate equations and factors (DW)

Arsenic	[Invert. tissue] = $10^{-0.292+0.754(\text{Log(Sediment concentration)})}$
Cadmium	[Invert. tissue] = $10^{-0.314+0.513(\text{Log(Sediment concentration)})}$
Chromium	[Invert. tissue] = $10^{0.2092+0.365(\text{Log(Sediment concentration)})}$
Copper	[Invert. tissue] = 0.824*[Sediment]
Lead	[Invert. tissue] = $10^{-0.515+0.653(\text{Log(Sediment concentration)})}$
Mercury	[Invert. tissue] = 1.2268*[Sediment] + 0.1301
Nickel	[Invert. tissue] = $10^{-0.44+0.695(\text{Log(Sediment concentration)})}$
Selenium	[Invert. tissue] = 1.0*Sediment concentration
Silver	[Invert. tissue] = 0.18*Sediment concentration
Zinc	[Invert. tissue] = 4.8814*Sediment concentration$^{0.4927}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.7 EU-07 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	24.8	1.31E-03	Measured	18.60	3.27E+00	4.37E-01	2.02E-04	3.71E+00	20.7	1.27E-03	Measured	4.14	7.28E-01	3.65E-01	1.97E-04	1.09E+00
Cadmium	12.0	1.03E-03	Measured	8.37	1.47E+00	2.11E-01	1.59E-04	1.68E+00	9.68	7.96E-04	Measured	2.59	4.55E-01	1.70E-01	1.23E-04	6.26E-01
Chromium	4.80	2.50E-03	Measured	3.95	6.95E-01	8.44E-02	3.88E-04	7.80E-01	4.12	2.50E-03	Measured	2.25	3.96E-01	7.25E-02	3.88E-04	4.69E-01
Copper	315	1.29E-02	Measured	143	2.52E+01	5.54E+00	2.00E-03	3.07E+01	267	8.51E-03	Measured	46.5	8.18E+00	4.70E+00	1.32E-03	1.29E+01
Lead	1442	1.28E-02	Measured	400	7.04E+01	2.54E+01	1.98E-03	9.58E+01	1232	6.23E-03	Measured	89.8	1.58E+01	2.17E+01	9.65E-04	3.75E+01
Mercury (inorganic)	0.11	-	Measured	0.05	9.08E-03	1.85E-03	-	1.09E-02	0.07	-	Measured	0.04	7.62E-03	1.26E-03	-	8.88E-03
Nickel	8.03	1.25E-03	Measured	0.50	8.73E-02	1.41E-01	1.94E-04	2.29E-01	6.96	1.25E-03	Measured	0.32	5.61E-02	1.23E-01	1.94E-04	1.79E-01
Selenium	1.14	2.50E-03	Measured	1.72	3.03E-01	2.00E-02	3.88E-04	3.24E-01	0.90	2.46E-03	Measured	1.15	2.02E-01	1.59E-02	3.82E-04	2.19E-01
Silver	5.79	1.25E-03	Measured	0.14	2.41E-02	1.02E-01	1.94E-04	1.26E-01	4.55	1.25E-03	Measured	0.11	1.85E-02	8.01E-02	1.94E-04	9.87E-02
Zinc	3505	3.20E-01	Measured	2140	3.77E+02	6.17E+01	4.97E-02	4.38E+02	2695	3.06E-01	Measured	708	1.25E+02	4.74E+01	4.75E-02	1.72E+02

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.8 EU-08 Estimated Daily Doses (EDDs) for American Dipper Foraging in Cunningham Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	11.9	1.25E-03	Measured	0.43	7.59E-02	2.09E-01	1.94E-04	2.85E-01	8.90	1.25E-03	Measured	0.43	7.59E-02	1.57E-01	1.94E-04	2.33E-01
Cadmium	2.87	2.50E-04	Measured	1.34	2.36E-01	5.05E-02	3.88E-05	2.86E-01	2.17	2.50E-04	Measured	1.34	2.36E-01	3.81E-02	3.88E-05	2.74E-01
Chromium	4.08	2.50E-03	Measured	0.53	9.35E-02	7.18E-02	3.88E-04	1.66E-01	3.36	2.50E-03	Measured	0.53	9.35E-02	5.90E-02	3.88E-04	1.53E-01
Copper	108	1.25E-03	Measured	29.0	5.10E+00	1.90E+00	1.94E-04	7.01E+00	70.9	1.25E-03	Measured	29.0	5.10E+00	1.25E+00	1.94E-04	6.35E+00
Lead	636	3.74E-03	Measured	8.52	1.50E+00	1.12E+01	5.79E-04	1.27E+01	441	2.06E-03	Measured	8.52	1.50E+00	7.75E+00	3.19E-04	9.25E+00
Mercury (inorganic)	0.04	-	Measured	0.05	8.72E-03	6.67E-04	-	9.39E-03	0.02	-	Measured	0.05	8.72E-03	3.19E-04	-	9.04E-03
Nickel	4.31	1.25E-03	Measured	0.10	1.81E-02	7.58E-02	1.94E-04	9.42E-02	3.54	1.25E-03	Measured	0.10	1.81E-02	6.23E-02	1.94E-04	8.07E-02
Selenium	4.01	2.50E-03	Measured	0.67	1.17E-01	7.05E-02	3.88E-04	1.88E-01	1.70	2.50E-03	Measured	0.67	1.17E-01	2.99E-02	3.88E-04	1.48E-01
Silver	1.64	1.25E-03	Measured	0.28	4.98E-02	2.89E-02	1.94E-04	7.89E-02	1.18	1.25E-03	Measured	0.28	4.98E-02	2.08E-02	1.94E-04	7.08E-02
Zinc	507	3.70E-02	Measured	134	2.36E+01	8.92E+00	5.73E-03	3.25E+01	429	2.94E-02	Measured	134	2.36E+01	7.55E+00	4.55E-03	3.11E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.9 EU-09 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River from Howardsville to Minnie Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	34.8	1.25E-03	Measured	0.88	1.54E-01	6.12E-01	1.94E-04	7.66E-01	28.6	1.19E-03	Measured	0.66	1.17E-01	5.04E-01	1.84E-04	6.20E-01
Cadmium	14.0	1.22E-03	Measured	3.43	6.03E-01	2.47E-01	1.89E-04	8.50E-01	10.7	1.03E-03	Measured	2.20	3.87E-01	1.89E-01	1.59E-04	5.76E-01
Chromium	4.49	2.50E-03	Measured	1.69	2.97E-01	7.91E-02	3.88E-04	3.76E-01	3.85	2.35E-03	Measured	1.15	2.03E-01	6.78E-02	3.65E-04	2.71E-01
Copper	458	2.04E-02	Measured	59.9	1.05E+01	8.06E+00	3.16E-03	1.86E+01	348	1.35E-02	Measured	39.8	7.00E+00	6.12E+00	2.10E-03	1.31E+01
Lead	1940	1.22E-02	Measured	22.1	3.89E+00	3.41E+01	1.89E-03	3.80E+01	1534	5.49E-03	Measured	16.3	2.88E+00	2.70E+01	8.51E-04	2.99E+01
Mercury (inorganic)	0.15	-	Measured	0.08	1.36E-02	2.68E-03	-	1.63E-02	0.06	-	Measured	0.06	1.12E-02	1.01E-03	-	1.22E-02
Nickel	9.9	1.25E-03	Measured	0.51	8.93E-02	1.74E-01	1.94E-04	2.63E-01	7.96	1.24E-03	Measured	0.38	6.62E-02	1.40E-01	1.92E-04	2.06E-01
Selenium	1.28	2.50E-03	Measured	0.39	6.87E-02	2.25E-02	3.88E-04	9.17E-02	0.90	2.38E-03	Measured	0.37	6.53E-02	1.59E-02	3.69E-04	8.15E-02
Silver	5.94	1.25E-03	Measured	0.20	3.44E-02	1.05E-01	1.94E-04	1.39E-01	4.69	1.18E-03	Measured	0.15	2.60E-02	8.25E-02	1.82E-04	1.09E-01
Zinc	3526	4.01E-01	Measured	575	1.01E+02	6.21E+01	6.21E-02	1.63E+02	2472	3.61E-01	Measured	394	6.93E+01	4.35E+01	5.59E-02	1.13E+02

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.10 EU-10 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River from Minnie Gulch to Eureka

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	49.7	1.25E-03	Measured	0.90	1.58E-01	8.75E-01	1.94E-04	1.03E+00	44.1	1.20E-03	Measured	0.90	1.58E-01	7.76E-01	1.86E-04	9.34E-01
Cadmium	33.1	2.01E-03	Measured	1.12	1.97E-01	5.82E-01	3.11E-04	7.79E-01	16.5	1.79E-03	Measured	1.12	1.97E-01	2.90E-01	2.78E-04	4.87E-01
Chromium	4.85	2.50E-03	Measured	0.58	1.02E-01	8.53E-02	3.88E-04	1.88E-01	4.51	2.36E-03	Measured	0.58	1.02E-01	7.94E-02	3.66E-04	1.82E-01
Copper	764	4.10E-02	Measured	30.7	5.40E+00	1.34E+01	6.35E-03	1.89E+01	500	2.90E-02	Measured	30.7	5.40E+00	8.80E+00	4.50E-03	1.42E+01
Lead	1907	9.67E-03	Measured	10.5	1.85E+00	3.36E+01	1.50E-03	3.54E+01	1433	6.17E-03	Measured	10.5	1.85E+00	2.52E+01	9.56E-04	2.71E+01
Mercury (inorganic)	0.12	-	Measured	0.05	9.42E-03	2.06E-03	-	1.15E-02	0.05	-	Measured	0.05	9.42E-03	8.45E-04	-	1.03E-02
Nickel	13.9	1.55E-03	Measured	0.30	5.21E-02	2.45E-01	2.40E-04	2.98E-01	10.0	1.36E-03	Measured	0.30	5.21E-02	1.76E-01	2.11E-04	2.29E-01
Selenium	4.81	2.50E-03	Measured	0.23	3.98E-02	8.47E-02	3.88E-04	1.25E-01	2.16	2.39E-03	Measured	0.23	3.98E-02	3.81E-02	3.70E-04	7.82E-02
Silver	24.5	1.25E-03	Measured	0.11	1.90E-02	4.30E-01	1.94E-04	4.50E-01	8.84	1.18E-03	Measured	0.11	1.90E-02	1.56E-01	1.83E-04	1.75E-01
Zinc	5966	6.07E-01	Measured	212	3.73E+01	1.05E+02	9.41E-02	1.42E+02	3528	5.49E-01	Measured	212	3.73E+01	6.21E+01	8.51E-02	9.95E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.11 EU-11 Estimated Daily Doses (EDDs) for American Dipper Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	40.9	1.25E-03	Measured	0.08	1.39E-02	7.20E-01	1.94E-04	7.34E-01	28.6	1.25E-03	Measured	0.08	1.39E-02	5.03E-01	1.94E-04	5.17E-01
Cadmium	1.56	2.50E-04	Measured	0.12	2.08E-02	2.75E-02	3.88E-05	4.83E-02	1.17	2.50E-04	Measured	0.12	2.08E-02	2.05E-02	3.88E-05	4.13E-02
Chromium	6.19	2.50E-03	Measured	0.31	5.39E-02	1.09E-01	3.88E-04	1.63E-01	5.44	2.50E-03	Measured	0.31	5.39E-02	9.57E-02	3.88E-04	1.50E-01
Copper	110	1.23E-02	Measured	1.89	3.33E-01	1.94E+00	1.91E-03	2.28E+00	91.2	8.01E-03	Measured	1.89	3.33E-01	1.60E+00	1.24E-03	1.94E+00
Lead	317	2.16E-03	Measured	0.33	5.76E-02	5.58E+00	3.35E-04	5.64E+00	207	8.32E-04	Measured	0.33	5.76E-02	3.64E+00	1.29E-04	3.70E+00
Mercury (inorganic)	0.01	-	Measured	0.05	8.38E-03	1.41E-04	-	8.52E-03	0.01	-	Measured	0.05	8.38E-03	1.10E-04	-	8.49E-03
Nickel	10.1	1.25E-03	Measured	0.17	3.04E-02	1.78E-01	1.94E-04	2.08E-01	7.40	1.25E-03	Measured	0.17	3.04E-02	1.30E-01	1.94E-04	1.61E-01
Selenium	2.60	2.50E-03	Measured	0.48	8.45E-02	4.58E-02	3.88E-04	1.31E-01	1.63	2.50E-03	Measured	0.48	8.45E-02	2.86E-02	3.88E-04	1.13E-01
Silver	1.54	1.25E-03	Measured	0.03	5.28E-03	2.71E-02	1.94E-04	3.26E-02	1.16	1.25E-03	Measured	0.03	5.28E-03	2.04E-02	1.94E-04	2.59E-02
Zinc	460	8.32E-02	Measured	46.8	8.24E+00	8.10E+00	1.29E-02	1.63E+01	323	5.76E-02	Measured	46.8	8.24E+00	5.68E+00	8.93E-03	1.39E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.12 EU-12 Estimated Daily Doses (EDDs) for American Dipper Foraging in Eureka Gulch up to Confluence with Upper South Fork Animas River

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	26.0	1.25E-03	Measured	0.33	5.81E-02	4.58E-01	1.94E-04	5.16E-01	18.5	1.25E-03	Measured	0.33	5.81E-02	3.25E-01	1.94E-04	3.83E-01
Cadmium	14.7	1.82E-03	Measured	1.09	1.92E-01	2.59E-01	2.83E-04	4.51E-01	10.9	1.05E-03	Measured	1.09	1.92E-01	1.92E-01	1.63E-04	3.84E-01
Chromium	4.82	2.50E-03	Measured	0.48	8.52E-02	8.47E-02	3.88E-04	1.70E-01	4.07	2.50E-03	Measured	0.48	8.52E-02	7.15E-02	3.88E-04	1.57E-01
Copper	318	1.66E-02	Measured	57.2	1.01E+01	5.60E+00	2.58E-03	1.57E+01	238	9.67E-03	Measured	57.2	1.01E+01	4.19E+00	1.50E-03	1.43E+01
Lead	693	3.99E-03	Measured	34.4	6.05E+00	1.22E+01	6.18E-04	1.82E+01	541	2.15E-03	Measured	34.4	6.05E+00	9.53E+00	3.32E-04	1.56E+01
Mercury (inorganic)	0.04	-	Measured	0.05	8.38E-03	6.16E-04	-	8.99E-03	0.02	-	Measured	0.05	8.38E-03	3.89E-04	-	8.76E-03
Nickel	11.3	1.25E-03	Measured	0.34	5.95E-02	1.99E-01	1.94E-04	2.59E-01	9.90	1.25E-03	Measured	0.34	5.95E-02	1.74E-01	1.94E-04	2.34E-01
Selenium	3.73	2.50E-03	Measured	0.23	4.10E-02	6.57E-02	3.88E-04	1.07E-01	1.67	2.50E-03	Measured	0.23	4.10E-02	2.95E-02	3.88E-04	7.09E-02
Silver	3.65	1.25E-03	Measured	0.19	3.29E-02	6.42E-02	1.94E-04	9.73E-02	2.03	1.25E-03	Measured	0.19	3.29E-02	3.57E-02	1.94E-04	6.88E-02
Zinc	4366	8.54E-01	Measured	199	3.50E+01	7.68E+01	1.32E-01	1.12E+02	2955	4.12E-01	Measured	199	3.50E+01	5.20E+01	6.38E-02	8.71E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.13 EU-13 Estimated Daily Doses (EDDs) for American Dipper Foraging in Mainstem South Fork Animas River Up to Confluence

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	36.2	1.25E-03	Measured	0.75	1.33E-01	6.37E-01	1.94E-04	7.70E-01	25.0	1.13E-03	Measured	0.75	1.33E-01	4.40E-01	1.76E-04	5.72E-01
Cadmium	7.41	1.72E-03	Measured	1.62	2.85E-01	1.30E-01	2.66E-04	4.16E-01	6.98	1.20E-03	Measured	1.62	2.85E-01	1.23E-01	1.86E-04	4.08E-01
Chromium	6.38	2.50E-03	Measured	0.72	1.27E-01	1.12E-01	3.88E-04	2.40E-01	5.66	2.25E-03	Measured	0.72	1.27E-01	9.96E-02	3.49E-04	2.27E-01
Copper	236	6.23E-02	Measured	31.5	5.54E+00	4.15E+00	9.66E-03	9.71E+00	221.3	2.49E-02	Measured	31.5	5.54E+00	3.89E+00	3.86E-03	9.44E+00
Lead	767	3.63E-03	Measured	7.64	1.34E+00	1.35E+01	5.63E-04	1.48E+01	643	2.19E-03	Measured	7.64	1.34E+00	1.13E+01	3.40E-04	1.27E+01
Mercury (inorganic)	0.50	-	Measured	0.10	1.74E-02	8.84E-03	-	2.63E-02	0.24	-	Measured	0.10	1.74E-02	4.27E-03	-	2.17E-02
Nickel	12.5	1.25E-03	Measured	0.62	1.09E-01	2.20E-01	1.94E-04	3.30E-01	10.41	1.24E-03	Measured	0.62	1.09E-01	1.83E-01	1.91E-04	2.93E-01
Selenium	4.14	2.50E-03	Measured	0.32	5.56E-02	7.28E-02	3.88E-04	1.29E-01	2.15	2.29E-03	Measured	0.32	5.56E-02	3.78E-02	3.56E-04	9.37E-02
Silver	2.80	1.25E-03	Measured	0.06	1.09E-02	4.93E-02	1.94E-04	6.04E-02	2.23	1.13E-03	Measured	0.06	1.09E-02	3.92E-02	1.75E-04	5.03E-02
Zinc	2420	5.37E-01	Measured	345	6.07E+01	4.26E+01	8.33E-02	1.03E+02	1940	4.13E-01	Measured	345	6.07E+01	3.41E+01	6.40E-02	9.49E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.14 EU-14 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River from Eureka to Animas Forks

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	58.6	1.25E-03	Measured	0.21	3.73E-02	1.03E+00	1.94E-04	1.07E+00	46.2	1.20E-03	Measured	0.21	3.73E-02	8.12E-01	1.86E-04	8.50E-01
Cadmium	12.00	7.36E-03	Measured	0.77	1.35E-01	2.11E-01	1.14E-03	3.48E-01	9.14	3.99E-03	Measured	0.77	1.35E-01	1.61E-01	6.19E-04	2.97E-01
Chromium	4.32	3.07E-03	Measured	0.41	7.29E-02	7.60E-02	4.76E-04	1.49E-01	3.86	2.71E-03	Measured	0.41	7.29E-02	6.79E-02	4.20E-04	1.41E-01
Copper	458	5.54E-02	Measured	26.20	4.61E+00	8.06E+00	8.58E-03	1.27E+01	325.9	3.93E-02	Measured	26.20	4.61E+00	5.74E+00	6.09E-03	1.04E+01
Lead	1307	1.58E-02	Measured	2.96	5.21E-01	2.30E+01	2.44E-03	2.35E+01	997	9.95E-03	Measured	2.96	5.21E-01	1.76E+01	1.54E-03	1.81E+01
Mercury (inorganic)	0.09	-	Measured	0.11	1.85E-02	1.61E-03	-	2.01E-02	0.06	-	Measured	0.11	1.85E-02	9.96E-04	-	1.95E-02
Nickel	8.5	7.01E-03	Measured	0.07	1.16E-02	1.50E-01	1.09E-03	1.63E-01	6.80	2.98E-03	Measured	0.07	1.16E-02	1.20E-01	4.62E-04	1.32E-01
Selenium	1.22	2.50E-03	Measured	0.13	2.33E-02	2.15E-02	3.88E-04	4.52E-02	0.90	2.36E-03	Measured	0.13	2.33E-02	1.58E-02	3.66E-04	3.95E-02
Silver	5.02	1.25E-03	Measured	0.07	1.16E-02	8.84E-02	1.94E-04	1.00E-01	3.67	1.17E-03	Measured	0.07	1.16E-02	6.45E-02	1.81E-04	7.63E-02
Zinc	3458	1.68E+00	Measured	82.5	1.45E+01	6.09E+01	2.60E-01	7.56E+01	2385	1.16E+00	Measured	82.5	1.45E+01	4.20E+01	1.79E-01	5.67E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.15 EU-15 Estimated Daily Doses (EDDs) for American Dipper Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	41.7	1.25E-03	Ref. Eq.	8.50	1.50E+00	7.34E-01	1.94E-04	2.23E+00	32.1	1.25E-03	Ref. Eq.	6.98	1.23E+00	5.65E-01	1.94E-04	1.79E+00
Cadmium	10.4	9.11E-03	Ref. Eq.	1.61	2.84E-01	1.83E-01	1.41E-03	4.68E-01	6.52	5.94E-03	Ref. Eq.	1.27	2.23E-01	1.15E-01	9.21E-04	3.39E-01
Chromium	4.81	2.50E-03	Ref. Eq.	2.87	5.05E-01	8.47E-02	3.88E-04	5.91E-01	3.73	2.50E-03	Ref. Eq.	2.62	4.61E-01	6.57E-02	3.88E-04	5.27E-01
Copper	477	3.62E-02	Ref. Factor	393.0	6.92E+01	8.40E+00	5.61E-03	7.76E+01	304	2.84E-02	Ref. Factor	251	4.41E+01	5.35E+00	4.40E-03	4.95E+01
Lead	2320	3.73E-02	Ref. Eq.	48.16	8.48E+00	4.08E+01	5.78E-03	4.93E+01	1546	1.56E-02	Ref. Eq.	36.9	6.50E+00	2.72E+01	2.42E-03	3.37E+01
Mercury (inorganic)	0.23	-	Site-sp. Eq.	0.42	7.34E-02	4.12E-03	-	7.75E-02	0.16	-	Site-sp. Eq.	0.33	5.77E-02	2.84E-03	-	6.06E-02
Nickel	7.3	7.64E-03	Ref. Eq.	1.45	2.54E-01	1.28E-01	1.18E-03	3.84E-01	5.14	4.60E-03	Ref. Eq.	1.13	1.99E-01	9.04E-02	7.14E-04	2.90E-01
Selenium	0.84	2.50E-03	Ref. Factor	0.84	1.47E-01	1.47E-02	3.88E-04	1.62E-01	0.55	2.50E-03	Ref. Factor	0.55	9.64E-02	9.64E-03	3.88E-04	1.06E-01
Silver	6.19	1.25E-03	Ref. Factor	1.11	1.96E-01	1.09E-01	1.94E-04	3.05E-01	3.51	1.25E-03	Ref. Factor	0.63	1.11E-01	6.17E-02	1.94E-04	1.73E-01
Zinc	2770	3.30E+00	Site-sp. Eq.	242.5	4.27E+01	4.88E+01	5.11E-01	9.19E+01	1548	2.13E+00	Site-sp. Eq.	182	3.20E+01	2.72E+01	3.29E-01	5.96E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-invertebrate equations and factors (DW)

Arsenic	[Invert. tissue] = $10^{-0.292+0.754(\text{Log(Sediment concentration)})}$
Cadmium	[Invert. tissue] = $10^{-0.314+0.513(\text{Log(Sediment concentration)})}$
Chromium	[Invert. tissue] = $10^{0.2092+0.365(\text{Log(Sediment concentration)})}$
Copper	[Invert. tissue] = 0.824*[Sediment]
Lead	[Invert. tissue] = $10^{-0.515+0.653(\text{Log(Sediment concentration)})}$
Mercury	[Invert. tissue] = 1.2268*[Sediment] + 0.1301
Nickel	[Invert. tissue] = $10^{-0.44+0.695(\text{Log(Sediment concentration)})}$
Selenium	[Invert. tissue] = 1.0*Sediment concentration
Silver	[Invert. tissue] = 0.18*Sediment concentration
Zinc	[Invert. tissue] = 4.8814*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.16 EU-16 Estimated Daily Doses (EDDs) for the American Dipper Foraging in Placer Gulch to Confluence with Upper West Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	66.4	1.25E-03	Measured	0.48	8.44E-02	1.17E+00	1.94E-04	1.25E+00	53.6	1.25E-03	Measured	0.48	8.44E-02	9.43E-01	1.94E-04	1.03E+00
Cadmium	64.2	3.25E-03	Measured	0.34	5.93E-02	1.13E+00	5.04E-04	1.19E+00	36.8	2.90E-03	Measured	0.34	5.93E-02	6.48E-01	4.50E-04	7.08E-01
Chromium	4.33	2.50E-03	Measured	0.96	1.69E-01	7.62E-02	3.88E-04	2.46E-01	3.57	2.50E-03	Measured	0.96	1.69E-01	6.29E-02	3.88E-04	2.32E-01
Copper	1700	3.09E-02	Measured	19.80	3.48E+00	2.99E+01	4.78E-03	3.34E+01	1070	2.45E-02	Measured	19.80	3.48E+00	1.88E+01	3.80E-03	2.23E+01
Lead	9009	2.12E-02	Measured	15.10	2.66E+00	1.59E+02	3.28E-03	1.61E+02	6488	1.66E-02	Measured	15.10	2.66E+00	1.14E+02	2.57E-03	1.17E+02
Mercury (inorganic)	0.98	-	Measured	0.76	1.34E-01	1.72E-02	-	1.51E-01	0.68	-	Measured	0.76	1.34E-01	1.19E-02	-	1.46E-01
Nickel	17.0	3.12E-03	Measured	0.48	8.44E-02	2.99E-01	4.84E-04	3.84E-01	9.53	2.20E-03	Measured	0.48	8.44E-02	1.68E-01	3.42E-04	2.53E-01
Selenium	4.20	2.50E-03	Measured	0.96	1.69E-01	7.40E-02	3.88E-04	2.43E-01	1.88	2.50E-03	Measured	0.96	1.69E-01	3.30E-02	3.88E-04	2.02E-01
Silver	22.2	1.25E-03	Measured	0.48	8.44E-02	3.91E-01	1.94E-04	4.76E-01	12.4	1.25E-03	Measured	0.48	8.44E-02	2.19E-01	1.94E-04	3.03E-01
Zinc	21500	1.45E+00	Measured	51.8	9.12E+00	3.78E+02	2.25E-01	3.88E+02	8470	1.18E+00	Measured	51.8	9.12E+00	1.49E+02	1.83E-01	1.58E+02

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.17 EU-17 Estimated Daily Doses (EDDs) for American Dipper Foraging in Upper West Fork Animas River from Placer Gulch Up to its Source

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	39.0	1.25E-03	Ref. Eq.	8.08	1.42E+00	6.86E-01	1.94E-04	2.11E+00	28.5	1.25E-03	Ref. Eq.	6.38	1.12E+00	5.02E-01	1.94E-04	1.63E+00
Cadmium	2.70	1.27E-02	Ref. Eq.	0.81	1.42E-01	4.75E-02	1.97E-03	1.92E-01	1.83	8.64E-03	Ref. Eq.	0.66	1.16E-01	3.22E-02	1.34E-03	1.50E-01
Chromium	8.52	2.50E-03	Ref. Eq.	3.54	6.23E-01	1.50E-01	3.88E-04	7.73E-01	5.57	2.50E-03	Ref. Eq.	3.03	5.33E-01	9.80E-02	3.88E-04	6.32E-01
Copper	277	3.55E-02	Ref. Factor	228	4.02E+01	4.88E+00	5.49E-03	4.51E+01	193.0	2.60E-02	Ref. Factor	159	2.80E+01	3.40E+00	4.03E-03	3.14E+01
Lead	339	6.16E-03	Ref. Eq.	13.72	2.41E+00	5.97E+00	9.54E-04	8.38E+00	242	3.58E-03	Ref. Eq.	11.00	1.94E+00	4.26E+00	5.55E-04	6.19E+00
Mercury (inorganic)	0.04	-	Site-sp. Eq.	0.18	3.11E-02	6.69E-04	-	3.18E-02	0.03	-	Site-sp. Eq.	0.17	2.94E-02	5.33E-04	-	3.00E-02
Nickel	12.3	1.34E-02	Ref. Eq.	2.07	3.65E-01	2.16E-01	2.07E-03	5.83E-01	7.36	8.69E-03	Ref. Eq.	1.45	2.56E-01	1.30E-01	1.35E-03	3.87E-01
Selenium	1.71	2.50E-03	Ref. Factor	1.71	3.01E-01	3.01E-02	3.88E-04	3.31E-01	0.90	2.50E-03	Ref. Factor	0.90	1.59E-01	1.59E-02	3.88E-04	1.75E-01
Silver	2.16	1.25E-03	Ref. Factor	0.39	6.84E-02	3.80E-02	1.94E-04	1.07E-01	1.27	1.25E-03	Ref. Factor	0.23	4.01E-02	2.23E-02	1.94E-04	6.25E-02
Zinc	834	3.93E+00	Site-sp. Eq.	134	2.36E+01	1.47E+01	6.09E-01	3.89E+01	686	2.64E+00	Site-sp. Eq.	122	2.15E+01	1.21E+01	4.09E-01	3.39E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-invertebrate equations and factors (DW)

Arsenic	[Invert. tissue] = $10^{-0.292+0.754(\text{Log(Sediment concentration)})}$
Cadmium	[Invert. tissue] = $10^{-0.314+0.513(\text{Log(Sediment concentration)})}$
Chromium	[Invert. tissue] = $10^{0.2092+0.365(\text{Log(Sediment concentration)})}$
Copper	[Invert. tissue] = 0.824*[Sediment]
Lead	[Invert. tissue] = $10^{-0.515+0.653(\text{Log(Sediment concentration)})}$
Mercury	[Invert. tissue] = 1.2268*[Sediment] + 0.1301
Nickel	[Invert. tissue] = $10^{-0.44+0.695(\text{Log(Sediment concentration)})}$
Selenium	[Invert. tissue] = 1.0*Sediment concentration
Silver	[Invert. tissue] = 0.18*Sediment concentration
Zinc	[Invert. tissue] = 4.8814*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.176	100% invertebrates
IR_{water} (L/kg BW-day)	0.155	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.0176	

Table A15.18 EU-18 Estimated Daily Doses (EDDs) for the American Dipper Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	57.1	1.25E-03	Ref. Eq.	10.8	1.90E+00	1.01E+00	1.94E-04	2.90E+00	41.1	1.25E-03	Ref. Eq.	8.41	1.48E+00	7.23E-01	1.94E-04	2.20E+00
Cadmium	7.62	6.24E-03	Ref. Eq.	1.38	2.42E-01	1.34E-01	9.67E-04	3.77E-01	6.05	5.10E-03	Ref. Eq.	1.22	2.15E-01	1.07E-01	7.91E-04	3.22E-01
Chromium	3.27	2.50E-03	Ref. Eq.	2.49	4.39E-01	5.75E-02	3.88E-04	4.97E-01	2.67	2.50E-03	Ref. Eq.	2.32	4.08E-01	4.69E-02	3.88E-04	4.55E-01
Copper	101	1.99E-02	Ref. Factor	83.0	1.46E+01	1.77E+00	3.08E-03	1.64E+01	85.0	1.69E-02	Ref. Factor	70.0	1.23E+01	1.50E+00	2.62E-03	1.38E+01
Lead	502	1.27E-02	Ref. Eq.	17.7	3.12E+00	8.84E+00	1.97E-03	1.20E+01	372	7.75E-03	Ref. Eq.	14.6	2.56E+00	6.54E+00	1.20E-03	9.10E+00
Mercury (inorganic)	0.07	-	Site-sp. Eq.	0.22	3.86E-02	1.28E-03	-	3.98E-02	0.03	-	Site-sp. Eq.	0.16	2.84E-02	4.45E-04	-	2.88E-02
Nickel	5.29	3.75E-03	Ref. Eq.	1.16	2.03E-01	9.31E-02	5.82E-04	2.97E-01	4.34	2.31E-03	Ref. Eq.	1.01	1.77E-01	7.64E-02	3.58E-04	2.54E-01
Selenium	3.68	2.50E-03	Ref. Factor	3.68	6.48E-01	6.48E-02	3.88E-04	7.14E-01	0.90	2.50E-03	Ref. Factor	0.90	1.58E-01	1.58E-02	3.88E-04	1.74E-01
Silver	2.08	1.25E-03	Ref. Factor	0.37	6.58E-02	3.66E-02	1.94E-04	1.03E-01	1.46	1.25E-03	Ref. Factor	0.26	4.62E-02	2.57E-02	1.94E-04	7.20E-02
Zinc	1423	1.05E+00	Site-sp. Eq.	175	3.07E+01	2.50E+01	1.63E-01	5.59E+01	938	8.64E-01	Site-sp. Eq.	142	2.50E+01	1.65E+01	1.34E-01	4.17E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Sediment-to-invertebrate equations and factors (DW)

Arsenic	[Invert. tissue] = $10^{-0.292+0.754(\text{Log(Sediment concentration)})}$
Cadmium	[Invert. tissue] = $10^{-0.314+0.513(\text{Log(Sediment concentration)})}$
Chromium	[Invert. tissue] = $10^{0.2092+0.365(\text{Log(Sediment concentration)})}$
Copper	[Invert. tissue] = 0.824*[Sediment]
Lead	[Invert. tissue] = $10^{-0.515+0.653(\text{Log(Sediment concentration)})}$
Mercury	[Invert. tissue] = 1.2268*[Sediment] + 0.1301
Nickel	[Invert. tissue] = $10^{-0.44+0.695(\text{Log(Sediment concentration)})}$
Selenium	[Invert. tissue] = 1.0*Sediment concentration
Silver	[Invert. tissue] = 0.18*Sediment concentration
Zinc	[Invert. tissue] = 4.8814*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.176	100% invertebrates
IR_{water} (L/kg BW-day)	0.155	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.0176	

Table A15.19 EU-19 Estimated Daily Doses (EDDs) for American Dipper Foraging in Burrows Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	54.4	1.25E-03	Measured	1.12	1.97E-01	9.57E-01	1.94E-04	1.15E+00	47.8	1.25E-03	Measured	1.12	1.97E-01	8.42E-01	1.94E-04	1.04E+00
Cadmium	7.7	1.86E-02	Measured	0.31	5.40E-02	1.36E-01	2.88E-03	1.92E-01	7.02	1.40E-02	Measured	0.31	5.40E-02	1.23E-01	2.16E-03	1.80E-01
Chromium	4.21	2.50E-03	Measured	0.30	5.25E-02	7.41E-02	3.88E-04	1.27E-01	3.19	2.50E-03	Measured	0.30	5.25E-02	5.61E-02	3.88E-04	1.09E-01
Copper	224	6.56E-02	Measured	15.9	2.80E+00	3.94E+00	1.02E-02	6.75E+00	204	5.07E-02	Measured	15.9	2.80E+00	3.59E+00	7.86E-03	6.40E+00
Lead	571	9.55E-03	Measured	13.3	2.34E+00	1.01E+01	1.48E-03	1.24E+01	448	7.37E-03	Measured	13.3	2.34E+00	7.88E+00	1.14E-03	1.02E+01
Mercury (inorganic)	0.04	-	Measured	0.24	4.15E-02	6.28E-04	-	4.22E-02	0.02	-	Measured	0.24	4.15E-02	3.61E-04	-	4.19E-02
Nickel	6.95	1.18E-02	Measured	0.15	2.62E-02	1.22E-01	1.83E-03	1.50E-01	5.76	8.18E-03	Measured	0.15	2.62E-02	1.01E-01	1.27E-03	1.29E-01
Selenium	1.28	2.50E-03	Measured	0.30	5.25E-02	2.25E-02	3.88E-04	7.54E-02	0.61	2.50E-03	Measured	0.30	5.25E-02	1.08E-02	3.88E-04	6.37E-02
Silver	1.99	1.25E-03	Measured	0.31	5.51E-02	3.50E-02	1.94E-04	9.03E-02	1.37	1.25E-03	Measured	0.31	5.51E-02	2.40E-02	1.94E-04	7.93E-02
Zinc	850	2.97E+00	Measured	38.5	6.78E+00	1.50E+01	4.60E-01	2.22E+01	712	2.23E+00	Measured	38.5	6.78E+00	1.25E+01	3.46E-01	1.96E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.20 EU-DR01 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	13.2	2.47E-03	Measured	3.93	6.91E-01	2.32E-01	3.83E-04	9.23E-01	11.4	9.91E-04	Measured	2.29	4.03E-01	2.00E-01	1.54E-04	6.03E-01
Cadmium	2.78	5.13E-04	Measured	2.01	3.53E-01	4.89E-02	7.95E-05	4.02E-01	2.22	3.83E-04	Measured	1.53	2.69E-01	3.91E-02	5.94E-05	3.08E-01
Chromium	8.18	1.97E-03	Measured	84	1.47E+01	1.44E-01	3.05E-04	1.49E+01	6.93	9.75E-04	Measured	31.3	5.51E+00	1.22E-01	1.51E-04	5.63E+00
Copper	94.2	1.59E-02	Measured	66.6	1.17E+01	1.66E+00	2.46E-03	1.34E+01	79.3	7.63E-03	Measured	45.1	7.94E+00	1.40E+00	1.18E-03	9.33E+00
Lead	242	7.39E-02	Measured	36.7	6.46E+00	4.25E+00	1.15E-02	1.07E+01	202	1.28E-02	Measured	17.5	3.08E+00	3.55E+00	1.98E-03	6.64E+00
Mercury (inorganic)	0.02	4.00E-05	Measured	0.79	1.38E-01	3.27E-04	6.20E-06	1.38E-01	0.01	1.96E-05	Measured	0.30	5.30E-02	2.32E-04	3.04E-06	5.32E-02
Nickel	9.59	2.40E-03	Measured	42.0	7.40E+00	1.69E-01	3.72E-04	7.57E+00	8.6	1.99E-03	Measured	15.8	2.77E+00	1.52E-01	3.09E-04	2.92E+00
Selenium	4.80	1.74E-03	Measured	7.85	1.38E+00	8.46E-02	2.70E-04	1.47E+00	1.95	6.58E-04	Measured	3.27	5.76E-01	3.44E-02	1.02E-04	6.11E-01
Silver	1.58	8.70E-04	Measured	3.93	6.91E-01	2.78E-02	1.35E-04	7.19E-01	1.21	2.98E-04	Measured	1.50	2.64E-01	2.12E-02	4.62E-05	2.85E-01
Zinc	883	1.50E-01	Measured	516	9.07E+01	1.55E+01	2.33E-02	1.06E+02	705	1.21E-01	Measured	431	7.58E+01	1.24E+01	1.87E-02	8.82E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.21 EU-DR02 Estimated Daily Doses (EDDs) for American Dipper Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	10.3	1.95E-03	Measured	1.74	3.07E-01	1.82E-01	3.03E-04	4.89E-01	9.49	9.73E-04	Measured	1.74	3.07E-01	1.67E-01	1.51E-04	4.74E-01
Cadmium	2.77	5.07E-04	Measured	0.54	9.56E-02	4.88E-02	7.86E-05	1.44E-01	2.30	2.95E-04	Measured	0.54	9.56E-02	4.06E-02	4.57E-05	1.36E-01
Chromium	8.76	1.28E-03	Measured	2.50	4.40E-01	1.54E-01	1.98E-04	5.95E-01	7.64	7.08E-04	Measured	2.50	4.40E-01	1.34E-01	1.10E-04	5.75E-01
Copper	82.4	8.69E-03	Measured	28.0	4.93E+00	1.45E+00	1.35E-03	6.38E+00	72.2	6.70E-03	Measured	28.0	4.93E+00	1.27E+00	1.04E-03	6.20E+00
Lead	190	2.78E-02	Measured	6.78	1.19E+00	3.35E+00	4.31E-03	4.55E+00	168	9.84E-03	Measured	6.78	1.19E+00	2.95E+00	1.53E-03	4.15E+00
Mercury (inorganic)	0.04	4.00E-05	Measured	0.03	5.23E-03	7.53E-04	6.20E-06	5.99E-03	0.03	1.68E-05	Measured	0.03	5.23E-03	5.35E-04	2.60E-06	5.77E-03
Nickel	11.5	1.88E-03	Measured	2.37	4.17E-01	2.02E-01	2.92E-04	6.20E-01	10.1	1.56E-03	Measured	2.37	4.17E-01	1.77E-01	2.42E-04	5.95E-01
Selenium	2.74	9.89E-04	Measured	0.92	1.62E-01	4.83E-02	1.53E-04	2.10E-01	1.13	4.50E-04	Measured	0.92	1.62E-01	1.99E-02	6.98E-05	1.82E-01
Silver	1.11	4.70E-04	Measured	0.15	2.69E-02	1.96E-02	7.29E-05	4.66E-02	0.95	1.74E-04	Measured	0.15	2.69E-02	1.66E-02	2.70E-05	4.36E-02
Zinc	864	1.29E-01	Measured	412	7.26E+01	1.52E+01	2.00E-02	8.78E+01	749	8.30E-02	Measured	412	7.26E+01	1.32E+01	1.29E-02	8.58E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.22 Reference Exposure Unit Bear Creek Estimated Daily Doses (EDDs) for American Dipper Foraging in Bear Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	14.6	1.25E-03	Measured	0.29	5.17E-02	2.57E-01	1.94E-04	3.09E-01	12.5	1.25E-03	Measured	0.29	5.17E-02	2.20E-01	1.94E-04	2.72E-01
Cadmium	0.95	2.50E-04	Measured	0.29	5.16E-02	1.67E-02	3.88E-05	6.83E-02	0.82	2.50E-04	Measured	0.29	5.16E-02	1.44E-02	3.88E-05	6.60E-02
Chromium	3.83	2.50E-03	Measured	0.46	8.10E-02	6.74E-02	3.88E-04	1.49E-01	3.82	2.50E-03	Measured	0.46	8.10E-02	6.71E-02	3.88E-04	1.48E-01
Copper	25.9	1.25E-03	Measured	5.16	9.08E-01	4.56E-01	1.94E-04	1.36E+00	23.6	1.25E-03	Measured	5.16	9.08E-01	4.14E-01	1.94E-04	1.32E+00
Lead	65.2	2.50E-04	Measured	0.20	3.50E-02	1.15E+00	3.88E-05	1.18E+00	53.5	2.50E-04	Measured	0.20	3.50E-02	9.42E-01	3.88E-05	9.77E-01
Mercury (inorganic)	0.01	-	Measured	0.05	8.72E-03	1.06E-04	-	8.83E-03	0.01	-	Measured	0.05	8.72E-03	9.68E-05	-	8.82E-03
Nickel	7.20	1.25E-03	Measured	0.25	4.38E-02	1.27E-01	1.94E-04	1.71E-01	6.93	1.25E-03	Measured	0.25	4.38E-02	1.22E-01	1.94E-04	1.66E-01
Selenium	1.50	2.50E-03	Measured	1.10	1.94E-01	2.64E-02	3.88E-04	2.20E-01	1.32	2.50E-03	Measured	1.10	1.94E-01	2.31E-02	3.88E-04	2.17E-01
Silver	0.12	1.25E-03	Measured	0.03	5.44E-03	2.18E-03	1.94E-04	7.81E-03	0.07	1.25E-03	Measured	0.03	5.44E-03	1.25E-03	1.94E-04	6.88E-03
Zinc	263	5.00E-03	Measured	62.4	1.10E+01	4.63E+00	7.75E-04	1.56E+01	257	5.00E-03	Measured	62.4	1.10E+01	4.52E+00	7.75E-04	1.55E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.23 Reference Exposure Unit Hermosa Creek Estimated Daily Doses (EDDs) for American Dipper Foraging in Hermosa Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	1.10	1.25E-03	Measured	0.14	2.45E-02	1.94E-02	1.94E-04	4.40E-02	1.10	1.25E-03	Measured	0.14	2.45E-02	1.94E-02	1.94E-04	4.40E-02
Cadmium	0.03	2.50E-04	Measured	0.03	5.33E-03	6.07E-04	3.88E-05	5.98E-03	0.03	2.50E-04	Measured	0.03	5.33E-03	6.07E-04	3.88E-05	5.98E-03
Chromium	23.0	2.50E-03	Measured	0.56	9.79E-02	4.05E-01	3.88E-04	5.03E-01	23.0	2.50E-03	Measured	0.56	9.79E-02	4.05E-01	3.88E-04	5.03E-01
Copper	11.5	1.25E-03	Measured	3.78	6.65E-01	2.02E-01	1.94E-04	8.68E-01	11.5	1.25E-03	Measured	3.78	6.65E-01	2.02E-01	1.94E-04	8.68E-01
Lead	11.7	2.50E-04	Measured	0.08	1.47E-02	2.06E-01	3.88E-05	2.21E-01	11.7	2.50E-04	Measured	0.08	1.47E-02	2.06E-01	3.88E-05	2.21E-01
Mercury (inorganic)	0.003	-	Measured	0.11	1.88E-02	4.66E-05	-	1.89E-02	0.003	-	Measured	0.11	1.88E-02	4.66E-05	-	1.89E-02
Nickel	15.0	1.25E-03	Measured	0.12	2.02E-02	2.64E-01	1.94E-04	2.84E-01	15.0	1.25E-03	Measured	0.12	2.02E-02	2.64E-01	1.94E-04	2.84E-01
Selenium	2.40	2.50E-03	Measured	0.86	1.50E-01	4.22E-02	3.88E-04	1.93E-01	2.40	2.50E-03	Measured	0.86	1.50E-01	4.22E-02	3.88E-04	1.93E-01
Silver	0.02	1.25E-03	Measured	0.03	5.40E-03	3.96E-04	1.94E-04	5.99E-03	0.02	1.25E-03	Measured	0.03	5.40E-03	3.96E-04	1.94E-04	5.99E-03
Zinc	65.9	5.00E-03	Measured	47.8	8.41E+00	1.16E+00	7.75E-04	9.57E+00	65.9	5.00E-03	Measured	47.8	8.41E+00	1.16E+00	7.75E-04	9.57E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.24 Reference Exposure Unit Mill Creek Estimated Daily Doses (EDDs) for American Dipper Foraging in Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	10.0	1.25E-03	Measured	0.31	5.49E-02	1.76E-01	1.94E-04	2.31E-01	10.0	1.25E-03	Measured	0.31	5.49E-02	1.76E-01	1.94E-04	2.31E-01
Cadmium	2.30	2.50E-04	Measured	0.26	4.54E-02	4.05E-02	3.88E-05	8.59E-02	2.30	2.50E-04	Measured	0.26	4.54E-02	4.05E-02	3.88E-05	8.59E-02
Chromium	0.87	2.50E-03	Measured	0.49	8.57E-02	1.53E-02	3.88E-04	1.01E-01	0.87	2.50E-03	Measured	0.49	8.57E-02	1.53E-02	3.88E-04	1.01E-01
Copper	15.7	1.25E-03	Measured	5.18	9.12E-01	2.76E-01	1.94E-04	1.19E+00	15.7	1.25E-03	Measured	5.18	9.12E-01	2.76E-01	1.94E-04	1.19E+00
Lead	329	1.74E-03	Measured	4.42	7.78E-01	5.79E+00	2.70E-04	6.57E+00	329	1.26E-03	Measured	4.42	7.78E-01	5.79E+00	1.95E-04	6.57E+00
Mercury (inorganic)	0.002	-	Measured	0.05	8.72E-03	3.17E-05	-	8.76E-03	0.002	-	Measured	0.05	8.72E-03	3.17E-05	-	8.76E-03
Nickel	2.70	1.25E-03	Measured	0.15	2.69E-02	4.75E-02	1.94E-04	7.46E-02	2.70	1.25E-03	Measured	0.15	2.69E-02	4.75E-02	1.94E-04	7.46E-02
Selenium	1.20	2.50E-03	Measured	0.34	5.91E-02	2.11E-02	3.88E-04	8.06E-02	1.20	2.50E-03	Measured	0.34	5.91E-02	2.11E-02	3.88E-04	8.06E-02
Silver	0.02	1.25E-03	Measured	0.03	5.50E-03	2.73E-04	1.94E-04	5.97E-03	0.02	1.25E-03	Measured	0.03	5.50E-03	2.73E-04	1.94E-04	5.97E-03
Zinc	431	4.21E-02	Measured	56.1	9.87E+00	7.59E+00	6.53E-03	1.75E+01	431	3.07E-02	Measured	56.1	9.87E+00	7.59E+00	4.76E-03	1.75E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.25 Reference Exposure Unit Maggie Gulch Estimated Daily Doses (EDDs) for American Dipper Foraging in Maggie Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	12.5	1.25E-03	Measured	0.23	4.03E-02	2.20E-01	1.94E-04	2.60E-01	9.40	1.25E-03	Measured	0.23	4.03E-02	1.65E-01	1.94E-04	2.06E-01
Cadmium	0.79	2.50E-04	Measured	0.22	3.92E-02	1.39E-02	3.88E-05	5.32E-02	0.45	2.50E-04	Measured	0.22	3.92E-02	7.87E-03	3.88E-05	4.72E-02
Chromium	3.20	2.50E-03	Measured	0.50	8.82E-02	5.63E-02	3.88E-04	1.45E-01	2.80	2.50E-03	Measured	0.50	8.82E-02	4.93E-02	3.88E-04	1.38E-01
Copper	33.1	1.25E-03	Measured	4.27	7.52E-01	5.83E-01	1.94E-04	1.33E+00	27.3	1.25E-03	Measured	4.27	7.52E-01	4.81E-01	1.94E-04	1.23E+00
Lead	36.3	4.70E-04	Measured	0.54	9.56E-02	6.39E-01	7.29E-05	7.35E-01	33.0	3.16E-04	Measured	0.54	9.56E-02	5.81E-01	4.90E-05	6.77E-01
Mercury (inorganic)	0.22	-	Measured	0.05	8.38E-03	3.80E-03	-	1.22E-02	0.09	-	Measured	0.05	8.38E-03	1.53E-03	-	9.90E-03
Nickel	6.70	1.25E-03	Measured	0.11	1.85E-02	1.18E-01	1.94E-04	1.37E-01	6.25	1.25E-03	Measured	0.11	1.85E-02	1.10E-01	1.94E-04	1.29E-01
Selenium	2.31	2.50E-03	Measured	0.90	1.58E-01	4.07E-02	3.88E-04	1.99E-01	1.02	2.50E-03	Measured	0.90	1.58E-01	1.79E-02	3.88E-04	1.76E-01
Silver	0.70	1.25E-03	Measured	0.03	5.35E-03	1.23E-02	1.94E-04	1.79E-02	0.32	1.25E-03	Measured	0.03	5.35E-03	5.60E-03	1.94E-04	1.11E-02
Zinc	168	5.00E-03	Measured	71.3	1.25E+01	2.96E+00	7.75E-04	1.55E+01	137	5.00E-03	Measured	71.3	1.25E+01	2.42E+00	7.75E-04	1.50E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.26 Reference Exposure Unit Picayne Gulch Estimated Daily Doses (EDDs) for American Dipper Foraging in Picayne Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	65.7	1.25E-03	Measured	1.26	2.22E-01	1.16E+00	1.94E-04	1.38E+00	49.2	1.25E-03	Measured	1.26	2.22E-01	8.66E-01	1.94E-04	1.09E+00
Cadmium	1.67	2.50E-04	Measured	0.18	3.19E-02	2.94E-02	3.88E-05	6.13E-02	1.56	2.50E-04	Measured	0.18	3.19E-02	2.74E-02	3.88E-05	5.93E-02
Chromium	5.16	2.50E-03	Measured	0.55	9.70E-02	9.08E-02	3.88E-04	1.88E-01	4.75	2.50E-03	Measured	0.55	9.70E-02	8.37E-02	3.88E-04	1.81E-01
Copper	40.4	1.25E-03	Measured	3.43	6.04E-01	7.11E-01	1.94E-04	1.31E+00	36.2	1.25E-03	Measured	3.43	6.04E-01	6.38E-01	1.94E-04	1.24E+00
Lead	134	7.76E-04	Measured	1.02	1.80E-01	2.36E+00	1.20E-04	2.54E+00	85.1	4.25E-04	Measured	1.02	1.80E-01	1.50E+00	6.59E-05	1.68E+00
Mercury (inorganic)	0.01	-	Measured	0.04	6.63E-03	2.11E-04	-	6.84E-03	0.01	-	Measured	0.04	6.63E-03	1.23E-04	-	6.75E-03
Nickel	9.92	1.25E-03	Measured	0.24	4.29E-02	1.75E-01	1.94E-04	2.18E-01	8.87	1.25E-03	Measured	0.24	4.29E-02	1.56E-01	1.94E-04	1.99E-01
Selenium	1.70	2.50E-03	Measured	0.54	9.57E-02	2.99E-02	3.88E-04	1.26E-01	0.85	2.50E-03	Measured	0.54	9.57E-02	1.49E-02	3.88E-04	1.11E-01
Silver	1.36	1.25E-03	Measured	0.06	1.02E-02	2.39E-02	1.94E-04	3.43E-02	1.09	1.25E-03	Measured	0.06	1.02E-02	1.91E-02	1.94E-04	2.95E-02
Zinc	421	4.07E-02	Measured	71.8	1.26E+01	7.41E+00	6.31E-03	2.01E+01	383	1.93E-02	Measured	71.8	1.26E+01	6.74E+00	3.00E-03	1.94E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.27 Reference Exposure Unit North Fork Animas River Estimated Daily Doses (EDDs) for American Dipper Foraging in North Fork Animas River Above Burrows Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Invert tissue concentration (C_{invert})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	73.0	1.25E-03	Measured	2.07	3.64E-01	1.28E+00	1.94E-04	1.65E+00	57.9	1.25E-03	Measured	2.07	3.64E-01	1.02E+00	1.94E-04	1.38E+00
Cadmium	10.8	1.44E-03	Measured	1.52	2.68E-01	1.91E-01	2.22E-04	4.58E-01	8.93	1.05E-03	Measured	1.52	2.68E-01	1.57E-01	1.63E-04	4.25E-01
Chromium	3.23	2.50E-03	Measured	0.67	1.18E-01	5.68E-02	3.88E-04	1.76E-01	2.60	2.50E-03	Measured	0.67	1.18E-01	4.57E-02	3.88E-04	1.65E-01
Copper	43.6	2.02E-03	Measured	5.46	9.61E-01	7.67E-01	3.14E-04	1.73E+00	35.7	1.51E-03	Measured	5.46	9.61E-01	6.29E-01	2.35E-04	1.59E+00
Lead	290	4.51E-03	Measured	5.97	1.05E+00	5.10E+00	6.99E-04	6.16E+00	208	2.32E-03	Measured	5.97	1.05E+00	3.65E+00	3.59E-04	4.70E+00
Mercury (inorganic)	0.04	-	Measured	0.05	8.72E-03	7.55E-04	-	9.48E-03	0.03	-	Measured	0.05	8.72E-03	5.10E-04	-	9.23E-03
Nickel	4.92	1.25E-03	Measured	0.27	4.82E-02	8.66E-02	1.94E-04	1.35E-01	4.66	1.25E-03	Measured	0.27	4.82E-02	8.19E-02	1.94E-04	1.30E-01
Selenium	1.49	2.50E-03	Measured	0.42	7.43E-02	2.63E-02	3.88E-04	1.01E-01	0.62	2.50E-03	Measured	0.42	7.43E-02	1.10E-02	3.88E-04	8.56E-02
Silver	2.02	1.25E-03	Measured	0.09	1.66E-02	3.56E-02	1.94E-04	5.24E-02	1.43	1.25E-03	Measured	0.09	1.66E-02	2.52E-02	1.94E-04	4.20E-02
Zinc	1180	2.18E-01	Measured	185	3.26E+01	2.08E+01	3.38E-02	5.34E+01	897	1.66E-01	Measured	185	3.26E+01	1.58E+01	2.57E-02	4.84E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{invert} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.176	100% invertebrates
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.155	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.0176	

Table A15.28 EU-01 Estimated Daily Doses (EDDs) for Mallard Foraging in Mineral Creek from Animas River to South Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	46.8	2.67E-03	Measured/Eq.	2.35	1.19	9.20E-02	4.87E-02	1.49E-04	1.41E-01	34.2	1.58E-03	Measured/Eq.	1.27	1.00	5.88E-02	3.56E-02	8.86E-05	9.45E-02
Cadmium	2.04	7.37E-04	Measured/Eq.	1.05	0.92	5.11E-02	2.12E-03	4.13E-05	5.32E-02	1.58	5.17E-04	Measured/Eq.	0.58	0.80	3.58E-02	1.64E-03	2.90E-05	3.75E-02
Chromium	6.45	2.52E-03	Measured/Fac.	5.24	0.26	1.43E-01	6.71E-03	1.41E-04	1.50E-01	3.67	2.32E-03	Measured/Fac.	2.87	0.15	7.84E-02	3.82E-03	1.30E-04	8.23E-02
Copper	140	1.13E-02	Measured/Eq.	80.6	13.7	2.45E+00	1.46E-01	6.31E-04	2.59E+00	118	9.75E-03	Measured/Eq.	46.0	12.8	1.53E+00	1.23E-01	5.46E-04	1.65E+00
Lead	276	1.49E-02	Measured/Eq.	75.0	6.2	2.11E+00	2.87E-01	8.35E-04	2.39E+00	229	9.96E-03	Measured/Eq.	38.3	5.6	1.14E+00	2.38E-01	5.58E-04	1.38E+00
Mercury (inorganic)	0.19	4.00E-05	Measured/Eq.	0.05	0.15	5.11E-03	1.92E-04	2.24E-06	5.31E-03	0.09	2.20E-05	Measured/Eq.	0.04	0.10	3.55E-03	9.31E-05	1.23E-06	3.64E-03
Nickel	7.18	1.96E-03	Measured/Eq.	0.07	0.47	1.42E-02	7.47E-03	1.10E-04	2.18E-02	5.88	1.64E-03	Measured/Eq.	0.07	0.41	1.25E-02	6.12E-03	9.17E-05	1.87E-02
Selenium	10.5	2.50E-03	Measured/Eq.	1.71	6.78	2.20E-01	1.09E-02	1.40E-04	2.31E-01	3.85	1.99E-03	Measured/Eq.	1.06	2.25	8.58E-02	4.01E-03	1.12E-04	8.99E-02
Silver	1.77	1.25E-03	Measured/Fac.	0.03	0.02	1.45E-03	1.84E-03	7.00E-05	3.36E-03	1.02	1.09E-03	Measured/Fac.	0.03	0.01	1.18E-03	1.06E-03	6.12E-05	2.30E-03
Zinc	678	1.60E-01	Measured/Eq.	192	180	9.66E+00	7.05E-01	8.98E-03	1.04E+01	517	1.40E-01	Measured/Eq.	116	155	7.03E+00	5.37E-01	7.86E-03	7.58E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00104	

Table A15.29 EU-02 Estimated Daily Doses (EDDs) for Mallard Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	62.9	1.77E-03	Measured/Eq.	0.32	1.41	4.48E-02	6.54E-02	9.90E-05	1.10E-01	47.3	0.001	Measured/Eq.	0.32	1.20	3.93E-02	4.92E-02	8.04E-05	8.87E-02
Cadmium	1.80	1.10E-03	Measured/Eq.	0.06	0.86	2.39E-02	1.87E-03	6.17E-05	2.58E-02	1.26	0.001	Measured/Eq.	0.06	0.71	1.99E-02	1.31E-03	5.04E-05	2.13E-02
Chromium	2.40	2.50E-03	Measured/Fac.	0.63	0.10	1.89E-02	2.49E-03	1.40E-04	2.15E-02	1.72	0.003	Measured/Fac.	0.63	0.07	1.82E-02	1.79E-03	1.40E-04	2.01E-02
Copper	84.0	1.71E-02	Measured/Eq.	5.46	11.2	4.32E-01	8.74E-02	9.56E-04	5.20E-01	76.1	0.016	Measured/Eq.	5.46	10.76	4.21E-01	7.91E-02	8.72E-04	5.01E-01
Lead	386	2.15E-02	Measured/Eq.	8.20	7.49	4.07E-01	4.01E-01	1.21E-03	8.10E-01	333	0.014	Measured/Eq.	8.20	6.90	3.92E-01	3.47E-01	7.84E-04	7.39E-01
Mercury (inorganic)	0.08	-	Measured/Eq.	0.50	0.10	1.55E-02	8.74E-05	-	1.55E-02	0.05	-	Measured/Eq.	0.50	0.07	1.49E-02	5.34E-05	-	1.49E-02
Nickel	3.43	1.25E-03	Measured/Eq.	0.32	0.27	1.52E-02	3.57E-03	7.00E-05	1.89E-02	2.85	0.001	Measured/Eq.	0.32	0.24	1.43E-02	2.96E-03	7.00E-05	1.74E-02
Selenium	1.90	2.50E-03	Measured/Eq.	0.63	1.03	4.31E-02	1.98E-03	1.40E-04	4.52E-02	1.52	0.003	Measured/Eq.	0.63	0.81	3.73E-02	1.58E-03	1.40E-04	3.90E-02
Silver	0.63	1.25E-03	Measured/Fac.	0.32	0.01	8.40E-03	6.50E-04	7.00E-05	9.12E-03	0.32	0.001	Measured/Fac.	0.32	0.00	8.29E-03	3.35E-04	7.00E-05	8.70E-03
Zinc	1328	2.65E-01	Measured/Eq.	23.6	261	7.40E+00	1.38E+00	1.48E-02	8.79E+00	722	0.222	Measured/Eq.	23.6	186.4	5.45E+00	7.51E-01	1.24E-02	6.21E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.30 EU-03 Estimated Daily Doses (EDDs) for Mallard Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	55.9	6.26E-03	Measured/Eq.	0.73	1.32	5.31E-02	5.81E-02	3.51E-04	1.12E-01	48.2	2.64E-03	Measured/Eq.	0.60	1.21	4.72E-02	5.02E-02	1.48E-04	9.75E-02
Cadmium	10.9	8.55E-04	Measured/Eq.	0.24	2.28	6.54E-02	1.13E-02	4.79E-05	7.67E-02	5.55	6.54E-04	Measured/Eq.	0.19	1.58	4.60E-02	5.78E-03	3.66E-05	5.19E-02
Chromium	3.90	2.50E-03	Measured/Fac.	0.57	0.16	1.88E-02	4.06E-03	1.40E-04	2.30E-02	2.53	2.50E-03	Measured/Fac.	0.55	0.10	1.70E-02	2.63E-03	1.40E-04	1.98E-02
Copper	185	2.30E-02	Measured/Eq.	18.9	15.3	8.86E-01	1.92E-01	1.29E-03	1.08E+00	117	1.80E-02	Measured/Eq.	16.5	12.8	7.59E-01	1.22E-01	1.01E-03	8.82E-01
Lead	778	4.80E-02	Measured/Eq.	28.5	11.1	1.03E+00	8.10E-01	2.69E-03	1.84E+00	456	3.09E-02	Measured/Eq.	18.3	8.22	6.87E-01	4.75E-01	1.73E-03	1.16E+00
Mercury (inorganic)	0.28	-	Measured/Eq.	0.05	0.19	6.05E-03	2.93E-04	-	6.34E-03	0.13	-	Measured/Eq.	0.05	0.12	4.33E-03	1.32E-04	-	4.46E-03
Nickel	5.85	1.25E-03	Measured/Eq.	0.11	0.41	1.34E-02	6.09E-03	7.00E-05	1.96E-02	4.25	1.25E-03	Measured/Eq.	0.11	0.32	1.11E-02	4.41E-03	7.00E-05	1.56E-02
Selenium	1.40	2.50E-03	Measured/Eq.	0.31	0.74	2.71E-02	1.46E-03	1.40E-04	2.87E-02	0.96	2.50E-03	Measured/Eq.	0.31	0.48	2.05E-02	9.96E-04	1.40E-04	2.16E-02
Silver	1.34	1.25E-03	Measured/Fac.	0.03	0.02	1.28E-03	1.39E-03	7.00E-05	2.74E-03	0.96	1.25E-03	Measured/Fac.	0.03	0.01	1.12E-03	9.94E-04	7.00E-05	2.18E-03
Zinc	2920	2.58E-01	Measured/Eq.	98.6	405	1.31E+01	3.04E+00	1.45E-02	1.61E+01	1749	2.09E-01	Measured/Eq.	75.2	305	9.86E+00	1.82E+00	1.17E-02	1.17E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic [Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium [Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium [Plant tissue] = 0.041*Sediment concentration
Copper [Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead [Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury [Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel [Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium [Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver [Plant tissue] = 0.014*Sediment concentration
Zinc [Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.31 EU-04 Estimated Daily Doses (EDDs) for Mallard Foraging in Mineral Creek Upstream of Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	160	1.25E-03	Measured/Eq.	2.55	2.39	1.28E-01	1.66E-01	7.00E-05	2.95E-01	126	1.25E-03	Measured/Eq.	2.55	2.09	1.20E-01	1.31E-01	7.00E-05	2.52E-01
Cadmium	12.7	2.39E-03	Measured/Eq.	0.37	2.49	7.41E-02	1.32E-02	1.34E-04	8.74E-02	8.00	1.38E-03	Measured/Eq.	0.37	1.93	5.97E-02	8.32E-03	7.72E-05	6.81E-02
Chromium	2.43	2.50E-03	Measured/Fac.	0.44	0.10	1.39E-02	2.53E-03	1.40E-04	1.66E-02	1.87	2.50E-03	Measured/Fac.	0.44	0.08	1.33E-02	1.94E-03	1.40E-04	1.54E-02
Copper	439	3.08E-02	Measured/Eq.	58.7	21.5	2.08E+00	4.57E-01	1.72E-03	2.54E+00	304	2.24E-02	Measured/Eq.	58.7	18.6	2.00E+00	3.16E-01	1.26E-03	2.32E+00
Lead	1890	9.21E-02	Measured/Eq.	166	18.3	4.78E+00	1.97E+00	5.16E-03	6.75E+00	1326	4.57E-02	Measured/Eq.	166	15.0	4.70E+00	1.38E+00	2.56E-03	6.08E+00
Mercury (inorganic)	0.31	-	Measured/Eq.	0.05	0.19	6.41E-03	3.17E-04	-	6.73E-03	0.17	-	Measured/Eq.	0.05	0.14	4.99E-03	1.72E-04	-	5.16E-03
Nickel	8.89	1.25E-03	Measured/Eq.	0.20	0.55	1.97E-02	9.25E-03	7.00E-05	2.90E-02	5.55	1.25E-03	Measured/Eq.	0.20	0.39	1.54E-02	5.77E-03	7.00E-05	2.13E-02
Selenium	0.70	2.50E-03	Measured/Eq.	0.18	0.34	1.35E-02	7.28E-04	1.40E-04	1.43E-02	0.70	2.50E-03	Measured/Eq.	0.18	0.34	1.35E-02	7.28E-04	1.40E-04	1.43E-02
Silver	3.55	1.25E-03	Measured/Fac.	0.07	0.05	3.05E-03	3.69E-03	7.00E-05	6.81E-03	3.55	1.25E-03	Measured/Fac.	0.07	0.05	3.05E-03	3.69E-03	7.00E-05	6.81E-03
Zinc	5900	8.70E-01	Measured/Eq.	110	598	1.84E+01	6.14E+00	4.87E-02	2.46E+01	5770	4.67E-01	Measured/Eq.	110	591	1.82E+01	6.00E+00	2.61E-02	2.42E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.32 EU-05 Estimated Daily Doses (EDDs) for Mallard Foraging in South Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	14.5	1.25E-03	Measured/Eq.	0.35	0.62	2.52E-02	1.51E-02	7.00E-05	4.03E-02	12.5	1.25E-03	Measured/Eq.	0.35	0.57	2.37E-02	1.30E-02	7.00E-05	3.68E-02
Cadmium	1.00	2.50E-04	Measured/Eq.	0.32	0.62	2.43E-02	1.04E-03	1.40E-05	2.54E-02	0.60	2.50E-04	Measured/Eq.	0.21	0.47	1.77E-02	6.24E-04	1.40E-05	1.84E-02
Chromium	3.20	2.50E-03	Measured/Fac.	0.79	0.13	2.38E-02	3.33E-03	1.40E-04	2.73E-02	3.11	2.50E-03	Measured/Fac.	0.65	0.13	2.02E-02	3.23E-03	1.40E-04	2.36E-02
Copper	18.9	1.25E-03	Measured/Eq.	7.92	6.22	3.67E-01	1.97E-02	7.00E-05	3.87E-01	18.8	1.25E-03	Measured/Eq.	5.92	6.20	3.14E-01	1.96E-02	7.00E-05	3.34E-01
Lead	106	1.19E-03	Measured/Eq.	1.62	3.63	1.36E-01	1.10E-01	6.64E-05	2.46E-01	87.3	7.41E-04	Measured/Eq.	1.16	3.25	1.14E-01	9.07E-02	4.15E-05	2.05E-01
Mercury (inorganic)	0.09	-	Measured/Eq.	0.09	0.10	4.82E-03	8.84E-05	-	4.91E-03	0.05	-	Measured/Eq.	0.07	0.07	3.52E-03	4.68E-05	-	3.57E-03
Nickel	11.6	1.25E-03	Measured/Eq.	0.88	0.68	4.03E-02	1.21E-02	7.00E-05	5.25E-02	8.45	1.25E-03	Measured/Eq.	0.57	0.53	2.87E-02	8.79E-03	7.00E-05	3.76E-02
Selenium	1.90	2.50E-03	Measured/Eq.	0.54	1.03	4.07E-02	1.98E-03	1.40E-04	4.29E-02	1.32	2.50E-03	Measured/Eq.	0.51	0.69	3.12E-02	1.37E-03	1.40E-04	3.27E-02
Silver	0.72	1.25E-03	Measured/Fac.	0.06	0.01	1.71E-03	7.47E-04	7.00E-05	2.53E-03	0.37	1.25E-03	Measured/Fac.	0.04	0.01	1.24E-03	3.83E-04	7.00E-05	1.69E-03
Zinc	386	2.28E-02	Measured/Eq.	90.9	132	5.78E+00	4.01E-01	1.28E-03	6.18E+00	255	1.96E-02	Measured/Eq.	66.3	105	4.44E+00	2.65E-01	1.10E-03	4.70E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.33 EU-06 Estimated Daily Doses (EDDs) for Mallard Foraging in Middle Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	16.9	1.25E-03	Eq./Eq.	4.30	0.67	1.29E-01	1.76E-02	7.00E-05	1.47E-01	13.9	1.25E-03	Eq./Eq.	3.71	0.60	1.12E-01	1.44E-02	7.00E-05	1.26E-01
Cadmium	0.60	1.40E-03	Eq./Eq.	0.37	0.47	2.19E-02	6.26E-04	7.85E-05	2.26E-02	0.40	7.21E-04	Eq./Eq.	0.30	0.38	1.77E-02	4.19E-04	4.04E-05	1.82E-02
Chromium	1.60	2.50E-03	Eq./Fac.	1.92	0.07	5.16E-02	1.66E-03	1.40E-04	5.34E-02	1.37	2.50E-03	Eq./Fac.	1.81	0.06	4.85E-02	1.42E-03	1.40E-04	5.01E-02
Copper	24.3	6.04E-03	Fac./Eq.	20.0	6.86	6.98E-01	2.53E-02	3.38E-04	7.23E-01	19.9	3.45E-03	Fac./Eq.	16.4	6.34	5.89E-01	2.07E-02	1.93E-04	6.10E-01
Lead	100.0	3.37E-03	Eq./Eq.	6.18	3.51	2.51E-01	1.04E-01	1.89E-04	3.56E-01	83.6	1.58E-03	Eq./Eq.	5.50	3.17	2.25E-01	8.69E-02	8.86E-05	3.12E-01
Mercury (inorganic)	0.01	-	Eq./Eq.	0.14	0.03	4.62E-03	1.25E-05	-	4.63E-03	0.01	-	Eq./Eq.	0.14	0.03	4.36E-03	8.81E-06	-	4.37E-03
Nickel	1.77	2.94E-03	Eq./Eq.	0.54	0.17	1.83E-02	1.84E-03	1.65E-04	2.03E-02	1.17	1.76E-03	Eq./Eq.	0.40	0.12	1.36E-02	1.21E-03	9.83E-05	1.49E-02
Selenium	1.50	2.50E-03	Fac./Eq.	1.50	0.79	5.95E-02	1.56E-03	1.40E-04	6.12E-02	1.33	2.50E-03	Fac./Eq.	1.33	0.70	5.27E-02	1.39E-03	1.40E-04	5.42E-02
Silver	0.63	1.25E-03	Eq./Fac.	0.11	0.01	3.15E-03	6.50E-04	7.00E-05	3.87E-03	0.42	1.25E-03	Eq./Fac.	0.08	0.01	2.13E-03	4.39E-04	7.00E-05	2.64E-03
Zinc	130	1.81E-01	Eq./Eq.	53.7	72.0	3.26E+00	1.35E-01	1.01E-02	3.41E+00	117	9.45E-02	Eq./Eq.	50.9	67.8	3.08E+00	1.21E-01	5.29E-03	3.21E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Sediment-to-invertebrate equations and factors (DW)

Arsenic	[Invert. tissue] = $10^{-0.292+0.754(\text{Log(Sediment concentration)})}$
Cadmium	[Invert. tissue] = $10^{-0.314+0.513(\text{Log(Sediment concentration)})}$
Chromium	[Invert. tissue] = $10^{0.2092+0.365(\text{Log(Sediment concentration)})}$
Copper	[Invert. tissue] = 0.824*[Sediment]
Lead	[Invert. tissue] = $10^{-0.515+0.653(\text{Log(Sediment concentration)})}$
Mercury	[Invert. tissue] = 1.2268*[Sediment] + 0.1301
Nickel	[Invert. tissue] = $10^{-0.44+0.695(\text{Log(Sediment concentration)})}$
Selenium	[Invert. tissue] = 1.0*Sediment concentration
Silver	[Invert. tissue] = 0.18*Sediment concentration
Zinc	[Invert. tissue] = 4.8814*Sediment concentration$^{0.4927}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.34 EU-07 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	24.8	1.31E-03	Measured/Eq.	18.6	0.83	5.04E-01	2.58E-02	7.31E-05	5.30E-01	20.7	1.27E-03	Measured/Eq.	4.14	0.75	1.27E-01	2.16E-02	7.11E-05	1.49E-01
Cadmium	12.0	1.03E-03	Measured/Eq.	8.37	2.41	2.80E-01	1.25E-02	5.74E-05	2.92E-01	9.68	7.96E-04	Measured/Eq.	2.59	2.15	1.23E-01	1.01E-02	4.46E-05	1.33E-01
Chromium	4.80	2.50E-03	Measured/Fac.	3.95	0.20	1.08E-01	4.99E-03	1.40E-04	1.13E-01	4.12	2.50E-03	Measured/Fac.	2.25	0.17	6.28E-02	4.28E-03	1.40E-04	6.72E-02
Copper	315	1.29E-02	Measured/Eq.	143	18.8	4.20E+00	3.27E-01	7.24E-04	4.53E+00	267	8.51E-03	Measured/Eq.	46.5	17.6	1.66E+00	2.78E-01	4.76E-04	1.94E+00
Lead	1442	1.28E-02	Measured/Eq.	400	15.7	1.08E+01	1.50E+00	7.14E-04	1.23E+01	1232	6.23E-03	Measured/Eq.	89.8	14.4	2.70E+00	1.28E+00	3.49E-04	3.98E+00
Mercury (inorganic)	0.11	-	Measured/Eq.	0.05	0.11	4.15E-03	1.09E-04	-	4.26E-03	0.07	-	Measured/Eq.	0.04	0.09	3.41E-03	7.44E-05	-	3.48E-03
Nickel	8.03	1.25E-03	Measured/Eq.	0.50	0.51	2.62E-02	8.35E-03	7.00E-05	3.46E-02	6.96	1.25E-03	Measured/Eq.	0.32	0.46	2.03E-02	7.24E-03	7.00E-05	2.76E-02
Selenium	1.14	2.50E-03	Measured/Eq.	1.72	0.58	5.99E-02	1.18E-03	1.40E-04	6.12E-02	0.90	2.46E-03	Measured/Eq.	1.15	0.45	4.16E-02	9.40E-04	1.38E-04	4.27E-02
Silver	5.79	1.25E-03	Measured/Fac.	0.14	0.08	5.66E-03	6.02E-03	7.00E-05	1.17E-02	4.55	1.25E-03	Measured/Fac.	0.11	0.06	4.38E-03	4.73E-03	7.00E-05	9.18E-03
Zinc	3505	3.20E-01	Measured/Eq.	2140	448	6.72E+01	3.65E+00	1.79E-02	7.08E+01	2695	3.06E-01	Measured/Eq.	708	387	2.84E+01	2.80E+00	1.72E-02	3.12E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.35 EU-08 Estimated Daily Doses (EDDs) for Mallard Foraging in Cunningham Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	11.9	1.25E-03	Measured/Eq.	0.43	0.55	2.55E-02	1.23E-02	7.00E-05	3.79E-02	8.90	1.25E-03	Measured/Eq.	0.43	0.47	2.33E-02	9.25E-03	7.00E-05	3.26E-02
Cadmium	2.87	2.50E-04	Measured/Eq.	1.34	1.10	6.34E-02	2.98E-03	1.40E-05	6.64E-02	2.17	2.50E-04	Measured/Eq.	1.34	0.95	5.94E-02	2.25E-03	1.40E-05	6.16E-02
Chromium	4.08	2.50E-03	Measured/Fac.	0.53	0.17	1.81E-02	4.25E-03	1.40E-04	2.25E-02	3.36	2.50E-03	Measured/Fac.	0.53	0.14	1.73E-02	3.49E-03	1.40E-04	2.10E-02
Copper	108	1.25E-03	Measured/Eq.	29.0	12.4	1.07E+00	1.13E-01	7.00E-05	1.19E+00	70.9	1.25E-03	Measured/Eq.	29.0	10.5	1.02E+00	7.37E-02	7.00E-05	1.10E+00
Lead	636	3.74E-03	Measured/Eq.	8.52	9.91	4.78E-01	6.61E-01	2.09E-04	1.14E+00	441	2.06E-03	Measured/Eq.	8.52	8.06	4.30E-01	4.58E-01	1.15E-04	8.89E-01
Mercury (inorganic)	0.04	-	Measured/Eq.	0.05	0.06	2.90E-03	3.94E-05	-	2.94E-03	0.02	-	Measured/Eq.	0.05	0.04	2.37E-03	1.88E-05	-	2.39E-03
Nickel	4.31	1.25E-03	Measured/Eq.	0.10	0.32	1.10E-02	4.48E-03	7.00E-05	1.56E-02	3.54	1.25E-03	Measured/Eq.	0.10	0.28	9.90E-03	3.68E-03	7.00E-05	1.37E-02
Selenium	4.01	2.50E-03	Measured/Eq.	0.67	2.35	7.83E-02	4.17E-03	1.40E-04	8.26E-02	1.70	2.50E-03	Measured/Eq.	0.67	0.91	4.09E-02	1.77E-03	1.40E-04	4.29E-02
Silver	1.64	1.25E-03	Measured/Fac.	0.28	0.02	7.94E-03	1.71E-03	7.00E-05	9.72E-03	1.18	1.25E-03	Measured/Fac.	0.28	0.02	7.77E-03	1.23E-03	7.00E-05	9.07E-03
Zinc	507	3.70E-02	Measured/Eq.	134	153	7.45E+00	5.27E-01	2.07E-03	7.98E+00	429	2.94E-02	Measured/Eq.	134	140	7.10E+00	4.46E-01	1.64E-03	7.55E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic [Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$

Cadmium [Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$

Chromium [Plant tissue] = 0.041*Sediment concentration

Copper [Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$

Lead [Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$

Mercury [Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$

Nickel [Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$

Selenium [Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$

Silver [Plant tissue] = 0.014*Sediment concentration

Zinc [Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.36 EU-09 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River from Howardsville to Minnie Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	34.8	1.25E-03	Measured/Eq.	0.88	1.01	4.89E-02	3.62E-02	7.00E-05	8.52E-02	28.6	1.19E-03	Measured/Eq.	0.66	0.90	4.07E-02	2.98E-02	6.66E-05	7.05E-02
Cadmium	14.0	1.22E-03	Measured/Eq.	3.43	2.63	1.57E-01	1.46E-02	6.82E-05	1.72E-01	10.7	1.03E-03	Measured/Eq.	2.20	2.27	1.16E-01	1.12E-02	5.75E-05	1.27E-01
Chromium	4.49	2.50E-03	Measured/Fac.	1.69	0.18	4.85E-02	4.67E-03	1.40E-04	5.33E-02	3.85	2.35E-03	Measured/Fac.	1.15	0.16	3.40E-02	4.01E-03	1.32E-04	3.81E-02
Copper	458	2.04E-02	Measured/Eq.	59.9	21.8	2.12E+00	4.76E-01	1.14E-03	2.60E+00	348	1.35E-02	Measured/Eq.	39.8	19.6	1.54E+00	3.62E-01	7.57E-04	1.90E+00
Lead	1940	1.22E-02	Measured/Eq.	22.1	18.5	1.05E+00	2.02E+00	6.82E-04	3.07E+00	1534	5.49E-03	Measured/Eq.	16.3	16.2	8.45E-01	1.60E+00	3.08E-04	2.44E+00
Mercury (inorganic)	0.15	-	Measured/Eq.	0.08	0.13	5.45E-03	1.58E-04	-	5.60E-03	0.06	-	Measured/Eq.	0.06	0.08	3.67E-03	5.97E-05	-	3.73E-03
Nickel	9.9	1.25E-03	Measured/Eq.	0.51	0.60	2.87E-02	1.03E-02	7.00E-05	3.91E-02	7.96	1.24E-03	Measured/Eq.	0.38	0.51	2.30E-02	8.28E-03	6.95E-05	3.14E-02
Selenium	1.28	2.50E-03	Measured/Eq.	0.39	0.67	2.74E-02	1.33E-03	1.40E-04	2.89E-02	0.90	2.38E-03	Measured/Eq.	0.37	0.45	2.14E-02	9.37E-04	1.33E-04	2.24E-02
Silver	5.94	1.25E-03	Measured/Fac.	0.20	0.08	7.24E-03	6.18E-03	7.00E-05	1.35E-02	4.69	1.18E-03	Measured/Fac.	0.15	0.07	5.54E-03	4.88E-03	6.59E-05	1.05E-02
Zinc	3526	4.01E-01	Measured/Eq.	575	450	2.66E+01	3.67E+00	2.24E-02	3.03E+01	2472	3.61E-01	Measured/Eq.	394	369	1.98E+01	2.57E+00	2.02E-02	2.24E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic [Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium [Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium [Plant tissue] = 0.041*Sediment concentration
Copper [Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead [Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury [Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel [Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium [Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver [Plant tissue] = 0.014*Sediment concentration
Zinc [Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.37 EU-10 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River from Minnie Gulch to Eureka

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	49.7	1.25E-03	Measured/Eq.	0.90	1.23	5.53E-02	5.17E-02	7.00E-05	1.07E-01	44.1	1.20E-03	Measured/Eq.	0.90	1.15	5.32E-02	4.58E-02	6.73E-05	9.91E-02
Cadmium	33.1	2.01E-03	Measured/Eq.	1.12	4.20	1.38E-01	3.44E-02	1.13E-04	1.72E-01	16.5	1.79E-03	Measured/Eq.	1.12	2.87	1.03E-01	1.71E-02	1.00E-04	1.21E-01
Chromium	4.85	2.50E-03	Measured/Fac.	0.58	0.20	2.02E-02	5.04E-03	1.40E-04	2.54E-02	4.51	2.36E-03	Measured/Fac.	0.58	0.19	1.99E-02	4.69E-03	1.32E-04	2.47E-02
Copper	764	4.10E-02	Measured/Eq.	30.7	26.7	1.49E+00	7.94E-01	2.29E-03	2.29E+00	500	2.90E-02	Measured/Eq.	30.7	22.6	1.38E+00	5.20E-01	1.62E-03	1.90E+00
Lead	1907	9.67E-03	Measured/Eq.	10.5	18.3	7.49E-01	1.98E+00	5.41E-04	2.73E+00	1433	6.17E-03	Measured/Eq.	10.5	15.6	6.78E-01	1.49E+00	3.45E-04	2.17E+00
Mercury (inorganic)	0.12	-	Measured/Eq.	0.05	0.11	4.37E-03	1.22E-04	-	4.49E-03	0.05	-	Measured/Eq.	0.05	0.07	3.23E-03	4.99E-05	-	3.28E-03
Nickel	13.9	1.55E-03	Measured/Eq.	0.30	0.78	2.78E-02	1.45E-02	8.66E-05	4.24E-02	10.0	1.36E-03	Measured/Eq.	0.30	0.61	2.34E-02	1.04E-02	7.61E-05	3.39E-02
Selenium	4.81	2.50E-03	Measured/Eq.	0.23	2.88	8.05E-02	5.00E-03	1.40E-04	8.56E-02	2.16	2.39E-03	Measured/Eq.	0.23	1.19	3.68E-02	2.25E-03	1.34E-04	3.91E-02
Silver	24.5	1.25E-03	Measured/Fac.	0.11	0.34	1.17E-02	2.54E-02	7.00E-05	3.72E-02	8.84	1.18E-03	Measured/Fac.	0.11	0.12	6.01E-03	9.19E-03	6.61E-05	1.53E-02
Zinc	5966	6.07E-01	Measured/Eq.	212	602	2.11E+01	6.20E+00	3.40E-02	2.74E+01	3528	5.49E-01	Measured/Eq.	212	450	1.72E+01	3.67E+00	3.08E-02	2.09E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic [Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$

Cadmium [Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$

Chromium [Plant tissue] = 0.041*Sediment concentration

Copper [Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$

Lead [Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$

Mercury [Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$

Nickel [Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$

Selenium [Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$

Silver [Plant tissue] = 0.014*Sediment concentration

Zinc [Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.38 EU-11 Estimated Daily Doses (EDDs) for Mallard Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	40.9	1.25E-03	Measured/Eq.	0.08	1.11	3.08E-02	4.25E-02	7.00E-05	7.34E-02	28.6	1.25E-03	Measured/Eq.	0.08	0.90	2.55E-02	2.97E-02	7.00E-05	5.53E-02
Cadmium	1.56	2.50E-04	Measured/Eq.	0.12	0.79	2.36E-02	1.62E-03	1.40E-05	2.53E-02	1.17	2.50E-04	Measured/Eq.	0.12	0.68	2.06E-02	1.21E-03	1.40E-05	2.18E-02
Chromium	6.19	2.50E-03	Measured/Fac.	0.31	0.25	1.45E-02	6.44E-03	1.40E-04	2.11E-02	5.44	2.50E-03	Measured/Fac.	0.31	0.22	1.37E-02	5.66E-03	1.40E-04	1.95E-02
Copper	110	1.23E-02	Measured/Eq.	1.89	12.5	3.72E-01	1.15E-01	6.91E-04	4.88E-01	91.2	8.01E-03	Measured/Eq.	1.89	11.6	3.49E-01	9.48E-02	4.48E-04	4.44E-01
Lead	317	2.16E-03	Measured/Eq.	0.33	6.70	1.82E-01	3.30E-01	1.21E-04	5.12E-01	207	8.32E-04	Measured/Eq.	0.33	5.28	1.45E-01	2.15E-01	4.66E-05	3.61E-01
Mercury (inorganic)	0.01	-	Measured/Eq.	0.05	0.03	1.93E-03	8.34E-06	-	1.94E-03	0.01	-	Measured/Eq.	0.05	0.02	1.84E-03	6.50E-06	-	1.85E-03
Nickel	10.1	1.25E-03	Measured/Eq.	0.17	0.61	2.03E-02	1.05E-02	7.00E-05	3.09E-02	7.40	1.25E-03	Measured/Eq.	0.17	0.48	1.70E-02	7.70E-03	7.00E-05	2.48E-02
Selenium	2.60	2.50E-03	Measured/Eq.	0.48	1.46	5.03E-02	2.70E-03	1.40E-04	5.31E-02	1.63	2.50E-03	Measured/Eq.	0.48	0.87	3.50E-02	1.69E-03	1.40E-04	3.68E-02
Silver	1.54	1.25E-03	Measured/Fac.	0.03	0.02	1.34E-03	1.60E-03	7.00E-05	3.01E-03	1.16	1.25E-03	Measured/Fac.	0.03	0.02	1.20E-03	1.21E-03	7.00E-05	2.47E-03
Zinc	460	8.32E-02	Measured/Eq.	46.8	145	########	4.79E-01	4.66E-03	5.46E+00	323	5.76E-02	Measured/Eq.	46.8	119	4.31E+00	3.35E-01	3.23E-03	4.65E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.39 EU-12 Estimated Daily Doses (EDDs) for Mallard Foraging in Eureka Gulch Up to Confluence with Upper South Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	26.0	1.25E-03	Measured/Eq.	0.33	0.86	3.08E-02	2.71E-02	7.00E-05	5.79E-02	18.5	1.25E-03	Measured/Eq.	0.33	0.71	2.69E-02	1.92E-02	7.00E-05	4.61E-02
Cadmium	14.69	1.82E-03	Measured/Eq.	1.09	2.69	9.82E-02	1.53E-02	1.02E-04	1.14E-01	10.9	1.05E-03	Measured/Eq.	1.09	2.29	8.78E-02	1.14E-02	5.89E-05	9.92E-02
Chromium	4.82	2.50E-03	Measured/Fac.	0.48	0.20	1.77E-02	5.01E-03	1.40E-04	2.28E-02	4.07	2.50E-03	Measured/Fac.	0.48	0.17	1.69E-02	4.23E-03	1.40E-04	2.13E-02
Copper	318	1.66E-02	Measured/Eq.	57.2	18.9	1.97E+00	3.31E-01	9.31E-04	2.31E+00	238	9.67E-03	Measured/Eq.	57.2	16.9	1.92E+00	2.48E-01	5.41E-04	2.17E+00
Lead	693	3.99E-03	Measured/Eq.	34.4	10.4	1.16E+00	7.20E-01	2.23E-04	1.88E+00	541	2.15E-03	Measured/Eq.	34.4	9.05	1.13E+00	5.63E-01	1.20E-04	1.69E+00
Mercury (inorganic)	0.04	-	Measured/Eq.	0.05	0.06	2.78E-03	3.64E-05	-	2.82E-03	0.02	-	Measured/Eq.	0.05	0.05	2.44E-03	2.30E-05	-	2.46E-03
Nickel	11.3	1.25E-03	Measured/Eq.	0.34	0.66	2.60E-02	1.18E-02	7.00E-05	3.78E-02	9.90	1.25E-03	Measured/Eq.	0.34	0.60	2.44E-02	1.03E-02	7.00E-05	3.47E-02
Selenium	3.73	2.50E-03	Measured/Eq.	0.23	2.17	6.24E-02	3.88E-03	1.40E-04	6.64E-02	1.67	2.50E-03	Measured/Eq.	0.23	0.90	2.93E-02	1.74E-03	1.40E-04	3.12E-02
Silver	3.65	1.25E-03	Measured/Fac.	0.19	0.05	6.18E-03	3.80E-03	7.00E-05	1.00E-02	2.03	1.25E-03	Measured/Fac.	0.19	0.03	5.59E-03	2.11E-03	7.00E-05	7.77E-03
Zinc	4366	8.54E-01	Measured/Eq.	199	506	1.83E+01	4.54E+00	4.78E-02	2.29E+01	2955	4.12E-01	Measured/Eq.	199	408	1.57E+01	3.07E+00	2.31E-02	1.88E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic [Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium [Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium [Plant tissue] = 0.041*Sediment concentration
Copper [Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead [Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury [Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel [Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium [Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver [Plant tissue] = 0.014*Sediment concentration
Zinc [Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.40 EU-13 Estimated Daily Doses (EDDs) for Mallard Foraging in Mainstem South Fork Animas River Up to Confluence

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	36.2	1.25E-03	Measured/Eq.	0.75	1.03	4.64E-02	3.76E-02	7.00E-05	8.41E-02	25.0	1.13E-03	Measured/Eq.	0.75	0.84	4.13E-02	2.60E-02	6.35E-05	6.73E-02
Cadmium	7.41	1.72E-03	Measured/Eq.	1.62	1.85	9.02E-02	7.71E-03	9.61E-05	9.80E-02	6.98	1.20E-03	Measured/Eq.	1.62	1.79	8.86E-02	7.26E-03	6.72E-05	9.59E-02
Chromium	6.38	2.50E-03	Measured/Fac.	0.72	0.26	2.55E-02	6.63E-03	1.40E-04	3.23E-02	5.66	2.25E-03	Measured/Fac.	0.72	0.23	2.48E-02	5.88E-03	1.26E-04	3.08E-02
Copper	236	6.23E-02	Measured/Eq.	31.5	16.8	1.25E+00	2.45E-01	3.49E-03	1.50E+00	221	2.49E-02	Measured/Eq.	31.5	16.4	1.24E+00	2.30E-01	1.39E-03	1.47E+00
Lead	767	3.63E-03	Measured/Eq.	7.64	11.0	4.84E-01	7.98E-01	2.03E-04	1.28E+00	643	2.19E-03	Measured/Eq.	7.64	9.97	4.57E-01	6.69E-01	1.23E-04	1.13E+00
Mercury (inorganic)	0.50	-	Measured/Eq.	0.10	0.25	9.16E-03	5.22E-04	-	9.68E-03	0.24	-	Measured/Eq.	0.10	0.17	7.01E-03	2.52E-04	-	7.26E-03
Nickel	12.5	1.25E-03	Measured/Eq.	0.62	0.72	3.47E-02	1.30E-02	7.00E-05	4.78E-02	10.4	1.24E-03	Measured/Eq.	0.62	0.62	3.23E-02	1.08E-02	6.92E-05	4.32E-02
Selenium	4.14	2.50E-03	Measured/Eq.	0.32	2.43	7.14E-02	4.30E-03	1.40E-04	7.58E-02	2.15	2.29E-03	Measured/Eq.	0.32	1.18	3.88E-02	2.23E-03	1.28E-04	4.11E-02
Silver	2.80	1.25E-03	Measured/Fac.	0.06	0.04	2.63E-03	2.91E-03	7.00E-05	5.61E-03	2.23	1.13E-03	Measured/Fac.	0.06	0.03	2.42E-03	2.32E-03	6.30E-05	4.80E-03
Zinc	2420	5.37E-01	Measured/Eq.	345	365	1.84E+01	2.52E+00	3.01E-02	2.10E+01	1940	4.13E-01	Measured/Eq.	345	323	1.73E+01	2.02E+00	2.31E-02	1.94E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic [Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$

Cadmium [Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$

Chromium [Plant tissue] = 0.041*Sediment concentration

Copper [Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$

Lead [Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$

Mercury [Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$

Nickel [Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$

Selenium [Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$

Silver [Plant tissue] = 0.014*Sediment concentration

Zinc [Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.41 EU-14 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River from Eureka to Animas Forks

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	58.6	1.25E-03	Measured/Eq.	0.21	1.36	4.07E-02	6.10E-02	7.00E-05	1.02E-01	46.2	1.20E-03	Measured/Eq.	0.21	1.18	3.62E-02	4.80E-02	6.73E-05	8.43E-02
Cadmium	12.0	7.36E-03	Measured/Eq.	0.77	2.41	8.26E-02	1.25E-02	4.12E-04	9.55E-02	9.14	3.99E-03	Measured/Eq.	0.77	2.08	7.39E-02	9.50E-03	2.24E-04	8.36E-02
Chromium	4.32	3.07E-03	Measured/Fac.	0.41	0.18	1.53E-02	4.49E-03	1.72E-04	2.00E-02	3.86	2.71E-03	Measured/Fac.	0.41	0.16	1.48E-02	4.01E-03	1.52E-04	1.90E-02
Copper	458	5.54E-02	Measured/Eq.	26.2	21.8	1.25E+00	4.76E-01	3.10E-03	1.73E+00	326	3.93E-02	Measured/Eq.	26.2	19.1	1.18E+00	3.39E-01	2.20E-03	1.52E+00
Lead	1307	1.58E-02	Measured/Eq.	2.96	14.8	4.62E-01	1.36E+00	8.83E-04	1.82E+00	997	9.95E-03	Measured/Eq.	2.96	12.8	4.08E-01	1.04E+00	5.57E-04	1.45E+00
Mercury (inorganic)	0.09	-	Measured/Eq.	0.11	0.10	5.34E-03	9.53E-05	-	5.43E-03	0.06	-	Measured/Eq.	0.11	0.08	4.74E-03	5.89E-05	-	4.80E-03
Nickel	8.51	7.01E-03	Measured/Eq.	0.07	0.54	1.56E-02	8.85E-03	3.92E-04	2.49E-02	6.80	2.98E-03	Measured/Eq.	0.07	0.45	1.35E-02	7.07E-03	1.67E-04	2.07E-02
Selenium	1.22	2.50E-03	Measured/Eq.	0.13	0.63	1.98E-02	1.27E-03	1.40E-04	2.13E-02	0.90	2.36E-03	Measured/Eq.	0.13	0.45	1.51E-02	9.33E-04	1.32E-04	1.62E-02
Silver	5.02	1.25E-03	Measured/Fac.	0.07	0.07	3.54E-03	5.22E-03	7.00E-05	8.83E-03	3.67	1.17E-03	Measured/Fac.	0.07	0.05	3.04E-03	3.81E-03	6.54E-05	6.92E-03
Zinc	3458	1.68E+00	Measured/Eq.	82.5	445	1.37E+01	3.60E+00	9.38E-02	1.74E+01	2385	1.16E+00	Measured/Eq.	82.5	362	1.15E+01	2.48E+00	6.48E-02	1.41E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic [Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$

Cadmium [Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$

Chromium [Plant tissue] = 0.041*Sediment concentration

Copper [Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$

Lead [Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$

Mercury [Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$

Nickel [Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$

Selenium [Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$

Silver [Plant tissue] = 0.014*Sediment concentration

Zinc [Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.42 EU-15 Estimated Daily Doses (EDDs) for Mallard Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	41.7	1.25E-03	Eq./Eq.	8.50	1.12	2.50E-01	4.34E-02	7.00E-05	2.93E-01	32.1	1.25E-03	Eq./Eq.	6.98	0.96	2.06E-01	3.34E-02	7.00E-05	2.40E-01
Cadmium	10.4	9.11E-03	Eq./Eq.	1.61	2.23	9.98E-02	1.08E-02	5.10E-04	1.11E-01	6.52	5.94E-03	Eq./Eq.	1.27	1.73	7.78E-02	6.78E-03	3.33E-04	8.49E-02
Chromium	4.81	2.50E-03	Eq./Fac.	2.87	0.20	7.96E-02	5.00E-03	1.40E-04	8.48E-02	3.73	2.50E-03	Eq./Fac.	2.62	0.15	7.19E-02	3.88E-03	1.40E-04	7.59E-02
Copper	477	3.62E-02	Fac./Eq.	393	22.2	1.08E+01	4.96E-01	2.03E-03	1.13E+01	304	2.84E-02	Fac./Eq.	251	18.6	6.98E+00	3.16E-01	1.59E-03	7.30E+00
Lead	2320	3.73E-02	Eq./Eq.	48.2	20.5	1.78E+00	2.41E+00	2.09E-03	4.20E+00	1546	1.56E-02	Eq./Eq.	36.9	16.3	1.38E+00	1.61E+00	8.74E-04	2.99E+00
Mercury (inorganic)	0.23	-	Eq./Eq.	0.42	0.17	1.52E-02	2.43E-04	-	1.54E-02	0.16	-	Eq./Eq.	0.33	0.14	1.21E-02	1.68E-04	-	1.22E-02
Nickel	7.30	7.64E-03	Eq./Eq.	1.45	0.48	4.99E-02	7.59E-03	4.28E-04	5.79E-02	5.14	4.60E-03	Eq./Eq.	1.13	0.37	3.89E-02	5.34E-03	2.58E-04	4.45E-02
Selenium	0.84	2.50E-03	Fac./Eq.	0.84	0.42	3.25E-02	8.70E-04	1.40E-04	3.36E-02	0.55	2.50E-03	Fac./Eq.	0.55	0.26	2.10E-02	5.70E-04	1.40E-04	2.17E-02
Silver	6.19	1.25E-03	Eq./Fac.	1.11	0.09	3.12E-02	6.44E-03	7.00E-05	3.77E-02	3.51	1.25E-03	Eq./Fac.	0.63	0.05	1.76E-02	3.65E-03	7.00E-05	2.14E-02
Zinc	2770	3.30E+00	Eq./Eq.	242	393	1.65E+01	2.88E+00	1.85E-01	1.96E+01	1548	2.13E+00	Eq./Eq.	182	285	1.21E+01	1.61E+00	1.19E-01	1.38E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-invertebrate equations and factors (DW)

Arsenic	[Invert. tissue] = $10^{-0.292+0.754(\text{Log(Sediment concentration)})}$
Cadmium	[Invert. tissue] = $10^{-0.314+0.513(\text{Log(Sediment concentration)})}$
Chromium	[Invert. tissue] = $10^{0.2092+0.365(\text{Log(Sediment concentration)})}$
Copper	[Invert. tissue] = 0.824*[Sediment]
Lead	[Invert. tissue] = $10^{-0.515+0.653(\text{Log(Sediment concentration)})}$
Mercury	[Invert. tissue] = 1.2268*[Sediment] + 0.1301
Nickel	[Invert. tissue] = $10^{-0.44+0.695(\text{Log(Sediment concentration)})}$
Selenium	[Invert. tissue] = 1.0*Sediment concentration
Silver	[Invert. tissue] = 0.18*Sediment concentration
Zinc	[Invert. tissue] = 4.8814*Sediment concentration$^{0.5757}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\text{ln Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\text{ln Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\text{ln Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\text{ln Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\text{ln Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\text{ln Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\text{ln Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\text{ln Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.43 EU-16 Estimated Daily Doses (EDDs) for Mallard Foraging in Placer Gulch to Confluence with Upper West Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	66.4	1.25E-03	Measured/Eq.	0.48	1.45	5.02E-02	6.91E-02	7.00E-05	1.19E-01	53.6	1.25E-03	Measured/Eq.	0.48	1.29	4.59E-02	5.57E-02	7.00E-05	1.02E-01
Cadmium	64.2	3.25E-03	Measured/Eq.	0.34	6.03	1.65E-01	6.68E-02	1.82E-04	2.32E-01	36.8	2.90E-03	Measured/Eq.	0.34	4.45	1.24E-01	3.83E-02	1.63E-04	1.63E-01
Chromium	4.33	2.50E-03	Measured/Fac.	0.96	0.18	2.95E-02	4.50E-03	1.40E-04	3.42E-02	3.57	2.50E-03	Measured/Fac.	0.96	0.15	2.87E-02	3.72E-03	1.40E-04	3.26E-02
Copper	1700	3.09E-02	Measured/Eq.	19.8	36.6	1.46E+00	1.77E+00	1.73E-03	3.23E+00	1070	2.45E-02	Measured/Eq.	19.8	30.5	1.30E+00	1.11E+00	1.37E-03	2.42E+00
Lead	9009	2.12E-02	Measured/Eq.	15.1	43.8	1.53E+00	9.37E+00	1.18E-03	1.09E+01	6488	1.66E-02	Measured/Eq.	15.1	36.5	1.34E+00	6.75E+00	9.29E-04	8.09E+00
Mercury (inorganic)	0.98	-	Measured/Eq.	0.76	0.36	2.92E-02	1.01E-03	-	3.02E-02	0.68	-	Measured/Eq.	0.76	0.30	2.74E-02	7.03E-04	-	2.82E-02
Nickel	17.0	3.12E-03	Measured/Eq.	0.48	0.90	3.58E-02	1.77E-02	1.75E-04	5.36E-02	9.53	2.20E-03	Measured/Eq.	0.48	0.58	2.76E-02	9.91E-03	1.23E-04	3.76E-02
Selenium	4.20	2.50E-03	Measured/Eq.	0.96	2.48	8.92E-02	4.37E-03	1.40E-04	9.37E-02	1.88	2.50E-03	Measured/Eq.	0.96	1.02	5.13E-02	1.95E-03	1.40E-04	5.34E-02
Silver	22.2	1.25E-03	Measured/Fac.	0.48	0.31	2.05E-02	2.31E-02	7.00E-05	4.37E-02	12.4	1.25E-03	Measured/Fac.	0.48	0.17	1.70E-02	1.29E-02	7.00E-05	2.99E-02
Zinc	21500	1.45E+00	Measured/Eq.	51.8	1226	3.32E+01	2.24E+01	8.13E-02	5.56E+01	8470	1.18E+00	Measured/Eq.	51.8	731	2.03E+01	8.81E+00	6.62E-02	2.92E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.44 EU-17 Estimated Daily Doses (EDDs) for Mallard Foraging in Mainstem West Fork Animas River from Placer Gulch Up to its Source

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**
Arsenic	39.0	1.25E-03	Eq./Eq.	8.08	1.08	2.38E-01	4.06E-02	7.00E-05	2.78E-01	28.5	1.25E-03	Eq./Eq.	6.38	0.90	1.89E-01	2.96E-02	7.00E-05	2.19E-01
Cadmium	2.70	1.27E-02	Eq./Eq.	0.81	1.07	4.87E-02	2.81E-03	7.13E-04	5.22E-02	1.83	8.64E-03	Eq./Eq.	0.66	0.86	3.96E-02	1.90E-03	4.84E-04	4.20E-02
Chromium	8.52	2.50E-03	Eq./Fac.	3.54	0.35	1.01E-01	8.86E-03	1.40E-04	1.10E-01	5.57	2.50E-03	Eq./Fac.	3.03	0.23	8.46E-02	5.79E-03	1.40E-04	9.05E-02
Copper	277	3.55E-02	Fac./Eq.	228	18	6.39E+00	2.88E-01	1.99E-03	6.68E+00	193	2.60E-02	Fac./Eq.	159	16	4.53E+00	2.01E-01	1.46E-03	4.73E+00
Lead	339	6.16E-03	Eq./Eq.	13.7	7.0	5.37E-01	3.53E-01	3.45E-04	8.89E-01	242	3.58E-03	Eq./Eq.	11.0	5.8	4.35E-01	2.51E-01	2.01E-04	6.87E-01
Mercury (inorganic)	0.04	-	Eq./Eq.	0.18	0.06	6.20E-03	3.95E-05	-	6.24E-03	0.03	-	Eq./Eq.	0.17	0.06	5.77E-03	3.15E-05	-	5.80E-03
Nickel	12.3	1.34E-02	Eq./Eq.	2.07	0.71	7.22E-02	1.28E-02	7.49E-04	8.57E-02	7.36	8.69E-03	Eq./Eq.	1.45	0.48	5.02E-02	7.65E-03	4.86E-04	5.83E-02
Selenium	1.71	2.50E-03	Fac./Eq.	1.71	0.92	6.82E-02	1.78E-03	1.40E-04	7.01E-02	0.90	2.50E-03	Fac./Eq.	0.90	0.45	3.51E-02	9.37E-04	1.40E-04	3.62E-02
Silver	2.16	1.25E-03	Eq./Fac.	0.39	0.03	1.09E-02	2.25E-03	7.00E-05	1.32E-02	1.27	1.25E-03	Eq./Fac.	0.23	0.02	6.37E-03	1.32E-03	7.00E-05	7.75E-03
Zinc	834	3.93E+00	Eq./Eq.	134	202	8.72E+00	8.67E-01	2.20E-01	9.81E+00	686	2.64E+00	Eq./Eq.	122	181	7.86E+00	7.13E-01	1.48E-01	8.73E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-invertebrate equations and factors (DW)

Arsenic	[Invert. tissue] = $10^{-0.292+0.754(\text{Log(Sediment concentration)})}$
Cadmium	[Invert. tissue] = $10^{-0.314+0.513(\text{Log(Sediment concentration)})}$
Chromium	[Invert. tissue] = $10^{0.2092+0.365(\text{Log(Sediment concentration)})}$
Copper	[Invert. tissue] = 0.824*[Sediment]
Lead	[Invert. tissue] = $10^{-0.515+0.653(\text{Log(Sediment concentration)})}$
Mercury	[Invert. tissue] = 1.2268*[Sediment] + 0.1301
Nickel	[Invert. tissue] = $10^{-0.44+0.695(\text{Log(Sediment concentration)})}$
Selenium	[Invert. tissue] = 1.0*Sediment concentration
Silver	[Invert. tissue] = 0.18*Sediment concentration
Zinc	[Invert. tissue] = 4.8814*Sediment concentration$^{0.5757}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\text{ln Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\text{ln Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\text{ln Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\text{ln Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\text{ln Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\text{ln Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\text{ln Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\text{ln Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.45 EU-18 Estimated Daily Doses (EDDs) for Mallard Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	57.1	1.25E-03	Eq./Eq.	10.78	1.34	3.14E-01	5.94E-02	7.00E-05	3.74E-01	41.1	1.25E-03	Eq./Eq.	8.41	1.11	2.47E-01	4.27E-02	7.00E-05	2.90E-01
Cadmium	7.62	6.24E-03	Eq./Eq.	1.38	1.88	8.46E-02	7.93E-03	3.49E-04	9.28E-02	6.05	5.10E-03	Eq./Eq.	1.22	1.66	7.48E-02	6.30E-03	2.86E-04	8.14E-02
Chromium	3.27	2.50E-03	Eq./Fac.	2.49	0.13	6.82E-02	3.40E-03	1.40E-04	7.17E-02	2.67	2.50E-03	Eq./Fac.	2.32	0.11	6.29E-02	2.77E-03	1.40E-04	6.58E-02
Copper	101	1.99E-02	Fac./Eq.	83	12.0	2.47E+00	1.05E-01	1.11E-03	2.57E+00	85.0	1.69E-02	Fac./Eq.	70.0	11.2	2.11E+00	8.84E-02	9.45E-04	2.20E+00
Lead	502	1.27E-02	Eq./Eq.	17.7	8.68	6.85E-01	5.22E-01	7.12E-04	1.21E+00	372	7.75E-03	Eq./Eq.	14.6	7.33	5.68E-01	3.86E-01	4.34E-04	9.55E-01
Mercury (inorganic)	0.07	-	Eq./Eq.	0.22	0.09	7.98E-03	7.54E-05	-	8.06E-03	0.03	-	Eq./Eq.	0.16	0.05	5.48E-03	2.63E-05	-	5.50E-03
Nickel	5.29	3.75E-03	Eq./Eq.	1.16	0.38	3.98E-02	5.50E-03	2.10E-04	4.55E-02	4.34	2.31E-03	Eq./Eq.	1.01	0.32	3.46E-02	4.51E-03	1.29E-04	3.92E-02
Selenium	3.68	2.50E-03	Fac./Eq.	3.68	2.14	1.51E-01	3.83E-03	1.40E-04	1.55E-01	0.90	2.50E-03	Fac./Eq.	0.90	0.45	3.50E-02	9.34E-04	1.40E-04	3.61E-02
Silver	2.08	1.25E-03	Eq./Fac.	0.37	0.03	1.05E-02	2.16E-03	7.00E-05	1.27E-02	1.46	1.25E-03	Eq./Fac.	0.26	0.02	7.34E-03	1.52E-03	7.00E-05	8.93E-03
Zinc	1423	1.05E+00	Eq./Eq.	175	272	1.16E+01	1.48E+00	5.90E-02	1.31E+01	938	8.64E-01	Eq./Eq.	142	216	9.29E+00	9.76E-01	4.84E-02	1.03E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-invertebrate equations and factors (DW)

Arsenic	[Invert. tissue] = $10^{-0.292+0.754(\text{Log(Sediment concentration)})}$
Cadmium	[Invert. tissue] = $10^{-0.314+0.513(\text{Log(Sediment concentration)})}$
Chromium	[Invert. tissue] = $10^{0.2092+0.365(\text{Log(Sediment concentration)})}$
Copper	[Invert. tissue] = 0.824*[Sediment]
Lead	[Invert. tissue] = $10^{-0.515+0.653(\text{Log(Sediment concentration)})}$
Mercury	[Invert. tissue] = 1.2268*[Sediment] + 0.1301
Nickel	[Invert. tissue] = $10^{-0.44+0.695(\text{Log(Sediment concentration)})}$
Selenium	[Invert. tissue] = 1.0*Sediment concentration
Silver	[Invert. tissue] = 0.18*Sediment concentration
Zinc	[Invert. tissue] = 4.8814*Sediment concentration$^{0.5757}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\text{ln Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\text{ln Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\text{ln Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\text{ln Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\text{ln Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\text{ln Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\text{ln Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\text{ln Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.46 EU-19 Estimated Daily Doses (EDDs) for Mallard Foraging in Burrows Gulch

COPECs	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	54.4	1.25E-03	Measured/Eq.	1.12	1.30	6.28E-02	5.66E-02	7.00E-05	1.19E-01	47.8	1.25E-03	Measured/Eq.	1.12	1.21	6.04E-02	4.97E-02	7.00E-05	1.10E-01
Cadmium	7.70	1.86E-02	Measured/Eq.	0.31	1.89	5.71E-02	8.01E-03	1.04E-03	6.62E-02	7.02	1.40E-02	Measured/Eq.	0.31	1.80	5.47E-02	7.30E-03	7.82E-04	6.27E-02
Chromium	4.21	2.50E-03	Measured/Fac.	0.30	0.17	1.22E-02	4.38E-03	1.40E-04	1.67E-02	3.19	2.50E-03	Measured/Fac.	0.30	0.13	1.11E-02	3.32E-03	1.40E-04	1.46E-02
Copper	224	6.56E-02	Measured/Eq.	15.9	16.5	8.40E-01	2.33E-01	3.67E-03	1.08E+00	204	5.07E-02	Measured/Eq.	15.9	15.9	8.24E-01	2.12E-01	2.84E-03	1.04E+00
Lead	571	9.55E-03	Measured/Eq.	13.3	9.33	5.87E-01	5.94E-01	5.35E-04	1.18E+00	448	7.37E-03	Measured/Eq.	13.3	8.13	5.56E-01	4.65E-01	4.13E-04	1.02E+00
Mercury (inorganic)	0.04	-	Measured/Eq.	0.24	0.06	7.69E-03	3.71E-05	-	7.72E-03	0.02	-	Measured/Eq.	0.24	0.04	7.28E-03	2.13E-05	-	7.30E-03
Nickel	6.95	1.18E-02	Measured/Eq.	0.15	0.46	1.58E-02	7.23E-03	6.61E-04	2.37E-02	5.76	8.18E-03	Measured/Eq.	0.15	0.40	1.43E-02	5.99E-03	4.58E-04	2.07E-02
Selenium	1.28	2.50E-03	Measured/Eq.	0.30	0.66	2.50E-02	1.33E-03	1.40E-04	2.65E-02	0.61	2.50E-03	Measured/Eq.	0.30	0.30	1.54E-02	6.36E-04	1.40E-04	1.62E-02
Silver	1.99	1.25E-03	Measured/Fac.	0.31	0.03	8.85E-03	2.07E-03	7.00E-05	1.10E-02	1.37	1.25E-03	Measured/Fac.	0.31	0.02	8.62E-03	1.42E-03	7.00E-05	1.01E-02
Zinc	850	2.97E+00	Measured/Eq.	38.5	204	6.29E+00	8.84E-01	1.66E-01	7.34E+00	712	2.23E+00	Measured/Eq.	38.5	185	5.80E+00	7.40E-01	1.25E-01	6.66E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic [Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$

Cadmium [Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$

Chromium [Plant tissue] = 0.041*Sediment concentration

Copper [Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$

Lead [Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$

Mercury [Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$

Nickel [Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$

Selenium [Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$

Silver [Plant tissue] = 0.014*Sediment concentration

Zinc [Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.47 EU-DR01 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	13.2	2.47E-03	Measured/Eq.	3.93	0.58	1.17E-01	1.37E-02	1.38E-04	1.31E-01	11.4	9.91E-04	Measured/Eq.	2.29	0.54	7.33E-02	1.18E-02	5.55E-05	8.52E-02
Cadmium	2.78	5.13E-04	Measured/Eq.	2.01	1.09	8.02E-02	2.89E-03	2.87E-05	8.32E-02	2.22	3.83E-04	Measured/Eq.	1.53	0.96	6.45E-02	2.31E-03	2.14E-05	6.69E-02
Chromium	8.18	1.97E-03	Measured/Fac.	83.7	0.34	2.18E+00	8.51E-03	1.10E-04	2.19E+00	6.93	9.75E-04	Measured/Fac.	31.3	0.28	8.19E-01	7.20E-03	5.46E-05	8.26E-01
Copper	94.2	1.59E-02	Measured/Eq.	66.6	11.7	2.03E+00	9.79E-02	8.90E-04	2.13E+00	79.3	7.63E-03	Measured/Eq.	45.1	10.9	1.45E+00	8.24E-02	4.27E-04	1.54E+00
Lead	242	7.39E-02	Measured/Eq.	36.7	5.76	1.10E+00	2.51E-01	4.14E-03	1.36E+00	202	1.28E-02	Measured/Eq.	17.5	5.21	5.89E-01	2.10E-01	7.14E-04	8.00E-01
Mercury (inorganic)	0.02	4.00E-05	Measured/Eq.	0.79	0.04	2.15E-02	1.93E-05	2.24E-06	2.15E-02	0.01	1.96E-05	Measured/Eq.	0.30	0.04	8.72E-03	1.37E-05	1.10E-06	8.74E-03
Nickel	9.59	2.40E-03	Measured/Eq.	42.0	0.59	1.11E+00	9.97E-03	1.35E-04	1.12E+00	8.63	1.99E-03	Measured/Eq.	15.8	0.54	4.23E-01	8.97E-03	1.12E-04	4.32E-01
Selenium	4.80	1.74E-03	Measured/Eq.	7.85	2.87	2.78E-01	5.00E-03	9.75E-05	2.83E-01	1.95	6.58E-04	Measured/Eq.	3.27	1.06	1.13E-01	2.03E-03	3.68E-05	1.15E-01
Silver	1.58	8.70E-04	Measured/Fac.	3.93	0.02	1.02E-01	1.64E-03	4.87E-05	1.04E-01	1.21	2.98E-04	Measured/Fac.	1.50	0.02	3.94E-02	1.25E-03	1.67E-05	4.07E-02
Zinc	883	1.50E-01	Measured/Eq.	516	208	1.88E+01	9.19E-01	8.41E-03	1.97E+01	705	1.21E-01	Measured/Eq.	431	184	1.59E+01	7.33E-01	6.77E-03	1.67E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.48 EU-DR02 Estimated Daily Doses (EDDs) for Mallard Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	10.3	1.95E-03	Measured/Eq.	1.74	0.51	5.85E-02	1.08E-02	1.09E-04	6.94E-02	9.5	9.73E-04	Measured/Eq.	1.74	0.49	5.79E-02	9.87E-03	5.45E-05	6.78E-02
Cadmium	2.77	5.07E-04	Measured/Eq.	0.54	1.08	4.22E-02	2.88E-03	2.84E-05	4.51E-02	2.30	2.95E-04	Measured/Eq.	0.54	0.98	3.95E-02	2.40E-03	1.65E-05	4.19E-02
Chromium	8.76	1.28E-03	Measured/Fac.	2.5	0.36	7.43E-02	9.11E-03	7.14E-05	8.34E-02	7.64	7.08E-04	Measured/Fac.	2.5	0.31	7.31E-02	7.94E-03	3.96E-05	8.10E-02
Copper	82.4	8.69E-03	Measured/Eq.	28.0	11.1	1.01E+00	8.57E-02	4.87E-04	1.10E+00	72.2	6.70E-03	Measured/Eq.	28.0	10.5	1.00E+00	7.51E-02	3.75E-04	1.08E+00
Lead	190	2.78E-02	Measured/Eq.	6.8	5.04	3.07E-01	1.98E-01	1.56E-03	5.06E-01	168	9.84E-03	Measured/Eq.	6.8	4.69	2.98E-01	1.74E-01	5.51E-04	4.73E-01
Mercury (inorganic)	0.04	4.00E-05	Measured/Eq.	0.03	0.07	2.50E-03	4.45E-05	2.24E-06	2.54E-03	0.03	1.68E-05	Measured/Eq.	0.03	0.06	2.20E-03	3.16E-05	9.41E-07	2.24E-03
Nickel	11.49	1.88E-03	Measured/Eq.	2.4	0.67	7.90E-02	1.19E-02	1.05E-04	9.10E-02	10.08	1.56E-03	Measured/Eq.	2.4	0.61	7.73E-02	1.05E-02	8.76E-05	8.79E-02
Selenium	2.74	9.89E-04	Measured/Eq.	0.92	1.55	6.40E-02	2.85E-03	5.54E-05	6.69E-02	1.13	4.50E-04	Measured/Eq.	0.92	0.58	3.90E-02	1.18E-03	2.52E-05	4.02E-02
Silver	1.11	4.70E-04	Measured/Fac.	0.15	0.02	4.38E-03	1.16E-03	2.63E-05	5.56E-03	0.95	1.74E-04	Measured/Fac.	0.15	0.01	4.32E-03	9.84E-04	9.74E-06	5.31E-03
Zinc	864	1.29E-01	Measured/Eq.	412	206	1.60E+01	8.99E-01	7.23E-03	1.70E+01	749	8.30E-02	Measured/Eq.	412	190	1.56E+01	7.79E-01	4.65E-03	1.64E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.49 Reference Exposure Unit Bear Creek Estimated Daily Doses (EDDs) for Mallard Foraging in Bear Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF (Invert/plant)	Invert tissue concentration (C_{invert})	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	14.6	1.25E-03	Measured/Eq.	0.29	0.62	2.37E-02	1.52E-02	7.00E-05	3.89E-02	12.5	1.25E-03	Measured/Eq.	0.29	0.57	2.23E-02	1.30E-02	7.00E-05	3.54E-02
Cadmium	0.95	2.50E-04	Measured/Eq.	0.29	0.60	2.33E-02	9.88E-04	1.40E-05	2.43E-02	0.82	2.50E-04	Measured/Eq.	0.29	0.56	2.21E-02	8.53E-04	1.40E-05	2.29E-02
Chromium	3.83	2.50E-03	Measured/Fac.	0.46	0.16	1.60E-02	3.98E-03	1.40E-04	2.01E-02	3.82	2.50E-03	Measured/Fac.	0.46	0.16	1.60E-02	3.97E-03	1.40E-04	2.01E-02
Copper	25.9	1.25E-03	Measured/Eq.	5.16	7.04	3.17E-01	2.69E-02	7.00E-05	3.44E-01	23.6	1.25E-03	Measured/Eq.	5.16	6.78	3.10E-01	2.45E-02	7.00E-05	3.34E-01
Lead	65.2	2.50E-04	Measured/Eq.	0.20	2.76	7.68E-02	6.78E-02	1.40E-05	1.45E-01	53.5	2.50E-04	Measured/Eq.	0.20	2.47	6.93E-02	5.56E-02	1.40E-05	1.25E-01
Mercury (inorganic)	0.01	-	Measured/Eq.	0.05	0.02	1.88E-03	6.24E-06	-	1.89E-03	0.01	-	Measured/Eq.	0.05	0.02	1.85E-03	5.72E-06	-	1.86E-03
Nickel	7.20	1.25E-03	Measured/Eq.	0.25	0.47	1.88E-02	7.49E-03	7.00E-05	2.63E-02	6.93	1.25E-03	Measured/Eq.	0.25	0.46	1.84E-02	7.21E-03	7.00E-05	2.57E-02
Selenium	1.50	2.50E-03	Measured/Eq.	1.10	0.79	4.92E-02	1.56E-03	1.40E-04	5.09E-02	1.32	2.50E-03	Measured/Eq.	1.10	0.69	4.64E-02	1.37E-03	1.40E-04	4.79E-02
Silver	0.12	1.25E-03	Measured/Fac.	0.03	0.002	8.47E-04	1.29E-04	7.00E-05	1.05E-03	0.07	1.25E-03	Measured/Fac.	0.03	0.001	8.28E-04	7.38E-05	7.00E-05	9.71E-04
Zinc	263	5.00E-03	Measured/Eq.	62.4	106	4.38E+00	2.74E-01	2.80E-04	4.66E+00	257	5.00E-03	Measured/Eq.	62.4	105	4.35E+00	2.67E-01	2.80E-04	4.61E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.50 Reference Exposure Unit Hermosa Creek Estimated Daily Doses (EDDs) for Mallard Foraging in Hermosa Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**
Arsenic	1.10	1.25E-03	Measured/Eq.	0.14	0.14	7.34E-03	1.14E-03	7.00E-05	8.56E-03	1.1	1.25E-03	Measured/Eq.	0.14	0.14	7.34E-03	1.14E-03	7.00E-05	8.56E-03
Cadmium	0.03	2.50E-04	Measured/Eq.	0.03	0.10	3.35E-03	3.59E-05	1.40E-05	3.40E-03	0.03	2.50E-04	Measured/Eq.	0.03	0.10	3.35E-03	3.59E-05	1.40E-05	3.40E-03
Chromium	23.00	2.50E-03	Measured/Fac.	0.56	0.94	3.89E-02	2.39E-02	1.40E-04	6.30E-02	23.00	2.50E-03	Measured/Fac.	0.56	0.94	3.89E-02	2.39E-02	1.40E-04	6.30E-02
Copper	11.5	1.25E-03	Measured/Eq.	3.78	5.11	2.31E-01	1.20E-02	7.00E-05	2.43E-01	11.5	1.25E-03	Measured/Eq.	3.78	5.11	2.31E-01	1.20E-02	7.00E-05	2.43E-01
Lead	11.7	2.50E-04	Measured/Eq.	0.08	1.05	2.95E-02	1.22E-02	1.40E-05	4.17E-02	11.7	2.50E-04	Measured/Eq.	0.08	1.05	2.95E-02	1.22E-02	1.40E-05	4.17E-02
Mercury (inorganic)	0.00	-	Measured/Eq.	0.11	0.01	3.16E-03	2.76E-06	-	3.16E-03	0.00	-	Measured/Eq.	0.11	0.01	3.16E-03	2.76E-06	-	3.16E-03
Nickel	15.00	1.25E-03	Measured/Eq.	0.12	0.82	2.43E-02	1.56E-02	7.00E-05	3.99E-02	15.00	1.25E-03	Measured/Eq.	0.12	0.82	2.43E-02	1.56E-02	7.00E-05	3.99E-02
Selenium	2.40	2.50E-03	Measured/Eq.	0.86	1.33	5.68E-02	2.50E-03	1.40E-04	5.95E-02	2.40	2.50E-03	Measured/Eq.	0.86	1.33	5.68E-02	2.50E-03	1.40E-04	5.95E-02
Silver	0.02	1.25E-03	Measured/Fac.	0.03	0.0003	8.05E-04	2.34E-05	7.00E-05	8.98E-04	0.02	1.25E-03	Measured/Fac.	0.03	0.0003	8.05E-04	2.34E-05	7.00E-05	8.98E-04
Zinc	65.9	5.00E-03	Measured/Eq.	47.8	49.4	2.52E+00	6.85E-02	2.80E-04	2.59E+00	65.9	5.00E-03	Measured/Eq.	47.8	49.4	2.52E+00	6.85E-02	2.80E-04	2.59E+00

mg/kg = milligrams per kilogram

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mg/kg bw-day = milligrams per kilogram of body weight per day

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BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.51 Reference Exposure Unit Mill Creek Estimated Daily Doses (EDDs) for Mallard Foraging in Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**
Arsenic	10.0	1.25E-03	Measured/Eq.	0.31	0.50	2.11E-02	1.04E-02	7.00E-05	3.15E-02	10.0	1.25E-03	Measured/Eq.	0.31	0.50	2.11E-02	1.04E-02	7.00E-05	3.15E-02
Cadmium	2.30	2.50E-04	Measured/Eq.	0.26	0.98	3.21E-02	2.39E-03	1.40E-05	3.45E-02	2.30	2.50E-04	Measured/Eq.	0.26	0.98	3.21E-02	2.39E-03	1.40E-05	3.45E-02
Chromium	0.87	2.50E-03	Measured/Fac.	0.49	0.04	1.36E-02	9.05E-04	1.40E-04	1.46E-02	0.87	2.50E-03	Measured/Fac.	0.49	0.04	1.36E-02	9.05E-04	1.40E-04	1.46E-02
Copper	15.7	1.25E-03	Measured/Eq.	5.18	5.78	2.84E-01	1.63E-02	7.00E-05	3.01E-01	15.7	1.25E-03	Measured/Eq.	5.18	5.78	2.84E-01	1.63E-02	7.00E-05	3.01E-01
Lead	329	1.74E-03	Measured/Eq.	4.42	6.85	2.92E-01	3.42E-01	9.74E-05	6.35E-01	329.0	1.26E-03	Measured/Eq.	4.42	6.85	2.92E-01	3.42E-01	7.05E-05	6.35E-01
Mercury (inorganic)	0.00	-	Measured/Eq.	0.05	0.01	1.59E-03	1.87E-06	-	1.60E-03	0.00	-	Measured/Eq.	0.05	0.01	1.59E-03	1.87E-06	-	1.60E-03
Nickel	2.70	1.25E-03	Measured/Eq.	0.15	0.23	9.87E-03	2.81E-03	7.00E-05	1.27E-02	2.70	1.25E-03	Measured/Eq.	0.15	0.23	9.87E-03	2.81E-03	7.00E-05	1.27E-02
Selenium	1.20	2.50E-03	Measured/Eq.	0.34	0.62	2.48E-02	1.25E-03	1.40E-04	2.62E-02	1.20	2.50E-03	Measured/Eq.	0.34	0.62	2.48E-02	1.25E-03	1.40E-04	2.62E-02
Silver	0.02	1.25E-03	Measured/Fac.	0.03	0.0002	8.17E-04	1.61E-05	7.00E-05	9.03E-04	0.02	1.25E-03	Measured/Fac.	0.03	0.0002	8.17E-04	1.61E-05	7.00E-05	9.03E-04
Zinc	431	4.21E-02	Measured/Eq.	56.1	140	5.09E+00	4.48E-01	2.36E-03	5.54E+00	431.0	3.07E-02	Measured/Eq.	56.1	140	5.09E+00	4.48E-01	1.72E-03	5.54E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.52 Reference Exposure Unit Maggie Gulch Estimated Daily Doses (EDDs) for Mallard Foraging in Maggie Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**
Arsenic	12.5	1.25E-03	Measured/Eq.	0.23	0.57	2.07E-02	1.30E-02	7.00E-05	3.37E-02	9.4	1.25E-03	Measured/Eq.	0.23	0.48	1.85E-02	9.78E-03	7.00E-05	2.83E-02
Cadmium	0.79	2.50E-04	Measured/Eq.	0.22	0.55	2.00E-02	8.23E-04	1.40E-05	2.08E-02	0.45	2.50E-04	Measured/Eq.	0.22	0.40	1.62E-02	4.65E-04	1.40E-05	1.67E-02
Chromium	3.20	2.50E-03	Measured/Fac.	0.50	0.13	1.64E-02	3.33E-03	1.40E-04	1.99E-02	2.80	2.50E-03	Measured/Fac.	0.50	0.11	1.60E-02	2.91E-03	1.40E-04	1.90E-02
Copper	33.1	1.25E-03	Measured/Eq.	4.27	7.75	3.12E-01	3.44E-02	7.00E-05	3.46E-01	27.3	1.25E-03	Measured/Eq.	4.27	7.19	2.97E-01	2.84E-02	7.00E-05	3.26E-01
Lead	36.3	4.70E-04	Measured/Eq.	0.54	1.99	6.57E-02	3.78E-02	2.63E-05	1.03E-01	33.0	3.16E-04	Measured/Eq.	0.54	1.89	6.30E-02	3.44E-02	1.77E-05	9.74E-02
Mercury (inorganic)	0.22	-	Measured/Eq.	0.05	0.16	5.40E-03	2.25E-04	-	5.62E-03	0.09	-	Measured/Eq.	0.05	0.10	3.77E-03	9.02E-05	-	3.86E-03
Nickel	6.70	1.25E-03	Measured/Eq.	0.11	0.45	1.44E-02	6.97E-03	7.00E-05	2.14E-02	6.25	1.25E-03	Measured/Eq.	0.11	0.43	1.38E-02	6.50E-03	7.00E-05	2.04E-02
Selenium	2.31	2.50E-03	Measured/Eq.	0.90	1.28	5.64E-02	2.40E-03	1.40E-04	5.90E-02	1.02	2.50E-03	Measured/Eq.	0.90	0.52	3.67E-02	1.06E-03	1.40E-04	3.79E-02
Silver	0.70	1.25E-03	Measured/Fac.	0.03	0.01	1.04E-03	7.28E-04	7.00E-05	1.84E-03	0.32	1.25E-03	Measured/Fac.	0.03	0.004	9.04E-04	3.31E-04	7.00E-05	1.31E-03
Zinc	168	5.00E-03	Measured/Eq.	71.3	83.0	4.00E+00	1.75E-01	2.80E-04	4.18E+00	137	5.00E-03	Measured/Eq.	71.3	74.2	3.78E+00	1.43E-01	2.80E-04	3.92E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.53 Reference Exposure Unit Picayne Gulch Estimated Daily Doses (EDDs) for Mallard Foraging in Picayne Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**
Arsenic	65.7	1.25E-03	Measured/Eq.	1.26	1.45	7.02E-02	6.83E-02	7.00E-05	1.39E-01	49.2	1.25E-03	Measured/Eq.	1.26	1.23	6.46E-02	5.12E-02	7.00E-05	1.16E-01
Cadmium	1.67	2.50E-04	Measured/Eq.	0.18	0.82	2.60E-02	1.74E-03	1.40E-05	2.78E-02	1.56	2.50E-04	Measured/Eq.	0.18	0.79	2.52E-02	1.62E-03	1.40E-05	2.69E-02
Chromium	5.16	2.50E-03	Measured/Fac.	0.55	0.21	1.98E-02	5.37E-03	1.40E-04	2.53E-02	4.75	2.50E-03	Measured/Fac.	0.55	0.19	1.94E-02	4.94E-03	1.40E-04	2.44E-02
Copper	40.4	1.25E-03	Measured/Eq.	3.43	8.38	3.07E-01	4.20E-02	7.00E-05	3.49E-01	36.2	1.25E-03	Measured/Eq.	3.43	8.03	2.97E-01	3.77E-02	7.00E-05	3.35E-01
Lead	134.0	7.76E-04	Measured/Eq.	1.02	4.14	1.34E-01	1.39E-01	4.35E-05	2.73E-01	85.1	4.25E-04	Measured/Eq.	1.02	3.21	1.10E-01	8.85E-02	2.38E-05	1.98E-01
Mercury (inorganic)	0.01	-	Measured/Eq.	0.04	0.03	1.84E-03	1.25E-05	-	1.85E-03	0.01	-	Measured/Eq.	0.04	0.02	1.62E-03	7.28E-06	-	1.63E-03
Nickel	9.92	1.25E-03	Measured/Eq.	0.24	0.60	2.20E-02	1.03E-02	7.00E-05	3.23E-02	8.87	1.25E-03	Measured/Eq.	0.24	0.55	2.07E-02	9.23E-03	7.00E-05	3.00E-02
Selenium	1.70	2.50E-03	Measured/Eq.	0.54	0.91	3.78E-02	1.77E-03	1.40E-04	3.97E-02	0.85	2.50E-03	Measured/Eq.	0.54	0.42	2.51E-02	8.82E-04	1.40E-04	2.61E-02
Silver	1.36	1.25E-03	Measured/Fac.	0.06	0.02	1.99E-03	1.41E-03	7.00E-05	3.48E-03	1.09	1.25E-03	Measured/Fac.	0.06	0.02	1.89E-03	1.13E-03	7.00E-05	3.09E-03
Zinc	421	4.07E-02	Measured/Eq.	71.8	138	5.45E+00	4.38E-01	2.28E-03	5.89E+00	383	1.93E-02	Measured/Eq.	71.8	131	5.27E+00	3.98E-01	1.08E-03	5.67E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.54 Reference Exposure Unit North Fork Animas River Estimated Daily Doses (EDDs) for Mallard Foraging in North Fork Animas River above Burrows Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)							CTE exposure point concentration		EDDs (mg/kg bw-day)						
			Dietary items (mg/kg DW)			Diet	Sediment	Water				Dietary items (mg/kg DW)			Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF (Invert/plant)**	**Invert tissue concentration (C_{invert})**	**Plant tissue concentration (C_{plant})**	**$Dose_{diet}$[1]**	**$Dose_{sed}$[2]**	**$Dose_{water}$[3]**	**Total EDD[4]**
Arsenic	73.0	1.25E-03	Measured/Eq.	2.07	1.53	9.35E-02	7.59E-02	7.00E-05	1.70E-01	57.9	1.25E-03	Measured/Eq.	2.07	1.35	8.86E-02	6.02E-02	7.00E-05	1.49E-01
Cadmium	10.8	1.44E-03	Measured/Eq.	1.52	2.28	9.86E-02	1.13E-02	8.04E-05	1.10E-01	8.93	1.05E-03	Measured/Eq.	1.52	2.05	9.27E-02	9.29E-03	5.88E-05	1.02E-01
Chromium	3.23	2.50E-03	Measured/Fac.	0.67	0.13	2.09E-02	3.36E-03	1.40E-04	2.44E-02	2.60	2.50E-03	Measured/Fac.	0.67	0.11	2.02E-02	2.70E-03	1.40E-04	2.31E-02
Copper	43.6	2.02E-03	Measured/Eq.	5.46	8.64	3.66E-01	4.53E-02	1.13E-04	4.11E-01	35.7	1.51E-03	Measured/Eq.	5.46	7.99	3.49E-01	3.72E-02	8.47E-05	3.86E-01
Lead	290	4.51E-03	Measured/Eq.	5.97	6.38	3.20E-01	3.02E-01	2.53E-04	6.22E-01	208	2.32E-03	Measured/Eq.	5.97	5.29	2.92E-01	2.16E-01	1.30E-04	5.08E-01
Mercury (inorganic)	0.04	-	Measured/Eq.	0.05	0.07	3.01E-03	4.46E-05	-	3.06E-03	0.03	-	Measured/Eq.	0.05	0.05	2.68E-03	3.02E-05	-	2.71E-03
Nickel	4.92	1.25E-03	Measured/Eq.	0.27	0.36	1.64E-02	5.12E-03	7.00E-05	2.15E-02	4.66	1.25E-03	Measured/Eq.	0.27	0.34	1.60E-02	4.84E-03	7.00E-05	2.09E-02
Selenium	1.49	2.50E-03	Measured/Eq.	0.42	0.79	3.15E-02	1.55E-03	1.40E-04	3.32E-02	0.62	2.50E-03	Measured/Eq.	0.42	0.30	1.88E-02	6.48E-04	1.40E-04	1.96E-02
Silver	2.02	1.25E-03	Measured/Fac.	0.09	0.03	3.19E-03	2.10E-03	7.00E-05	5.36E-03	1.43	1.25E-03	Measured/Fac.	0.09	0.02	2.97E-03	1.49E-03	7.00E-05	4.53E-03
Zinc	1180	2.18E-01	Measured/Eq.	185	245	1.12E+01	1.23E+00	1.22E-02	1.24E+01	897	1.66E-01	Measured/Eq.	185	210	1.03E+01	9.32E-01	9.28E-03	1.12E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic [Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$

Cadmium [Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$

Chromium [Plant tissue] = 0.041*Sediment concentration

Copper [Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$

Lead [Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$

Mercury [Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$

Nickel [Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$

Selenium [Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$

Silver [Plant tissue] = 0.014*Sediment concentration

Zinc [Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = (IR_{diet} \times C_{invert} \times AUF)/2 + (IR_{diet} \times C_{plant} \times AUF)/2$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, dw)	0.0519	50% invertebrates; 50% plants
IR_{water} (L/kg BW-day)	0.056	
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00104	

Table A15.55 EU-01 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Mineral Creek from Animas River to South Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	46.8	2.67E-03	0.13	5.90	9.32E-01	6.55E-02	2.93E-04	9.98E-01	34.2	1.58E-03	0.13	4.31	6.82E-01	4.79E-02	1.74E-04	7.30E-01
Cadmium	2.04	7.37E-04	Site-sp. Eq.	0.57	8.97E-02	2.86E-03	8.11E-05	9.26E-02	1.58	5.17E-04	Site-sp. Eq.	0.52	8.24E-02	2.21E-03	5.69E-05	8.47E-02
Chromium	6.45	2.52E-03	0.038	0.25	3.87E-02	9.03E-03	2.78E-04	4.80E-02	3.67	2.32E-03	0.038	0.14	2.20E-02	5.14E-03	2.55E-04	2.74E-02
Copper	140	1.13E-02	Site-sp. Eq.	9.20	1.45E+00	1.96E-01	1.24E-03	1.65E+00	118	9.75E-03	Site-sp. Eq.	8.46	1.34E+00	1.66E-01	1.07E-03	1.50E+00
Lead	276	1.49E-02	0.07	19.3	3.05E+00	3.86E-01	1.64E-03	3.44E+00	229	9.96E-03	0.07	16.02	2.53E+00	3.20E-01	1.10E-03	2.85E+00
Mercury (inorganic)	0.19	4.00E-05	3.25	0.60	9.50E-02	2.59E-04	4.40E-06	9.53E-02	0.09	2.20E-05	3.25	0.29	4.60E-02	1.25E-04	2.42E-06	4.61E-02
Nickel	7.18	1.96E-03	1	7.18	1.14E+00	1.01E-02	2.16E-04	1.15E+00	5.88	1.64E-03	1	5.88	9.29E-01	8.23E-03	1.80E-04	9.37E-01
Selenium	10.5	2.50E-03	Site-sp. Eq.	19.5	3.08E+00	1.46E-02	2.75E-04	3.10E+00	3.85	1.99E-03	Site-sp. Eq.	7.67	1.21E+00	5.39E-03	2.19E-04	1.22E+00
Silver	1.77	1.25E-03	1	1.77	2.80E-01	2.48E-03	1.38E-04	2.82E-01	1.02	1.09E-03	1	1.02	1.61E-01	1.42E-03	1.20E-04	1.62E-01
Zinc	678	1.60E-01	Site-sp. Eq.	128	2.02E+01	9.50E-01	1.76E-02	2.12E+01	517	1.40E-01	Site-sp. Eq.	109.46	1.73E+01	7.23E-01	1.54E-02	1.80E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.56 EU-02 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	62.9	1.77E-03	0.13	7.93	1.25E+00	8.81E-02	1.94E-04	1.34E+00	47.3	1.44E-03	0.13	5.96	9.42E-01	6.63E-02	1.58E-04	1.01E+00
Cadmium	1.80	1.10E-03	Site-sp. Eq.	0.54	8.60E-02	2.52E-03	1.21E-04	8.87E-02	1.26	9.00E-04	Site-sp. Eq.	0.48	7.65E-02	1.77E-03	9.90E-05	7.84E-02
Chromium	2.40	2.50E-03	0.038	0.09	1.44E-02	3.36E-03	2.75E-04	1.80E-02	1.72	2.50E-03	0.038	0.07	1.03E-02	2.41E-03	2.75E-04	1.30E-02
Copper	84.0	1.71E-02	Site-sp. Eq.	7.14	1.13E+00	1.18E-01	1.88E-03	1.25E+00	76.1	1.56E-02	Site-sp. Eq.	6.80	1.07E+00	1.07E-01	1.71E-03	1.18E+00
Lead	386	2.15E-02	0.07	27.0	4.27E+00	5.40E-01	2.37E-03	4.81E+00	333	1.40E-02	0.07	23.3	3.69E+00	4.67E-01	1.54E-03	4.15E+00
Mercury (inorganic)	0.08	-	3.25	0.27	4.31E-02	1.18E-04	-	4.33E-02	0.05	-	3.25	0.17	2.63E-02	7.18E-05	-	2.64E-02
Nickel	3.43	1.25E-03	1	3.43	5.42E-01	4.80E-03	1.38E-04	5.47E-01	2.85	1.25E-03	1	2.85	4.50E-01	3.99E-03	1.38E-04	4.54E-01
Selenium	1.90	2.50E-03	Site-sp. Eq.	4.17	6.59E-01	2.66E-03	2.75E-04	6.62E-01	1.52	2.50E-03	Site-sp. Eq.	3.50	5.53E-01	2.13E-03	2.75E-04	5.55E-01
Silver	0.63	1.25E-03	1	0.63	9.88E-02	8.75E-04	1.38E-04	9.98E-02	0.32	1.25E-03	1	0.32	5.09E-02	4.51E-04	1.38E-04	5.15E-02
Zinc	1328	2.65E-01	Site-sp. Eq.	188	2.98E+01	1.86E+00	2.91E-02	3.17E+01	722	2.22E-01	Site-sp. Eq.	133	2.10E+01	1.01E+00	2.44E-02	2.20E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, DW)	0.158	100% fish
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.11	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, DW)	0.0014	

Table A15.57 EU-03 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	55.9	6.26E-03	Measured	1.98	3.13E-01	7.83E-02	6.89E-04	3.92E-01	48.2	2.64E-03	Measured	0.70	1.10E-01	6.75E-02	2.90E-04	1.78E-01
Cadmium	10.9	8.55E-04	Measured	0.96	1.52E-01	1.52E-02	9.41E-05	1.67E-01	5.55	6.54E-04	Measured	0.72	1.13E-01	7.77E-03	7.19E-05	1.21E-01
Chromium	3.90	2.50E-03	Measured	5.40	8.52E-01	5.46E-03	2.75E-04	8.58E-01	2.53	2.50E-03	Measured	3.68	5.81E-01	3.54E-03	2.75E-04	5.85E-01
Copper	185	2.30E-02	Measured	14.5	2.28E+00	2.58E-01	2.53E-03	2.54E+00	117	1.80E-02	Measured	10.5	1.65E+00	1.64E-01	1.98E-03	1.82E+00
Lead	778	4.80E-02	Measured	27.5	4.35E+00	1.09E+00	5.28E-03	5.44E+00	456	3.09E-02	Measured	10.3	1.62E+00	6.39E-01	3.40E-03	2.26E+00
Mercury (inorganic)	0.28	-	Measured	0.15	2.43E-02	3.95E-04	-	2.47E-02	0.13	-	Measured	0.10	1.64E-02	1.78E-04	-	1.66E-02
Nickel	5.85	1.25E-03	Measured	0.47	7.39E-02	8.19E-03	1.38E-04	8.23E-02	4.25	1.25E-03	Measured	0.20	3.19E-02	5.94E-03	1.38E-04	3.80E-02
Selenium	1.40	2.50E-03	Measured	4.06	6.41E-01	1.96E-03	2.75E-04	6.43E-01	0.96	2.50E-03	Measured	3.23	5.11E-01	1.34E-03	2.75E-04	5.12E-01
Silver	1.34	1.25E-03	Measured	0.47	7.39E-02	1.88E-03	1.38E-04	7.60E-02	0.96	1.25E-03	Measured	0.20	3.19E-02	1.34E-03	1.38E-04	3.34E-02
Zinc	2920	2.58E-01	Measured	306	4.84E+01	4.09E+00	2.84E-02	5.25E+01	1749	2.09E-01	Measured	222	3.51E+01	2.45E+00	2.30E-02	3.76E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.58 EU-04 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Mineral Creek Upstream of Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	160	1.25E-03	0.13	20.2	3.19E+00	2.24E-01	1.38E-04	3.41E+00	126	1.25E-03	0.13	15.9	2.52E+00	1.77E-01	1.38E-04	2.69E+00
Cadmium	12.7	2.39E-03	Site-sp. Eq.	1.04	1.64E-01	1.78E-02	2.63E-04	1.82E-01	8.00	1.38E-03	Site-sp. Eq.	0.89	1.41E-01	1.12E-02	1.52E-04	1.52E-01
Chromium	2.43	2.50E-03	0.038	0.09	1.46E-02	3.40E-03	2.75E-04	1.83E-02	1.87	2.50E-03	0.038	0.07	1.12E-02	2.62E-03	2.75E-04	1.41E-02
Copper	439	3.08E-02	Site-sp. Eq.	16.2	2.56E+00	6.15E-01	3.39E-03	3.18E+00	304	2.24E-02	Site-sp. Eq.	13.5	2.13E+00	4.25E-01	2.47E-03	2.56E+00
Lead	1890	9.21E-02	0.07	132	2.09E+01	2.65E+00	1.01E-02	2.36E+01	1326	4.57E-02	0.07	92.8	1.47E+01	1.86E+00	5.03E-03	1.65E+01
Mercury (inorganic)	0.31	-	3.25	0.99	1.57E-01	4.27E-04	-	1.57E-01	0.17	-	3.25	0.54	8.47E-02	2.31E-04	-	8.50E-02
Nickel	8.89	1.25E-03	1	8.89	1.40E+00	1.24E-02	1.38E-04	1.42E+00	5.55	1.25E-03	1	5.55	8.77E-01	7.77E-03	1.38E-04	8.85E-01
Selenium	0.70	2.50E-03	Site-sp. Eq.	2.02	3.20E-01	9.80E-04	2.75E-04	3.21E-01	0.70	2.50E-03	Site-sp. Eq.	2.02	3.20E-01	9.80E-04	2.75E-04	3.21E-01
Silver	3.55	1.25E-03	1	3.55	5.61E-01	4.97E-03	1.38E-04	5.66E-01	3.55	1.25E-03	1	3.55	5.61E-01	4.97E-03	1.38E-04	5.66E-01
Zinc	5900	8.70E-01	Site-sp. Eq.	445	7.03E+01	8.26E+00	9.57E-02	7.86E+01	5770	4.67E-01	Site-sp. Eq.	439	6.94E+01	8.08E+00	5.13E-02	7.75E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.59 EU-05 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in South Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	14.5	1.25E-03	Measured	1.23	1.95E-01	2.03E-02	1.38E-04	2.15E-01	12.5	1.25E-03	Measured	0.85	1.35E-01	1.75E-02	1.38E-04	1.53E-01
Cadmium	1.00	2.50E-04	Measured	0.72	1.14E-01	1.40E-03	2.75E-05	1.15E-01	0.60	2.50E-04	Measured	0.55	8.71E-02	8.40E-04	2.75E-05	8.79E-02
Chromium	3.20	2.50E-03	Measured	3.82	6.04E-01	4.48E-03	2.75E-04	6.09E-01	3.11	2.50E-03	Measured	3.60	5.69E-01	4.35E-03	2.75E-04	5.73E-01
Copper	18.9	1.25E-03	Measured	3.82	6.03E-01	2.65E-02	1.38E-04	6.29E-01	18.8	1.25E-03	Measured	3.36	5.31E-01	2.63E-02	1.38E-04	5.57E-01
Lead	106	1.19E-03	Measured	3.15	4.97E-01	1.48E-01	1.30E-04	6.46E-01	87.3	7.41E-04	Measured	1.56	2.47E-01	1.22E-01	8.15E-05	3.69E-01
Mercury (inorganic)	0.09	-	Measured	0.13	2.04E-02	1.19E-04	-	2.05E-02	0.05	-	Measured	0.10	1.58E-02	6.30E-05	-	1.59E-02
Nickel	11.6	1.25E-03	Measured	0.14	2.23E-02	1.62E-02	1.38E-04	3.87E-02	8.45	1.25E-03	Measured	0.13	2.09E-02	1.18E-02	1.38E-04	3.28E-02
Selenium	1.90	2.50E-03	Measured	5.21	8.23E-01	2.66E-03	2.75E-04	8.26E-01	1.32	2.50E-03	Measured	4.59	7.25E-01	1.84E-03	2.75E-04	7.27E-01
Silver	0.72	1.25E-03	Measured	0.14	2.23E-02	1.01E-03	1.38E-04	2.34E-02	0.37	1.25E-03	Measured	0.13	2.09E-02	5.15E-04	1.38E-04	2.15E-02
Zinc	386	2.28E-02	Measured	125	1.97E+01	5.40E-01	2.51E-03	2.02E+01	255	1.96E-02	Measured	87.2	1.38E+01	3.57E-01	2.16E-03	1.41E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, DW)	0.158	100% fish
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.11	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, DW)	0.0014	

Table A15.60 EU-06 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Middle Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	14.5	1.25E-03	Measured	1.23	1.95E-01	2.03E-02	1.38E-04	2.15E-01	12.5	1.25E-03	Measured	0.85	1.35E-01	1.75E-02	1.38E-04	1.53E-01
Cadmium	1.00	2.50E-04	Measured	0.72	1.14E-01	1.40E-03	2.75E-05	1.15E-01	0.60	2.50E-04	Measured	0.55	8.71E-02	8.40E-04	2.75E-05	8.79E-02
Chromium	3.20	2.50E-03	Measured	3.82	6.04E-01	4.48E-03	2.75E-04	6.09E-01	3.11	2.50E-03	Measured	3.60	5.69E-01	4.35E-03	2.75E-04	5.73E-01
Copper	18.9	1.25E-03	Measured	3.82	6.03E-01	2.65E-02	1.38E-04	6.29E-01	18.8	1.25E-03	Measured	3.36	5.31E-01	2.63E-02	1.38E-04	5.57E-01
Lead	106	1.19E-03	Measured	3.15	4.97E-01	1.48E-01	1.30E-04	6.46E-01	87.3	7.41E-04	Measured	1.56	2.47E-01	1.22E-01	8.15E-05	3.69E-01
Mercury (inorganic)	0.09	-	Measured	0.13	2.04E-02	1.19E-04	-	2.05E-02	0.05	-	Measured	0.10	1.58E-02	6.30E-05	-	1.59E-02
Nickel	11.6	1.25E-03	Measured	0.14	2.23E-02	1.62E-02	1.38E-04	3.87E-02	8.45	1.25E-03	Measured	0.13	2.09E-02	1.18E-02	1.38E-04	3.28E-02
Selenium	1.90	2.50E-03	Measured	5.21	8.23E-01	2.66E-03	2.75E-04	8.26E-01	1.32	2.50E-03	Measured	4.59	7.25E-01	1.84E-03	2.75E-04	7.27E-01
Silver	0.72	1.25E-03	Measured	0.14	2.23E-02	1.01E-03	1.38E-04	2.34E-02	0.37	1.25E-03	Measured	0.13	2.09E-02	5.15E-04	1.38E-04	2.15E-02
Zinc	386	2.28E-02	Measured	125	1.97E+01	5.40E-01	2.51E-03	2.02E+01	255	1.96E-02	Measured	87.2	1.38E+01	3.57E-01	2.16E-03	1.41E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.61 EU-07 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	24.8	1.30E-03	0.13	3.13	4.94E-01	3.47E-02	1.43E-04	5.29E-01	20.7	1.27E-03	0.13	2.61	4.13E-01	2.90E-02	1.40E-04	4.42E-01
Cadmium	12.0	1.02E-03	Site-sp. Eq.	1.02	1.61E-01	1.68E-02	1.12E-04	1.78E-01	9.68	7.95E-04	Site-sp. Eq.	0.95	1.50E-01	1.36E-02	8.75E-05	1.63E-01
Chromium	4.80	2.50E-03	0.038	0.18	2.88E-02	6.72E-03	2.75E-04	3.58E-02	4.12	2.50E-03	0.038	0.16	2.47E-02	5.77E-03	2.75E-04	3.08E-02
Copper	315	1.34E-02	Site-sp. Eq.	13.7	2.17E+00	4.41E-01	1.47E-03	2.61E+00	267	8.89E-03	Site-sp. Eq.	12.7	2.00E+00	3.74E-01	9.78E-04	2.38E+00
Lead	1442	1.27E-02	0.07	101	1.59E+01	2.02E+00	1.40E-03	1.80E+01	1232	6.35E-03	0.07	86.2	1.36E+01	1.72E+00	6.99E-04	1.54E+01
Mercury (inorganic)	0.11	-	3.25	0.34	5.39E-02	1.47E-04	-	5.41E-02	0.07	-	3.25	0.23	3.67E-02	1.00E-04	-	3.68E-02
Nickel	8.0	1.25E-03	1	8.03	1.27E+00	1.12E-02	1.38E-04	1.28E+00	6.96	1.25E-03	1	6.96	1.10E+00	9.75E-03	1.38E-04	1.11E+00
Selenium	1.14	2.51E-03	Site-sp. Eq.	2.80	4.43E-01	1.59E-03	2.76E-04	4.45E-01	0.90	2.46E-03	Site-sp. Eq.	2.39	3.77E-01	1.27E-03	2.71E-04	3.79E-01
Silver	5.79	1.25E-03	1	5.79	9.14E-01	8.10E-03	1.38E-04	9.22E-01	4.55	1.25E-03	1	4.55	7.19E-01	6.37E-03	1.38E-04	7.25E-01
Zinc	3505	3.22E-01	Site-sp. Eq.	330	5.21E+01	4.91E+00	3.55E-02	5.70E+01	2695	3.09E-01	Site-sp. Eq.	283	4.48E+01	3.77E+00	3.39E-02	4.86E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.62 EU-08 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Cunningham Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	11.9	1.25E-03	0.13	1.49	2.36E-01	1.66E-02	1.38E-04	2.53E-01	8.9	1.25E-03	0.13	1.12	1.77E-01	1.25E-02	1.38E-04	1.90E-01
Cadmium	2.87	2.50E-04	Site-sp. Eq.	0.64	1.00E-01	4.02E-03	2.75E-05	1.04E-01	2.17	2.50E-04	Site-sp. Eq.	0.58	9.15E-02	3.03E-03	2.75E-05	9.45E-02
Chromium	4.08	2.50E-03	0.038	0.16	2.45E-02	5.71E-03	2.75E-04	3.05E-02	3.36	2.50E-03	0.038	0.13	2.01E-02	4.70E-03	2.75E-04	2.51E-02
Copper	108	1.25E-03	Site-sp. Eq.	8.09	1.28E+00	1.51E-01	1.38E-04	1.43E+00	71	1.25E-03	Site-sp. Eq.	6.56	1.04E+00	9.92E-02	1.38E-04	1.14E+00
Lead	636	3.74E-03	0.07	44.5	7.03E+00	8.90E-01	4.11E-04	7.92E+00	441	2.06E-03	0.07	30.8	4.87E+00	6.17E-01	2.26E-04	5.49E+00
Mercury (inorganic)	0.04	-	3.25	0.12	1.95E-02	5.31E-05	-	1.95E-02	0.02	-	3.25	0.06	9.30E-03	2.54E-05	-	9.33E-03
Nickel	4.31	1.25E-03	1	4.31	6.81E-01	6.03E-03	1.38E-04	6.87E-01	3.54	1.25E-03	1	3.54	5.60E-01	4.96E-03	1.38E-04	5.65E-01
Selenium	4.01	2.50E-03	Site-sp. Eq.	7.95	1.26E+00	5.61E-03	2.75E-04	1.26E+00	1.70	2.50E-03	Site-sp. Eq.	3.81	6.02E-01	2.38E-03	2.75E-04	6.05E-01
Silver	1.64	1.25E-03	1	1.64	2.59E-01	2.30E-03	1.38E-04	2.62E-01	1.18	1.25E-03	1	1.18	1.87E-01	1.66E-03	1.38E-04	1.89E-01
Zinc	507	3.70E-02	Site-sp. Eq.	108	1.71E+01	7.10E-01	4.07E-03	1.78E+01	429	2.94E-02	Site-sp. Eq.	98.3	1.55E+01	6.00E-01	3.23E-03	1.61E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.63 EU-09 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in the Animas River from Howardsville to Minnie Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	34.8	1.25E-03	Measured	0.38	5.97E-02	4.87E-02	1.38E-04	1.09E-01	28.6	1.19E-03	Measured	0.32	5.07E-02	4.01E-02	1.31E-04	9.09E-02
Cadmium	14.0	1.22E-03	Measured	1.12	1.77E-01	1.96E-02	1.34E-04	1.96E-01	10.7	1.03E-03	Measured	1.02	1.62E-01	1.50E-02	1.13E-04	1.77E-01
Chromium	4.49	2.50E-03	Measured	3.63	5.73E-01	6.29E-03	2.75E-04	5.80E-01	3.85	2.35E-03	Measured	3.52	5.56E-01	5.40E-03	2.59E-04	5.62E-01
Copper	458	2.04E-02	Measured	13.1	2.08E+00	6.41E-01	2.24E-03	2.72E+00	348	1.35E-02	Measured	11.8	1.87E+00	4.87E-01	1.49E-03	2.36E+00
Lead	1940	1.22E-02	Measured	4.98	7.86E-01	2.72E+00	1.34E-03	3.50E+00	1534	5.49E-03	Measured	3.86	6.09E-01	2.15E+00	6.04E-04	2.76E+00
Mercury (inorganic)	0.15	-	Measured	0.39	6.19E-02	2.13E-04	-	6.21E-02	0.06	-	Measured	0.17	2.62E-02	8.04E-05	-	2.63E-02
Nickel	9.87	1.25E-03	Measured	2.34	3.70E-01	1.38E-02	1.38E-04	3.84E-01	7.96	1.24E-03	Measured	1.02	1.61E-01	1.11E-02	1.37E-04	1.73E-01
Selenium	1.28	2.50E-03	Measured	2.56	4.04E-01	1.79E-03	2.75E-04	4.06E-01	0.90	2.38E-03	Measured	2.34	3.69E-01	1.26E-03	2.62E-04	3.71E-01
Silver	5.94	1.25E-03	Measured	0.23	3.62E-02	8.32E-03	1.38E-04	4.46E-02	4.69	1.18E-03	Measured	0.22	3.41E-02	6.56E-03	1.29E-04	4.08E-02
Zinc	3526	4.01E-01	Measured	243	3.85E+01	4.94E+00	4.41E-02	4.34E+01	2472	3.61E-01	Measured	222	3.51E+01	3.46E+00	3.97E-02	3.86E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.64 EU-10 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in the Animas River from Minnie Gulch to Eureka

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	49.7	1.25E-03	0.13	6.26	9.89E-01	6.96E-02	1.38E-04	1.06E+00	44.1	1.20E-03	0.13	5.55	8.77E-01	6.17E-02	1.32E-04	9.39E-01
Cadmium	33.1	2.01E-03	Site-sp. Eq.	1.42	2.24E-01	4.63E-02	2.21E-04	2.71E-01	16.5	1.79E-03	Site-sp. Eq.	1.13	1.78E-01	2.30E-02	1.97E-04	2.02E-01
Chromium	4.85	2.50E-03	0.038	0.18	2.91E-02	6.79E-03	2.75E-04	3.62E-02	4.51	2.36E-03	0.038	0.17	2.71E-02	6.32E-03	2.60E-04	3.37E-02
Copper	764	4.10E-02	Site-sp. Eq.	21.3	3.37E+00	1.07E+00	4.51E-03	4.44E+00	500	2.90E-02	Site-sp. Eq.	17.3	2.73E+00	7.00E-01	3.19E-03	3.43E+00
Lead	1907	9.67E-03	0.07	133	2.11E+01	2.67E+00	1.06E-03	2.38E+01	1433	6.17E-03	0.07	100	1.58E+01	2.01E+00	6.78E-04	1.78E+01
Mercury (inorganic)	0.12	-	3.25	0.38	6.01E-02	1.64E-04	-	6.02E-02	0.05	-	3.25	0.16	2.46E-02	6.72E-05	-	2.47E-02
Nickel	13.9	1.55E-03	1	13.9	2.20E+00	1.95E-02	1.70E-04	2.22E+00	10.0	1.36E-03	1	10.0	1.58E+00	1.40E-02	1.49E-04	1.60E+00
Selenium	4.81	2.50E-03	Site-sp. Eq.	9.39	1.48E+00	6.74E-03	2.75E-04	1.49E+00	2.16	2.39E-03	Site-sp. Eq.	4.65	7.34E-01	3.03E-03	2.62E-04	7.38E-01
Silver	24.5	1.25E-03	1	24.5	3.86E+00	3.42E-02	1.38E-04	3.90E+00	8.84	1.18E-03	1	8.84	1.40E+00	1.24E-02	1.30E-04	1.41E+00
Zinc	5966	6.07E-01	Site-sp. Eq.	448	7.07E+01	8.35E+00	6.68E-02	7.91E+01	3528	5.49E-01	Site-sp. Eq.	331	5.23E+01	4.94E+00	6.04E-02	5.73E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.65 EU-11 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	40.9	1.25E-03	0.13	5.15	8.14E-01	5.73E-02	1.38E-04	8.72E-01	28.6	1.25E-03	0.13	3.60	5.69E-01	4.00E-02	1.38E-04	6.09E-01
Cadmium	1.56	2.50E-04	Site-sp. Eq.	0.52	8.21E-02	2.18E-03	2.75E-05	8.43E-02	1.17	2.50E-04	Site-sp. Eq.	0.47	7.46E-02	1.63E-03	2.75E-05	7.63E-02
Chromium	6.19	2.50E-03	0.038	0.24	3.72E-02	8.67E-03	2.75E-04	4.61E-02	5.44	2.50E-03	0.038	0.21	3.27E-02	7.62E-03	2.75E-04	4.06E-02
Copper	110	1.23E-02	Site-sp. Eq.	8.17	1.29E+00	1.54E-01	1.36E-03	1.45E+00	91.2	8.01E-03	Site-sp. Eq.	7.44	1.17E+00	1.28E-01	8.81E-04	1.30E+00
Lead	317	2.16E-03	0.07	22.2	3.51E+00	4.44E-01	2.38E-04	3.95E+00	207	8.32E-04	0.07	14.5	2.29E+00	2.90E-01	9.15E-05	2.58E+00
Mercury (inorganic)	0.01	-	3.25	0.03	4.12E-03	1.12E-05	-	4.13E-03	0.01	-	3.25	0.02	3.21E-03	8.75E-06	-	3.22E-03
Nickel	10.1	1.25E-03	1	10.1	1.60E+00	1.41E-02	1.38E-04	1.61E+00	7.40	1.25E-03	1	7.40	1.17E+00	1.04E-02	1.38E-04	1.18E+00
Selenium	2.60	2.50E-03	Site-sp. Eq.	5.43	8.58E-01	3.64E-03	2.75E-04	8.62E-01	1.63	2.50E-03	Site-sp. Eq.	3.68	5.82E-01	2.28E-03	2.75E-04	5.84E-01
Silver	1.54	1.25E-03	1	1.54	2.43E-01	2.16E-03	1.38E-04	2.46E-01	1.16	1.25E-03	1	1.16	1.83E-01	1.62E-03	1.38E-04	1.85E-01
Zinc	460	8.32E-02	Site-sp. Eq.	102	1.62E+01	6.44E-01	9.15E-03	1.68E+01	323	5.76E-02	Site-sp. Eq.	83.4	1.32E+01	4.52E-01	6.34E-03	1.36E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.66 EU-12 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Eureka Gulch Up to Confluence with Upper South Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	26.0	1.25E-03	0.13	3.28	5.18E-01	3.64E-02	1.38E-04	5.55E-01	18.5	1.25E-03	0.13	2.32	3.67E-01	2.58E-02	1.38E-04	3.93E-01
Cadmium	14.7	1.82E-03	Site-sp. Eq.	1.09	1.72E-01	2.06E-02	2.01E-04	1.93E-01	10.9	1.05E-03	Site-sp. Eq.	0.99	1.56E-01	1.53E-02	1.16E-04	1.71E-01
Chromium	4.82	2.50E-03	0.038	0.18	2.89E-02	6.74E-03	2.75E-04	3.59E-02	4.07	2.50E-03	0.038	0.15	2.44E-02	5.69E-03	2.75E-04	3.04E-02
Copper	318	1.66E-02	Site-sp. Eq.	13.8	2.18E+00	4.45E-01	1.83E-03	2.63E+00	238	9.67E-03	Site-sp. Eq.	12.0	1.89E+00	3.34E-01	1.06E-03	2.23E+00
Lead	693	3.99E-03	0.07	48.5	7.66E+00	9.70E-01	4.39E-04	8.63E+00	541	2.15E-03	0.07	37.9	5.99E+00	7.58E-01	2.36E-04	6.74E+00
Mercury (inorganic)	0.04	-	3.25	0.11	1.80E-02	4.90E-05	-	1.80E-02	0.02	-	3.25	0.07	1.14E-02	3.10E-05	-	1.14E-02
Nickel	11.3	1.25E-03	1	11.3	1.79E+00	1.58E-02	1.38E-04	1.80E+00	9.90	1.25E-03	1	9.90	1.56E+00	1.39E-02	1.38E-04	1.58E+00
Selenium	3.73	2.50E-03	Site-sp. Eq.	7.46	1.18E+00	5.22E-03	2.75E-04	1.18E+00	1.67	2.50E-03	Site-sp. Eq.	3.77	5.96E-01	2.34E-03	2.75E-04	5.98E-01
Silver	3.65	1.25E-03	1	3.65	5.77E-01	5.11E-03	1.38E-04	5.82E-01	2.03	1.25E-03	1	2.03	3.20E-01	2.84E-03	1.38E-04	3.23E-01
Zinc	4366	8.54E-01	Site-sp. Eq.	374	5.91E+01	6.11E+00	9.39E-02	6.53E+01	2955	4.12E-01	Site-sp. Eq.	299	4.72E+01	4.14E+00	4.53E-02	5.14E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.67 EU-13 Estimated Daily Doses (EDDs) for the Belted Kingfisher Foraging in mainstem South Fork Animas River Up to Confluence

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	36.2	1.25E-03	0.13	4.56	7.21E-01	5.07E-02	1.38E-04	7.71E-01	25.0	1.13E-03	0.13	3.15	4.97E-01	3.50E-02	1.25E-04	5.32E-01
Cadmium	7.41	1.72E-03	Site-sp. Eq.	0.87	1.37E-01	1.04E-02	1.89E-04	1.48E-01	7.0	1.20E-03	Site-sp. Eq.	0.85	1.34E-01	9.77E-03	1.32E-04	1.44E-01
Chromium	6.38	2.50E-03	0.038	0.24	3.83E-02	8.93E-03	2.75E-04	4.75E-02	5.66	2.25E-03	0.038	0.21	3.40E-02	7.92E-03	2.48E-04	4.21E-02
Copper	236	6.23E-02	Site-sp. Eq.	11.9	1.88E+00	3.30E-01	6.86E-03	2.22E+00	221	2.49E-02	Site-sp. Eq.	11.5	1.82E+00	3.10E-01	2.74E-03	2.14E+00
Lead	767	3.63E-03	0.07	53.7	8.48E+00	1.07E+00	4.00E-04	9.56E+00	643	2.19E-03	0.07	45.0	7.11E+00	9.01E-01	2.41E-04	8.02E+00
Mercury (inorganic)	0.50	-	3.25	1.63	2.58E-01	7.03E-04	-	2.58E-01	0.24	-	3.25	0.79	1.25E-01	3.40E-04	-	1.25E-01
Nickel	12.5	1.25E-03	1	12.5	1.98E+00	1.75E-02	1.38E-04	1.99E+00	10.41	1.24E-03	1	10.4	1.65E+00	1.46E-02	1.36E-04	1.66E+00
Selenium	4.14	2.50E-03	Site-sp. Eq.	8.18	1.29E+00	5.79E-03	2.75E-04	1.30E+00	2.15	2.29E-03	Site-sp. Eq.	4.61	7.29E-01	3.00E-03	2.52E-04	7.32E-01
Silver	2.80	1.25E-03	1	2.80	4.42E-01	3.92E-03	1.38E-04	4.46E-01	2.23	1.13E-03	1	2.23	3.52E-01	3.12E-03	1.24E-04	3.56E-01
Zinc	2420	5.37E-01	Site-sp. Eq.	266	4.21E+01	3.39E+00	5.91E-02	4.55E+01	1940	4.13E-01	Site-sp. Eq.	234	3.70E+01	2.72E+00	4.54E-02	3.98E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.68 EU-14 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in the Animas River from Eureka to Animas Forks

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	58.6	1.25E-03	0.13	7.39	1.17E+00	8.21E-02	1.38E-04	1.25E+00	46.2	1.20E-03	0.13	5.82	9.19E-01	6.46E-02	1.32E-04	9.84E-01
Cadmium	12.0	7.36E-03	Site-sp. Eq.	1.02	1.61E-01	1.68E-02	8.09E-04	1.78E-01	9.14	3.99E-03	Site-sp. Eq.	0.93	1.47E-01	1.28E-02	4.39E-04	1.60E-01
Chromium	4.32	3.07E-03	0.038	0.16	2.59E-02	6.04E-03	3.38E-04	3.23E-02	3.86	2.71E-03	0.038	0.15	2.32E-02	5.40E-03	2.98E-04	2.89E-02
Copper	458	5.54E-02	Site-sp. Eq.	16.5	2.61E+00	6.41E-01	6.09E-03	3.26E+00	326	3.93E-02	Site-sp. Eq.	14.0	2.21E+00	4.56E-01	4.32E-03	2.67E+00
Lead	1307	1.58E-02	0.07	91.5	1.45E+01	1.83E+00	1.73E-03	1.63E+01	997	9.95E-03	0.07	69.8	1.10E+01	1.40E+00	1.09E-03	1.24E+01
Mercury (inorganic)	0.09	-	3.25	0.30	4.70E-02	1.28E-04	-	4.72E-02	0.06	-	3.25	0.18	2.91E-02	7.92E-05	-	2.91E-02
Nickel	8.51	7.01E-03	1	8.51	1.35E+00	1.19E-02	7.71E-04	1.36E+00	6.80	2.98E-03	1	6.80	1.07E+00	9.52E-03	3.28E-04	1.08E+00
Selenium	1.22	2.50E-03	Site-sp. Eq.	2.96	4.67E-01	1.71E-03	2.75E-04	4.69E-01	0.90	2.36E-03	Site-sp. Eq.	2.38	3.76E-01	1.26E-03	2.60E-04	3.77E-01
Silver	5.02	1.25E-03	1	5.02	7.94E-01	7.03E-03	1.38E-04	8.01E-01	3.67	1.17E-03	1	3.67	5.79E-01	5.13E-03	1.28E-04	5.84E-01
Zinc	3458	1.68E+00	Site-sp. Eq.	327	5.17E+01	4.84E+00	1.84E-01	5.67E+01	2385	1.16E+00	Site-sp. Eq.	264	4.17E+01	3.34E+00	1.27E-01	4.52E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.69 EU-15 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	41.7	1.25E-03	0.13	5.25	8.30E-01	5.84E-02	1.38E-04	8.89E-01	32.1	1.25E-03	0.13	4.04	6.39E-01	4.49E-02	1.38E-04	6.84E-01
Cadmium	10.4	9.11E-03	Site-sp. Eq.	0.97	1.53E-01	1.46E-02	1.00E-03	1.69E-01	6.52	5.94E-03	Site-sp. Eq.	0.83	1.31E-01	9.12E-03	6.54E-04	1.41E-01
Chromium	4.81	2.50E-03	0.038	0.18	2.89E-02	6.73E-03	2.75E-04	3.59E-02	3.73	2.50E-03	0.038	0.14	2.24E-02	5.23E-03	2.75E-04	2.79E-02
Copper	477	3.62E-02	Site-sp. Eq.	16.9	2.67E+00	6.68E-01	3.98E-03	3.34E+00	304	2.84E-02	Site-sp. Eq.	13.5	2.13E+00	4.26E-01	3.12E-03	2.56E+00
Lead	2320	3.73E-02	0.07	162	2.57E+01	3.25E+00	4.10E-03	2.89E+01	1546	1.56E-02	0.07	108	1.71E+01	2.16E+00	1.72E-03	1.93E+01
Mercury (inorganic)	0.23	-	3.25	0.76	1.20E-01	3.28E-04	-	1.20E-01	0.16	-	3.25	0.52	8.28E-02	2.26E-04	-	8.30E-02
Nickel	7.30	7.64E-03	1	7.30	1.15E+00	1.02E-02	8.40E-04	1.16E+00	5.14	4.60E-03	1	5.14	8.12E-01	7.19E-03	5.06E-04	8.19E-01
Selenium	0.84	2.50E-03	Site-sp. Eq.	2.27	3.59E-01	1.17E-03	2.75E-04	3.60E-01	0.55	2.50E-03	Site-sp. Eq.	1.75	2.77E-01	7.67E-04	2.75E-04	2.78E-01
Silver	6.19	1.25E-03	1	6.19	9.78E-01	8.67E-03	1.38E-04	9.87E-01	3.51	1.25E-03	1	3.51	5.54E-01	4.91E-03	1.38E-04	5.59E-01
Zinc	2770	3.30E+00	Site-sp. Eq.	288	4.55E+01	3.88E+00	3.63E-01	4.97E+01	1548	2.13E+00	Site-sp. Eq.	206	3.25E+01	2.17E+00	2.34E-01	3.49E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.70 EU-16 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Placer Gulch to Confluence with Upper West Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	66.4	1.25E-03	0.13	8.37	1.32E+00	9.30E-02	1.38E-04	1.41E+00	53.6	1.25E-03	0.13	6.75	1.07E+00	7.50E-02	1.38E-04	1.14E+00
Cadmium	64.2	3.25E-03	Site-sp. Eq.	1.77	2.79E-01	8.99E-02	3.58E-04	3.69E-01	36.8	2.90E-03	Site-sp. Eq.	1.47	2.33E-01	5.16E-02	3.19E-04	2.84E-01
Chromium	4.33	2.50E-03	0.038	0.16	2.60E-02	6.06E-03	2.75E-04	3.23E-02	3.57	2.50E-03	0.038	0.14	2.14E-02	5.00E-03	2.75E-04	2.67E-02
Copper	1700	3.09E-02	Site-sp. Eq.	31.7	5.00E+00	2.38E+00	3.39E-03	7.39E+00	1070	2.45E-02	Site-sp. Eq.	25.2	3.98E+00	1.50E+00	2.70E-03	5.48E+00
Lead	9009	2.12E-02	0.07	631	9.96E+01	1.26E+01	2.33E-03	1.12E+02	6488	1.66E-02	0.07	454	7.18E+01	9.08E+00	1.82E-03	8.08E+01
Mercury (inorganic)	0.98	-	3.25	3.17	5.01E-01	1.37E-03	-	5.02E-01	0.68	-	3.25	2.20	3.47E-01	9.46E-04	-	3.48E-01
Nickel	17.0	3.12E-03	1	17.0	2.68E+00	2.38E-02	3.43E-04	2.71E+00	9.53	2.20E-03	1	9.53	1.51E+00	1.33E-02	2.42E-04	1.52E+00
Selenium	4.20	2.50E-03	Site-sp. Eq.	8.30	1.31E+00	5.88E-03	2.75E-04	1.32E+00	1.88	2.50E-03	Site-sp. Eq.	4.13	6.52E-01	2.63E-03	2.75E-04	6.55E-01
Silver	22.2	1.25E-03	1	22.2	3.51E+00	3.11E-02	1.38E-04	3.54E+00	12.4	1.25E-03	1	12.4	1.96E+00	1.74E-02	1.38E-04	1.98E+00
Zinc	21500	1.45E+00	Site-sp. Eq.	936	1.48E+02	3.01E+01	1.60E-01	1.78E+02	8470	1.18E+00	Site-sp. Eq.	548	8.65E+01	1.19E+01	1.30E-01	9.85E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.71 EU-17 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Mainstem West Fork Animas River from Placer Gulch Up to its Source

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	39.0	1.25E-03	0.13	4.91	7.76E-01	5.46E-02	1.38E-04	8.31E-01	28.5	1.25E-03	0.13	3.59	5.67E-01	3.99E-02	1.38E-04	6.07E-01
Cadmium	2.70	1.27E-02	Site-sp. Eq.	0.62	9.83E-02	3.78E-03	1.40E-03	1.04E-01	1.83	8.64E-03	Site-sp. Eq.	0.55	8.65E-02	2.56E-03	9.51E-04	9.00E-02
Chromium	8.52	2.50E-03	0.038	0.32	5.12E-02	1.19E-02	2.75E-04	6.34E-02	5.57	2.50E-03	0.038	0.21	3.34E-02	7.80E-03	2.75E-04	4.15E-02
Copper	277	3.55E-02	Site-sp. Eq.	12.9	2.04E+00	3.88E-01	3.90E-03	2.43E+00	193	2.60E-02	Site-sp. Eq.	10.8	1.70E+00	2.70E-01	2.86E-03	1.98E+00
Lead	339	6.16E-03	0.07	23.7	3.75E+00	4.75E-01	6.77E-04	4.22E+00	242	3.58E-03	0.07	16.9	2.67E+00	3.39E-01	3.94E-04	3.01E+00
Mercury (inorganic)	0.04	-	3.25	0.12	1.95E-02	5.32E-05	-	1.96E-02	0.03	-	3.25	0.10	1.56E-02	4.24E-05	-	1.56E-02
Nickel	12.3	1.34E-02	1	12.3	1.94E+00	1.72E-02	1.47E-03	1.96E+00	7.36	8.69E-03	1	7.36	1.16E+00	1.03E-02	9.55E-04	1.17E+00
Selenium	1.71	2.50E-03	Site-sp. Eq.	3.83	6.05E-01	2.39E-03	2.75E-04	6.08E-01	0.90	2.50E-03	Site-sp. Eq.	2.38	3.77E-01	1.26E-03	2.75E-04	3.78E-01
Silver	2.16	1.25E-03	1	2.16	3.41E-01	3.02E-03	1.38E-04	3.44E-01	1.27	1.25E-03	1	1.27	2.00E-01	1.77E-03	1.38E-04	2.02E-01
Zinc	834	3.93E+00	Site-sp. Eq.	144	2.28E+01	1.17E+00	4.33E-01	2.44E+01	686	2.64E+00	Site-sp. Eq.	129	2.04E+01	9.60E-01	2.90E-01	2.16E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.72 EU-18 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	57.1	1.25E-03	0.13	7.20	1.14E+00	8.00E-02	1.38E-04	1.22E+00	41.1	1.25E-03	0.13	5.18	8.18E-01	5.75E-02	1.38E-04	8.75E-01
Cadmium	7.62	6.24E-03	Site-sp. Eq.	0.88	1.38E-01	1.07E-02	6.86E-04	1.50E-01	6.05	5.10E-03	Site-sp. Eq.	0.81	1.28E-01	8.47E-03	5.61E-04	1.37E-01
Chromium	3.27	2.50E-03	0.038	0.12	1.96E-02	4.57E-03	2.75E-04	2.44E-02	2.67	2.50E-03	0.038	0.10	1.60E-02	3.73E-03	2.75E-04	2.00E-02
Copper	101	1.99E-02	Site-sp. Eq.	7.81	1.23E+00	1.41E-01	2.19E-03	1.38E+00	85.0	1.69E-02	Site-sp. Eq.	7.18	1.13E+00	1.19E-01	1.86E-03	1.26E+00
Lead	502	1.27E-02	0.07	35.2	5.56E+00	7.03E-01	1.40E-03	6.26E+00	372	7.75E-03	0.07	26.0	4.11E+00	5.20E-01	8.53E-04	4.63E+00
Mercury (inorganic)	0.07	-	3.25	0.24	3.72E-02	1.02E-04	-	3.73E-02	0.03	-	3.25	0.08	1.30E-02	3.54E-05	-	1.30E-02
Nickel	5.29	3.75E-03	1	5.29	8.36E-01	7.41E-03	4.13E-04	8.44E-01	4.34	2.31E-03	1	4.34	6.86E-01	6.08E-03	2.54E-04	6.92E-01
Selenium	3.68	2.50E-03	Site-sp. Eq.	7.37	1.16E+00	5.16E-03	2.75E-04	1.17E+00	0.90	2.50E-03	Site-sp. Eq.	2.38	3.76E-01	1.26E-03	2.75E-04	3.77E-01
Silver	2.08	1.25E-03	1	2.08	3.28E-01	2.91E-03	1.38E-04	3.31E-01	1.46	1.25E-03	1	1.46	2.30E-01	2.04E-03	1.38E-04	2.33E-01
Zinc	1423	1.05E+00	Site-sp. Eq.	196	3.10E+01	1.99E+00	1.16E-01	3.31E+01	938	8.64E-01	Site-sp. Eq.	154	2.44E+01	1.31E+00	9.50E-02	2.58E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.73 EU-19 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Burrows Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	54.4	1.25E-03	0.13	6.85	1.08E+00	7.62E-02	1.38E-04	1.16E+00	47.8	1.25E-03	0.13	6.03	9.52E-01	6.70E-02	1.38E-04	1.02E+00
Cadmium	7.70	1.86E-02	Site-sp. Eq.	0.88	1.39E-01	1.08E-02	2.05E-03	1.52E-01	7.02	1.40E-02	Site-sp. Eq.	0.85	1.35E-01	9.82E-03	1.54E-03	1.46E-01
Chromium	4.21	2.50E-03	0.038	0.16	2.53E-02	5.89E-03	2.75E-04	3.14E-02	3.19	2.50E-03	0.038	0.12	1.91E-02	4.46E-03	2.75E-04	2.39E-02
Copper	224	6.56E-02	Site-sp. Eq.	11.6	1.83E+00	3.14E-01	7.22E-03	2.15E+00	204	5.07E-02	Site-sp. Eq.	11.1	1.75E+00	2.86E-01	5.58E-03	2.04E+00
Lead	571	9.55E-03	0.07	40.0	6.32E+00	8.00E-01	1.05E-03	7.12E+00	448	7.37E-03	0.07	31.3	4.95E+00	6.27E-01	8.11E-04	5.58E+00
Mercury (inorganic)	0.04	-	3.25	0.12	1.83E-02	5.00E-05	-	1.84E-02	0.02	-	3.25	0.07	1.05E-02	2.87E-05	-	1.06E-02
Nickel	6.95	1.18E-02	1	6.95	1.10E+00	9.73E-03	1.30E-03	1.11E+00	5.76	8.18E-03	1	5.76	9.09E-01	8.06E-03	9.00E-04	9.18E-01
Selenium	1.28	2.50E-03	Site-sp. Eq.	3.06	4.83E-01	1.79E-03	2.75E-04	4.85E-01	0.61	2.50E-03	Site-sp. Eq.	1.87	2.95E-01	8.56E-04	2.75E-04	2.96E-01
Silver	1.99	1.25E-03	1	1.99	3.15E-01	2.79E-03	1.38E-04	3.18E-01	1.37	1.25E-03	1	1.37	2.16E-01	1.91E-03	1.38E-04	2.18E-01
Zinc	850	2.97E+00	Site-sp. Eq.	146	2.30E+01	1.19E+00	3.27E-01	2.45E+01	712	2.23E+00	Site-sp. Eq.	132	2.08E+01	9.96E-01	2.46E-01	2.20E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.74 EU-DR01 Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	13.2	2.47E-03	0.13	1.66	2.62E-01	1.84E-02	2.72E-04	2.81E-01	11.4	9.91E-04	0.13	1.43	2.26E-01	1.59E-02	1.09E-04	2.42E-01
Cadmium	2.78	5.13E-04	Site-sp. Eq.	0.63	9.93E-02	3.89E-03	5.64E-05	1.03E-01	2.22	3.83E-04	Site-sp. Eq.	0.58	9.22E-02	3.11E-03	4.21E-05	9.53E-02
Chromium	8.18	1.97E-03	0.038	0.31	4.91E-02	1.15E-02	2.17E-04	6.08E-02	6.93	9.75E-04	0.038	0.26	4.16E-02	9.70E-03	1.07E-04	5.14E-02
Copper	94.2	1.59E-02	Site-sp. Eq.	7.56	1.19E+00	1.32E-01	1.75E-03	1.33E+00	79.3	7.63E-03	Site-sp. Eq.	6.94	1.10E+00	1.11E-01	8.40E-04	1.21E+00
Lead	242	7.39E-02	0.07	16.9	2.67E+00	3.38E-01	8.13E-03	3.02E+00	202	1.28E-02	0.07	14.1	2.23E+00	2.83E-01	1.40E-03	2.52E+00
Mercury (inorganic)	0.02	4.00E-05	3.25	0.06	9.55E-03	2.60E-05	4.40E-06	9.58E-03	0.01	1.96E-05	3.25	0.04	6.78E-03	1.85E-05	2.16E-06	6.80E-03
Nickel	9.59	2.40E-03	1	9.59	1.52E+00	1.34E-02	2.64E-04	1.53E+00	8.63	1.99E-03	1	8.63	1.36E+00	1.21E-02	2.19E-04	1.38E+00
Selenium	4.80	1.74E-03	Site-sp. Eq.	9.38	1.48E+00	6.73E-03	1.92E-04	1.49E+00	1.95	6.58E-04	Site-sp. Eq.	4.27	6.75E-01	2.74E-03	7.24E-05	6.78E-01
Silver	1.58	8.70E-04	1	1.58	2.49E-01	2.21E-03	9.57E-05	2.52E-01	1.21	2.98E-04	1	1.21	1.90E-01	1.69E-03	3.28E-05	1.92E-01
Zinc	883	1.50E-01	Site-sp. Eq.	149	2.35E+01	1.24E+00	1.65E-02	2.48E+01	705	1.21E-01	Site-sp. Eq.	131	2.07E+01	9.87E-01	1.33E-02	2.17E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.75 EU-DR02 Estimated Daily Doses (EDDs) for belted kingfisher foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	10.3	1.95E-03	0.13	1.30	2.06E-01	1.45E-02	2.15E-04	2.21E-01	9.49	9.73E-04	0.13	1.20	1.89E-01	1.33E-02	1.07E-04	2.02E-01
Cadmium	2.77	5.07E-04	Site-sp. Eq.	0.63	9.92E-02	3.88E-03	5.58E-05	1.03E-01	2.30	2.95E-04	Site-sp. Eq.	0.59	9.33E-02	3.23E-03	3.25E-05	9.66E-02
Chromium	8.76	1.28E-03	0.038	0.33	5.26E-02	1.23E-02	1.40E-04	6.50E-02	7.64	7.08E-04	0.038	0.29	4.58E-02	1.07E-02	7.79E-05	5.66E-02
Copper	82.4	8.69E-03	Site-sp. Eq.	7.07	1.12E+00	1.15E-01	9.56E-04	1.23E+00	72.2	6.70E-03	Site-sp. Eq.	6.63	1.05E+00	1.01E-01	7.37E-04	1.15E+00
Lead	190	2.78E-02	0.07	13.3	2.11E+00	2.67E-01	3.06E-03	2.38E+00	168	9.84E-03	0.07	11.7	1.85E+00	2.35E-01	1.08E-03	2.09E+00
Mercury (inorganic)	0.04	4.00E-05	3.25	0.14	2.20E-02	5.99E-05	4.40E-06	2.20E-02	0.03	1.68E-05	3.25	0.10	1.56E-02	4.26E-05	1.85E-06	1.57E-02
Nickel	11.5	1.88E-03	1	11.5	1.82E+00	1.61E-02	2.07E-04	1.83E+00	10.1	1.56E-03	1	10.1	1.59E+00	1.41E-02	1.72E-04	1.61E+00
Selenium	2.74	9.89E-04	Site-sp. Eq.	5.68	8.98E-01	3.84E-03	1.09E-04	9.02E-01	1.13	4.50E-04	Site-sp. Eq.	2.80	4.42E-01	1.58E-03	4.95E-05	4.44E-01
Silver	1.11	4.70E-04	1	1.11	1.76E-01	1.56E-03	5.17E-05	1.77E-01	0.95	1.74E-04	1	0.95	1.49E-01	1.32E-03	1.91E-05	1.51E-01
Zinc	864	1.29E-01	Site-sp. Eq.	147	2.33E+01	1.21E+00	1.42E-02	2.45E+01	749	8.30E-02	Site-sp. Eq.	136	2.14E+01	1.05E+00	9.13E-03	2.25E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.76 Reference Exposure Unit Bear Creek Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Bear Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	14.6	1.25E-03	0.13	1.84	2.91E-01	2.04E-02	1.38E-04	3.11E-01	12.5	1.25E-03	0.13	1.58	2.49E-01	1.75E-02	1.38E-04	2.66E-01
Cadmium	0.95	2.50E-04	Site-sp. Eq.	0.44	6.97E-02	1.33E-03	2.75E-05	7.11E-02	0.82	2.50E-04	Site-sp. Eq.	0.42	6.64E-02	1.15E-03	2.75E-05	6.76E-02
Chromium	3.83	2.50E-03	0.038	0.15	2.30E-02	5.36E-03	2.75E-04	2.86E-02	3.82	2.50E-03	0.038	0.14	2.29E-02	5.34E-03	2.75E-04	2.85E-02
Copper	25.9	1.25E-03	Site-sp. Eq.	3.99	6.30E-01	3.63E-02	1.38E-04	6.66E-01	23.6	1.25E-03	Site-sp. Eq.	3.80	6.01E-01	3.30E-02	1.38E-04	6.34E-01
Lead	65.2	2.50E-04	0.07	4.56	7.21E-01	9.13E-02	2.75E-05	8.12E-01	53.5	2.50E-04	0.07	3.75	5.92E-01	7.49E-02	2.75E-05	6.67E-01
Mercury (inorganic)	0.01	-	3.25	0.02	3.08E-03	8.40E-06	-	3.09E-03	0.01	-	3.25	0.02	2.82E-03	7.70E-06	-	2.83E-03
Nickel	7.20	1.25E-03	1	7.20	1.14E+00	1.01E-02	1.38E-04	1.15E+00	6.93	1.25E-03	1	6.93	1.09E+00	9.70E-03	1.38E-04	1.10E+00
Selenium	1.50	2.50E-03	Site-sp. Eq.	3.46	5.46E-01	2.10E-03	2.75E-04	5.49E-01	1.32	2.50E-03	Site-sp. Eq.	3.13	4.94E-01	1.84E-03	2.75E-04	4.96E-01
Silver	0.12	1.25E-03	1	0.12	1.96E-02	1.74E-04	1.38E-04	1.99E-02	0.07	1.25E-03	1	0.07	1.12E-02	9.94E-05	1.38E-04	1.15E-02
Zinc	263	5.00E-03	Site-sp. Eq.	74.2	1.17E+01	3.68E-01	5.50E-04	1.21E+01	257	5.00E-03	Site-sp. Eq.	73.2	1.16E+01	3.60E-01	5.50E-04	1.19E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.77 Reference Exposure Unit Hermosa Creek Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Hermosa Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	1.10	1.25E-03	0.13	0.14	2.19E-02	1.54E-03	1.38E-04	2.36E-02	1.10	1.25E-03	0.13	0.14	2.19E-02	1.54E-03	1.38E-04	2.36E-02
Cadmium	0.03	2.50E-04	Site-sp. Eq.	0.15	2.34E-02	4.83E-05	2.75E-05	2.35E-02	0.03	2.50E-04	Site-sp. Eq.	0.15	2.34E-02	4.83E-05	2.75E-05	2.35E-02
Chromium	23.0	2.50E-03	0.038	0.87	1.38E-01	3.22E-02	2.75E-04	1.71E-01	23.0	2.50E-03	0.038	0.87	1.38E-01	3.22E-02	2.75E-04	1.71E-01
Copper	11.5	1.25E-03	Site-sp. Eq.	2.67	4.21E-01	1.61E-02	1.38E-04	4.38E-01	11.5	1.25E-03	Site-sp. Eq.	2.67	4.21E-01	1.61E-02	1.38E-04	4.38E-01
Lead	11.7	2.50E-04	0.07	0.82	1.29E-01	1.64E-02	2.75E-05	1.46E-01	11.7	2.50E-04	0.07	0.82	1.29E-01	1.64E-02	2.75E-05	1.46E-01
Mercury (inorganic)	0.00	-	3.25	0.01	1.36E-03	3.71E-06	-	1.36E-03	0.003	-	3.25	0.01	1.36E-03	3.71E-06	-	1.36E-03
Nickel	15.0	1.25E-03	1	15.0	2.37E+00	2.10E-02	1.38E-04	2.39E+00	15.0	1.25E-03	1	15.0	2.37E+00	2.10E-02	1.38E-04	2.39E+00
Selenium	2.40	2.50E-03	Site-sp. Eq.	5.07	8.01E-01	3.36E-03	2.75E-04	8.05E-01	2.40	2.50E-03	Site-sp. Eq.	5.07	8.01E-01	3.36E-03	2.75E-04	8.05E-01
Silver	0.02	1.25E-03	1	0.02	3.56E-03	3.15E-05	1.38E-04	3.72E-03	0.02	1.25E-03	1	0.02	3.56E-03	3.15E-05	1.38E-04	3.72E-03
Zinc	65.9	5.00E-03	Site-sp. Eq.	33.4	5.28E+00	9.23E-02	5.50E-04	5.38E+00	65.9	5.00E-03	Site-sp. Eq.	33.4	5.28E+00	9.23E-02	5.50E-04	5.38E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.78 Reference Exposure Unit Mill Creek Estimated Daily Doses (EDDs) for Belted kKingfisher Foraging in Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	10.0	1.25E-03	Measured	0.47	7.35E-02	1.40E-02	1.38E-04	8.76E-02	10.0	1.25E-03	Measured	0.34	5.36E-02	1.40E-02	1.38E-04	6.77E-02
Cadmium	2.30	2.50E-04	Measured	0.56	8.90E-02	3.22E-03	2.75E-05	9.22E-02	2.30	2.50E-04	Measured	0.43	6.81E-02	3.22E-03	2.75E-05	7.13E-02
Chromium	0.87	2.50E-03	Measured	3.79	5.99E-01	1.22E-03	2.75E-04	6.00E-01	0.87	2.50E-03	Measured	3.51	5.54E-01	1.22E-03	2.75E-04	5.56E-01
Copper	15.7	1.25E-03	Measured	4.52	7.14E-01	2.20E-02	1.38E-04	7.36E-01	15.7	1.25E-03	Measured	3.23	5.11E-01	2.20E-02	1.38E-04	5.33E-01
Lead	329	1.74E-03	Measured	8.12	1.28E+00	4.61E-01	1.91E-04	1.74E+00	329	1.26E-03	Measured	4.95	7.81E-01	4.61E-01	1.38E-04	1.24E+00
Mercury (inorganic)	0.002	-	Measured	0.09	1.35E-02	2.52E-06	-	1.35E-02	0.002	-	Measured	0.06	1.00E-02	2.52E-06	-	1.00E-02
Nickel	2.70	1.25E-03	Measured	0.20	3.18E-02	3.78E-03	1.38E-04	3.57E-02	2.70	1.25E-03	Measured	0.15	2.43E-02	3.78E-03	1.38E-04	2.82E-02
Selenium	1.20	2.50E-03	Measured	3.98	6.29E-01	1.68E-03	2.75E-04	6.31E-01	1.20	2.50E-03	Measured	3.38	5.34E-01	1.68E-03	2.75E-04	5.36E-01
Silver	0.02	1.25E-03	Measured	0.20	3.18E-02	2.17E-05	1.38E-04	3.19E-02	0.02	1.25E-03	Measured	0.15	2.43E-02	2.17E-05	1.38E-04	2.45E-02
Zinc	431	4.21E-02	Measured	171	2.70E+01	6.03E-01	4.63E-03	2.76E+01	431	3.07E-02	Measured	117	1.85E+01	6.03E-01	3.38E-03	1.91E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
$\mathbf{IR_{diet}}$ (kg/kg BW-day, DW)	0.158	100% fish
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.11	
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, DW)	0.0014	

Table A15.79 Reference Exposure Unit Maggie Gulch Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Maggie Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	12.5	1.25E-03	0.13	1.58	2.49E-01	1.75E-02	1.38E-04	2.66E-01	9.40	1.25E-03	0.13	1.18	1.87E-01	1.32E-02	1.38E-04	2.00E-01
Cadmium	0.79	2.50E-04	Site-sp. Eq.	0.42	6.56E-02	1.11E-03	2.75E-05	6.68E-02	0.45	2.50E-04	Site-sp. Eq.	0.34	5.44E-02	6.26E-04	2.75E-05	5.50E-02
Chromium	3.20	2.50E-03	0.038	0.12	1.92E-02	4.48E-03	2.75E-04	2.40E-02	2.80	2.50E-03	0.038	0.11	1.68E-02	3.92E-03	2.75E-04	2.10E-02
Copper	33.1	1.25E-03	Site-sp. Eq.	4.50	7.11E-01	4.63E-02	1.38E-04	7.58E-01	27.3	1.25E-03	Site-sp. Eq.	4.09	6.47E-01	3.83E-02	1.38E-04	6.85E-01
Lead	36.3	4.70E-04	0.07	2.54	4.01E-01	5.08E-02	5.17E-05	4.52E-01	33.0	3.16E-04	0.07	2.31	3.65E-01	4.62E-02	3.48E-05	4.12E-01
Mercury (inorganic)	0.22	-	3.25	0.70	1.11E-01	3.02E-04	-	1.11E-01	0.09	-	3.25	0.28	4.45E-02	1.21E-04	-	4.46E-02
Nickel	6.70	1.25E-03	1	6.70	1.06E+00	9.38E-03	1.38E-04	1.07E+00	6.25	1.25E-03	1	6.25	9.88E-01	8.75E-03	1.38E-04	9.97E-01
Selenium	2.31	2.50E-03	Site-sp. Eq.	4.91	7.76E-01	3.24E-03	2.75E-04	7.79E-01	1.02	2.50E-03	Site-sp. Eq.	2.59	4.10E-01	1.43E-03	2.75E-04	4.11E-01
Silver	0.70	1.25E-03	1	0.70	1.11E-01	9.80E-04	1.38E-04	1.12E-01	0.32	1.25E-03	1	0.32	5.02E-02	4.45E-04	1.38E-04	5.08E-02
Zinc	168	5.00E-03	Site-sp. Eq.	57.3	9.06E+00	2.35E-01	5.50E-04	9.29E+00	137	5.00E-03	Site-sp. Eq.	51.0	8.06E+00	1.92E-01	5.50E-04	8.26E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.80 Reference Exposure Unit Picayne Gulch Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in Picayne Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	65.7	1.25E-03	0.13	8.28	1.31E+00	9.20E-02	1.38E-04	1.40E+00	49.2	1.25E-03	0.13	6.20	9.80E-01	6.89E-02	1.38E-04	1.05E+00
Cadmium	1.67	2.50E-04	Site-sp. Eq.	0.53	8.39E-02	2.34E-03	2.75E-05	8.63E-02	1.56	2.50E-04	Site-sp. Eq.	0.52	8.20E-02	2.18E-03	2.75E-05	8.42E-02
Chromium	5.16	2.50E-03	0.038	0.20	3.10E-02	7.22E-03	2.75E-04	3.85E-02	4.75	2.50E-03	0.038	0.18	2.85E-02	6.65E-03	2.75E-04	3.55E-02
Copper	40.4	1.25E-03	Site-sp. Eq.	4.97	7.85E-01	5.66E-02	1.38E-04	8.42E-01	36.2	1.25E-03	Site-sp. Eq.	4.71	7.44E-01	5.07E-02	1.38E-04	7.95E-01
Lead	134	7.76E-04	0.07	9.38	1.48E+00	1.88E-01	8.54E-05	1.67E+00	85.1	4.25E-04	0.07	5.96	9.41E-01	1.19E-01	4.68E-05	1.06E+00
Mercury (inorganic)	0.01	-	3.25	0.04	6.16E-03	1.68E-05	-	6.18E-03	0.01	-	3.25	0.02	3.59E-03	9.80E-06	-	3.60E-03
Nickel	9.92	1.25E-03	1	9.92	1.57E+00	1.39E-02	1.38E-04	1.58E+00	8.87	1.25E-03	1	8.87	1.40E+00	1.24E-02	1.38E-04	1.41E+00
Selenium	1.70	2.50E-03	Site-sp. Eq.	3.82	6.03E-01	2.38E-03	2.75E-04	6.05E-01	0.85	2.50E-03	Site-sp. Eq.	2.29	3.62E-01	1.19E-03	2.75E-04	3.63E-01
Silver	1.36	1.25E-03	1	1.36	2.15E-01	1.90E-03	1.38E-04	2.17E-01	1.09	1.25E-03	1	1.09	1.72E-01	1.52E-03	1.38E-04	1.73E-01
Zinc	421	4.07E-02	Site-sp. Eq.	97.3	1.54E+01	5.89E-01	4.48E-03	1.60E+01	383	1.93E-02	Site-sp. Eq.	92.1	1.46E+01	5.36E-01	2.13E-03	1.51E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.81 Reference Exposure Unit North Fork Animas River Estimated Daily Doses (EDDs) for Belted Kingfisher Foraging in North Fork Animas River Above Burrows Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	73.0	1.25E-03	0.13	9.20	1.45E+00	1.02E-01	1.38E-04	1.56E+00	57.9	1.25E-03	0.13	7.29	1.15E+00	8.10E-02	1.38E-04	1.23E+00
Cadmium	10.8	1.44E-03	Site-sp. Eq.	0.98	1.55E-01	1.52E-02	1.58E-04	1.71E-01	8.93	1.05E-03	Site-sp. Eq.	0.92	1.46E-01	1.25E-02	1.16E-04	1.58E-01
Chromium	3.23	2.50E-03	0.038	0.12	1.94E-02	4.52E-03	2.75E-04	2.42E-02	2.60	2.50E-03	0.038	0.10	1.56E-02	3.63E-03	2.75E-04	1.95E-02
Copper	43.6	2.02E-03	Site-sp. Eq.	5.16	8.15E-01	6.10E-02	2.23E-04	8.77E-01	35.7	1.51E-03	Site-sp. Eq.	4.68	7.39E-01	5.00E-02	1.66E-04	7.89E-01
Lead	290	4.51E-03	0.07	20.3	3.21E+00	4.06E-01	4.96E-04	3.61E+00	208	2.32E-03	0.07	14.5	2.29E+00	2.91E-01	2.55E-04	2.59E+00
Mercury (inorganic)	0.04	-	3.25	0.14	2.20E-02	6.01E-05	-	2.21E-02	0.03	-	3.25	0.09	1.49E-02	4.06E-05	-	1.49E-02
Nickel	4.92	1.25E-03	1	4.92	7.77E-01	6.89E-03	1.38E-04	7.84E-01	4.66	1.25E-03	1	4.66	7.35E-01	6.52E-03	1.38E-04	7.42E-01
Selenium	1.49	2.50E-03	Site-sp. Eq.	3.45	5.45E-01	2.09E-03	2.75E-04	5.47E-01	0.62	2.50E-03	Site-sp. Eq.	1.89	2.98E-01	8.72E-04	2.75E-04	2.99E-01
Silver	2.02	1.25E-03	1	2.02	3.19E-01	2.83E-03	1.38E-04	3.22E-01	1.43	1.25E-03	1	1.43	2.26E-01	2.00E-03	1.38E-04	2.28E-01
Zinc	1180	2.18E-01	Site-sp. Eq.	176	2.78E+01	1.65E+00	2.40E-02	2.95E+01	897	1.66E-01	Site-sp. Eq.	150	2.38E+01	1.26E+00	1.82E-02	2.50E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
IR_{diet} (kg/kg BW-day, DW)	0.158	100% fish
IR_{water} (L/kg BW-day)	0.11	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.0014	

Table A15.82 EU-01 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mineral Creek from Animas River to South Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	46.8	2.67E-03	Equation	1.19	1.00E-01	3.93E-01	2.60E-04	4.93E-01	34.2	1.58E-03	Equation	1.00	8.40E-02	2.87E-01	1.54E-04	3.71E-01
Cadmium	2.04	7.37E-04	Equation	0.92	7.70E-02	1.71E-02	7.19E-05	9.42E-02	1.58	5.17E-04	Equation	0.80	6.69E-02	1.33E-02	5.04E-05	8.02E-02
Chromium	6.45	2.52E-03	Factor	0.26	2.22E-02	5.41E-02	2.46E-04	7.66E-02	3.67	2.32E-03	Factor	0.15	1.26E-02	3.08E-02	2.26E-04	4.37E-02
Copper	140	1.13E-02	Equation	13.7	1.15E+00	1.17E+00	1.10E-03	2.32E+00	118	9.75E-03	Equation	12.8	1.07E+00	9.93E-01	9.51E-04	2.07E+00
Lead	276	1.49E-02	Equation	6.20	5.20E-01	2.31E+00	1.45E-03	2.83E+00	229	9.96E-03	Equation	5.58	4.68E-01	1.92E+00	9.71E-04	2.39E+00
Mercury (inorganic)	0.19	4.00E-05	Equation	0.15	1.24E-02	1.55E-03	3.90E-06	1.39E-02	0.09	2.20E-05	Equation	0.10	8.34E-03	7.51E-04	2.15E-06	9.09E-03
Nickel	7.18	1.96E-03	Equation	0.47	3.97E-02	6.03E-02	1.91E-04	1.00E-01	5.88	1.64E-03	Equation	0.41	3.41E-02	4.93E-02	1.60E-04	8.36E-02
Selenium	10.5	2.50E-03	Equation	6.78	5.69E-01	8.78E-02	2.44E-04	6.57E-01	3.85	1.99E-03	Equation	2.25	1.89E-01	3.23E-02	1.94E-04	2.21E-01
Silver	1.77	1.25E-03	Factor	0.02	2.08E-03	1.48E-02	1.22E-04	1.70E-02	1.02	1.09E-03	Factor	0.01	1.19E-03	8.53E-03	1.07E-04	9.83E-03
Zinc	678	1.60E-01	Equation	180	1.51E+01	5.69E+00	1.56E-02	2.08E+01	517	1.40E-01	Equation	155	1.30E+01	4.34E+00	1.37E-02	1.73E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.83 EU-02 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)				
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	62.9	1.77E-03	Equation	1.41	1.18E-01	5.28E-01	1.72E-04	6.46E-01	47.3	1.44E-03	Equation	1.20	1.01E-01	3.97E-01	1.40E-04	4.98E-01
Cadmium	1.80	1.10E-03	Equation	0.86	7.18E-02	1.51E-02	1.07E-04	8.70E-02	1.26	9.00E-04	Equation	0.71	5.92E-02	1.06E-02	8.77E-05	6.98E-02
Chromium	2.40	2.50E-03	Factor	0.10	8.25E-03	2.01E-02	2.44E-04	2.86E-02	1.72	2.50E-03	Factor	0.07	5.93E-03	1.45E-02	2.44E-04	2.06E-02
Copper	84.0	1.71E-02	Equation	11.2	9.39E-01	7.05E-01	1.67E-03	1.65E+00	76.1	1.56E-02	Equation	10.8	9.03E-01	6.38E-01	1.52E-03	1.54E+00
Lead	386	2.15E-02	Equation	7.49	6.28E-01	3.24E+00	2.10E-03	3.87E+00	333	1.40E-02	Equation	6.90	5.79E-01	2.80E+00	1.37E-03	3.38E+00
Mercury (inorganic)	0.08	-	Equation	0.10	8.05E-03	7.05E-04	-	8.76E-03	0.05	-	Equation	0.07	6.16E-03	4.30E-04	-	6.59E-03
Nickel	3.43	1.25E-03	Equation	0.27	2.28E-02	2.88E-02	1.22E-04	5.17E-02	2.85	1.25E-03	Equation	0.24	1.99E-02	2.39E-02	1.22E-04	4.39E-02
Selenium	1.90	2.50E-03	Equation	1.03	8.65E-02	1.59E-02	2.44E-04	1.03E-01	1.52	2.50E-03	Equation	0.81	6.78E-02	1.28E-02	2.44E-04	8.08E-02
Silver	0.63	1.25E-03	Factor	0.01	7.34E-04	5.24E-03	1.22E-04	6.10E-03	0.32	1.25E-03	Factor	0.00	3.78E-04	2.70E-03	1.22E-04	3.20E-03
Zinc	1328	2.65E-01	Equation	261	2.19E+01	1.11E+01	2.58E-02	3.31E+01	722	2.22E-01	Equation	186	1.56E+01	6.06E+00	2.16E-02	2.17E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	$[Plant\ tissue] = e^{(-1.992 + 0.564(\ln Sediment\ concentration))}$
Cadmium	$[Plant\ tissue] = e^{(-0.476 + 0.546(\ln Sediment\ concentration))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	$[Plant\ tissue] = e^{(0.669 + 0.394(\ln Sediment\ concentration))}$
Lead	$[Plant\ tissue] = e^{(-1.328 + 0.561(\ln Sediment\ concentration))}$
Mercury	$[Plant\ tissue] = e^{(-0.996 + 0.544(\ln Sediment\ concentration))}$
Nickel	$[Plant\ tissue] = e^{(-2.224 + 0.748(\ln Sediment\ concentration))}$
Selenium	$[Plant\ tissue] = e^{(-0.678 + 1.104(\ln Sediment\ concentration))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	$[Plant\ tissue] = e^{(1.575 + 0.555(\ln Sediment\ concentration))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.84 EU-03 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	55.9	6.26E-03	Equation	1.32	1.11E-01	4.69E-01	6.10E-04	5.80E-01	48.2	2.64E-03	Equation	1.21	1.02E-01	4.05E-01	2.57E-04	5.07E-01
Cadmium	10.9	8.55E-04	Equation	2.28	1.92E-01	9.10E-02	8.34E-05	2.83E-01	5.55	6.54E-04	Equation	1.58	1.33E-01	4.66E-02	6.37E-05	1.80E-01
Chromium	3.90	2.50E-03	Factor	0.16	1.34E-02	3.27E-02	2.44E-04	4.64E-02	2.53	2.50E-03	Factor	0.10	8.70E-03	2.12E-02	2.44E-04	3.02E-02
Copper	185	2.30E-02	Equation	15.3	1.28E+00	1.55E+00	2.25E-03	2.83E+00	117	1.80E-02	Equation	12.8	1.07E+00	9.83E-01	1.76E-03	2.06E+00
Lead	778	4.80E-02	Equation	11.1	9.31E-01	6.53E+00	4.68E-03	7.47E+00	456	3.09E-02	Equation	8.22	6.90E-01	3.83E+00	3.01E-03	4.52E+00
Mercury (inorganic)	0.28	-	Equation	0.19	1.56E-02	2.37E-03	-	1.79E-02	0.13	-	Equation	0.12	1.01E-02	1.07E-03	-	1.12E-02
Nickel	5.85	1.25E-03	Equation	0.41	3.40E-02	4.91E-02	1.22E-04	8.32E-02	4.25	1.25E-03	Equation	0.32	2.68E-02	3.56E-02	1.22E-04	6.25E-02
Selenium	1.40	2.50E-03	Equation	0.74	6.17E-02	1.17E-02	2.44E-04	7.37E-02	0.96	2.50E-03	Equation	0.48	4.06E-02	8.04E-03	2.44E-04	4.89E-02
Silver	1.34	1.25E-03	Factor	0.02	1.57E-03	1.12E-02	1.22E-04	1.29E-02	0.96	1.25E-03	Factor	0.01	1.12E-03	8.02E-03	1.22E-04	9.27E-03
Zinc	2920	2.58E-01	Equation	405	3.40E+01	2.45E+01	2.52E-02	5.85E+01	1749	2.09E-01	Equation	305	2.56E+01	1.47E+01	2.03E-02	4.03E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	$[Plant\ tissue] = e^{(-1.992 + 0.564(\ln Sediment\ concentration))}$
Cadmium	$[Plant\ tissue] = e^{(-0.476 + 0.546(\ln Sediment\ concentration))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	$[Plant\ tissue] = e^{(0.669 + 0.394(\ln Sediment\ concentration))}$
Lead	$[Plant\ tissue] = e^{(-1.328 + 0.561(\ln Sediment\ concentration))}$
Mercury	$[Plant\ tissue] = e^{(-0.996 + 0.544(\ln Sediment\ concentration))}$
Nickel	$[Plant\ tissue] = e^{(-2.224 + 0.748(\ln Sediment\ concentration))}$
Selenium	$[Plant\ tissue] = e^{(-0.678 + 1.104(\ln Sediment\ concentration))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	$[Plant\ tissue] = e^{(1.575 + 0.555(\ln Sediment\ concentration))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.85 EU-04 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mineral Creek Upstream of Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	160	1.25E-03	Equation	2.39	2.00E-01	1.34E+00	1.22E-04	1.54E+00	126	1.25E-03	Equation	2.09	1.75E-01	1.06E+00	1.22E-04	1.24E+00
Cadmium	12.7	2.39E-03	Equation	2.49	2.09E-01	1.07E-01	2.33E-04	3.16E-01	8.00	1.38E-03	Equation	1.93	1.62E-01	6.71E-02	1.34E-04	2.29E-01
Chromium	2.43	2.50E-03	Factor	0.10	8.36E-03	2.04E-02	2.44E-04	2.90E-02	1.87	2.50E-03	Factor	0.08	6.43E-03	1.57E-02	2.44E-04	2.24E-02
Copper	439	3.08E-02	Equation	21.5	1.80E+00	3.68E+00	3.00E-03	5.49E+00	304	2.24E-02	Equation	18.6	1.56E+00	2.55E+00	2.19E-03	4.11E+00
Lead	1890	9.21E-02	Equation	18.3	1.53E+00	1.59E+01	8.98E-03	1.74E+01	1326	4.57E-02	Equation	15.0	1.26E+00	1.11E+01	4.46E-03	1.24E+01
Mercury (inorganic)	0.31	-	Equation	0.19	1.62E-02	2.56E-03	-	1.88E-02	0.17	-	Equation	0.14	1.16E-02	1.38E-03	-	1.30E-02
Nickel	8.89	1.25E-03	Equation	0.55	4.65E-02	7.46E-02	1.22E-04	1.21E-01	5.55	1.25E-03	Equation	0.39	3.27E-02	4.66E-02	1.22E-04	7.94E-02
Selenium	0.70	2.50E-03	Equation	0.34	2.87E-02	5.87E-03	2.44E-04	3.48E-02	0.70	2.50E-03	Equation	0.34	2.87E-02	5.87E-03	2.44E-04	3.48E-02
Silver	3.55	1.25E-03	Factor	0.05	4.17E-03	2.98E-02	1.22E-04	3.41E-02	3.55	1.25E-03	Factor	0.05	4.17E-03	2.98E-02	1.22E-04	3.41E-02
Zinc	5900	8.70E-01	Equation	598	5.02E+01	4.95E+01	8.48E-02	9.98E+01	5770	4.67E-01	Equation	591	4.96E+01	4.84E+01	4.55E-02	9.80E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

1 $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

2 $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$

4 Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.86 EU-05 Estimated Daily Doses (EDDs) for Muskrat Foraging in South Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	14.5	1.25E-03	Equation	0.62	5.17E-02	1.22E-01	1.22E-04	1.73E-01	12.5	1.25E-03	Equation	0.57	4.76E-02	1.05E-01	1.22E-04	1.53E-01
Cadmium	1.00	2.50E-04	Equation	0.62	5.21E-02	8.39E-03	2.44E-05	6.05E-02	0.60	2.50E-04	Equation	0.47	3.94E-02	5.03E-03	2.44E-05	4.45E-02
Chromium	3.20	2.50E-03	Factor	0.13	1.10E-02	2.68E-02	2.44E-04	3.81E-02	3.11	2.50E-03	Factor	0.13	1.07E-02	2.61E-02	2.44E-04	3.70E-02
Copper	18.9	1.25E-03	Equation	6.22	5.21E-01	1.59E-01	1.22E-04	6.80E-01	18.8	1.25E-03	Equation	6.20	5.20E-01	1.58E-01	1.22E-04	6.78E-01
Lead	106	1.19E-03	Equation	3.63	3.04E-01	8.89E-01	1.16E-04	1.19E+00	87.3	7.41E-04	Equation	3.25	2.73E-01	7.32E-01	7.22E-05	1.00E+00
Mercury (inorganic)	0.09	-	Equation	0.10	8.11E-03	7.13E-04	-	8.82E-03	0.05	-	Equation	0.07	5.74E-03	3.78E-04	-	6.11E-03
Nickel	11.6	1.25E-03	Equation	0.68	5.68E-02	9.73E-02	1.22E-04	1.54E-01	8.45	1.25E-03	Equation	0.53	4.48E-02	7.09E-02	1.22E-04	1.16E-01
Selenium	1.90	2.50E-03	Equation	1.03	8.65E-02	1.59E-02	2.44E-04	1.03E-01	1.32	2.50E-03	Equation	0.69	5.77E-02	1.10E-02	2.44E-04	6.90E-02
Silver	0.72	1.25E-03	Factor	0.01	8.43E-04	6.02E-03	1.22E-04	6.99E-03	0.37	1.25E-03	Factor	0.01	4.32E-04	3.09E-03	1.22E-04	3.64E-03
Zinc	386	2.28E-02	Equation	132	1.10E+01	3.24E+00	2.22E-03	1.43E+01	255	1.96E-02	Equation	105	8.78E+00	2.14E+00	1.91E-03	1.09E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

1 $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

2 $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$

4 Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.87 EU-06 Estimated Daily Doses (EDDs) for Muskrat Foraging in Middle Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	16.9	1.25E-03	Equation	0.67	5.64E-02	1.42E-01	1.22E-04	1.98E-01	13.9	1.25E-03	Equation	0.60	5.04E-02	1.16E-01	1.22E-04	1.67E-01
Cadmium	0.60	1.40E-03	Equation	0.47	3.95E-02	5.05E-03	1.37E-04	4.47E-02	0.40	7.21E-04	Equation	0.38	3.17E-02	3.38E-03	7.03E-05	3.52E-02
Chromium	1.60	2.50E-03	Factor	0.07	5.50E-03	1.34E-02	2.44E-04	1.92E-02	1.37	2.50E-03	Factor	0.06	4.70E-03	1.15E-02	2.44E-04	1.64E-02
Copper	24.3	6.04E-03	Equation	6.86	5.76E-01	2.04E-01	5.89E-04	7.80E-01	19.9	3.45E-03	Equation	6.34	5.32E-01	1.67E-01	3.36E-04	6.99E-01
Lead	100	3.37E-03	Equation	3.51	2.94E-01	8.39E-01	3.28E-04	1.13E+00	83.6	1.58E-03	Equation	3.17	2.66E-01	7.01E-01	1.54E-04	9.68E-01
Mercury (inorganic)	0.01	-	Equation	0.03	2.79E-03	1.01E-04	-	2.90E-03	0.01	-	Equation	0.03	2.31E-03	7.10E-05	-	2.38E-03
Nickel	1.77	2.94E-03	Equation	0.17	1.39E-02	1.49E-02	2.87E-04	2.90E-02	1.17	1.76E-03	Equation	0.12	1.02E-02	9.77E-03	1.71E-04	2.01E-02
Selenium	1.50	2.50E-03	Equation	0.79	6.66E-02	1.26E-02	2.44E-04	7.95E-02	1.33	2.50E-03	Equation	0.70	5.85E-02	1.12E-02	2.44E-04	6.99E-02
Silver	0.63	1.25E-03	Factor	0.01	7.34E-04	5.24E-03	1.22E-04	6.10E-03	0.42	1.25E-03	Factor	0.01	4.96E-04	3.54E-03	1.22E-04	4.16E-03
Zinc	130	1.81E-01	Equation	72.0	6.04E+00	1.09E+00	1.77E-02	7.15E+00	117	9.45E-02	Equation	67.8	5.68E+00	9.78E-01	9.21E-03	6.67E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.88 EU-07 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)				
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	24.8	1.31E-03	Equation	0.83	7.00E-02	2.08E-01	1.27E-04	2.78E-01	20.7	1.27E-03	Equation	0.75	6.33E-02	1.74E-01	1.24E-04	2.37E-01
Cadmium	12.0	1.03E-03	Equation	2.41	2.03E-01	1.01E-01	9.99E-05	3.03E-01	9.68	7.96E-04	Equation	2.15	1.80E-01	8.12E-02	7.76E-05	2.61E-01
Chromium	4.80	2.50E-03	Factor	0.20	1.65E-02	4.03E-02	2.44E-04	5.70E-02	4.12	2.50E-03	Factor	0.17	1.42E-02	3.46E-02	2.44E-04	4.90E-02
Copper	315	1.29E-02	Equation	18.8	1.58E+00	2.64E+00	1.26E-03	4.22E+00	267	8.51E-03	Equation	17.6	1.48E+00	2.24E+00	8.29E-04	3.72E+00
Lead	1442	1.28E-02	Equation	15.7	1.32E+00	1.21E+01	1.24E-03	1.34E+01	1232	6.23E-03	Equation	14.4	1.20E+00	1.03E+01	6.07E-04	1.15E+01
Mercury (inorganic)	0.11	-	Equation	0.11	9.09E-03	8.81E-04	-	9.97E-03	0.07	-	Equation	0.09	7.38E-03	6.00E-04	-	7.98E-03
Nickel	8.03	1.25E-03	Equation	0.51	4.31E-02	6.73E-02	1.22E-04	1.11E-01	6.96	1.25E-03	Equation	0.46	3.87E-02	5.84E-02	1.22E-04	9.73E-02
Selenium	1.14	2.50E-03	Equation	0.58	4.90E-02	9.52E-03	2.44E-04	5.87E-02	0.90	2.46E-03	Equation	0.45	3.81E-02	7.58E-03	2.40E-04	4.59E-02
Silver	5.79	1.25E-03	Factor	0.08	6.80E-03	4.85E-02	1.22E-04	5.55E-02	4.55	1.25E-03	Factor	0.06	5.34E-03	3.82E-02	1.22E-04	4.36E-02
Zinc	3505	3.20E-01	Equation	448	3.76E+01	2.94E+01	3.12E-02	6.70E+01	2695	3.06E-01	Equation	387	3.25E+01	2.26E+01	2.99E-02	5.51E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.89 EU-08 Estimated Daily Doses (EDDs) for Muskrat Foraging in Cunningham Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	11.9	1.25E-03	Equation	0.55	4.62E-02	9.95E-02	1.22E-04	1.46E-01	8.90	1.25E-03	Equation	0.47	3.93E-02	7.46E-02	1.22E-04	1.14E-01
Cadmium	2.87	2.50E-04	Equation	1.10	9.27E-02	2.41E-02	2.44E-05	1.17E-01	2.17	2.50E-04	Equation	0.95	7.95E-02	1.82E-02	2.44E-05	9.77E-02
Chromium	4.08	2.50E-03	Factor	0.17	1.40E-02	3.42E-02	2.44E-04	4.85E-02	3.36	2.50E-03	Factor	0.14	1.15E-02	2.81E-02	2.44E-04	3.99E-02
Copper	108	1.25E-03	Equation	12.4	1.04E+00	9.08E-01	1.22E-04	1.94E+00	70.9	1.25E-03	Equation	10.5	8.78E-01	5.95E-01	1.22E-04	1.47E+00
Lead	636	3.74E-03	Equation	9.91	8.31E-01	5.34E+00	3.64E-04	6.17E+00	441	2.06E-03	Equation	8.06	6.77E-01	3.70E+00	2.01E-04	4.37E+00
Mercury (inorganic)	0.04	-	Equation	0.06	5.22E-03	3.18E-04	-	5.54E-03	0.02	-	Equation	0.04	3.50E-03	1.52E-04	-	3.65E-03
Nickel	4.31	1.25E-03	Equation	0.32	2.71E-02	3.62E-02	1.22E-04	6.33E-02	3.54	1.25E-03	Equation	0.28	2.34E-02	2.97E-02	1.22E-04	5.32E-02
Selenium	4.01	2.50E-03	Equation	2.35	1.97E-01	3.36E-02	2.44E-04	2.31E-01	1.70	2.50E-03	Equation	0.91	7.64E-02	1.42E-02	2.44E-04	9.09E-02
Silver	1.64	1.25E-03	Factor	0.02	1.93E-03	1.38E-02	1.22E-04	1.58E-02	1.18	1.25E-03	Factor	0.02	1.39E-03	9.92E-03	1.22E-04	1.14E-02
Zinc	507	3.70E-02	Equation	153	1.29E+01	4.25E+00	3.61E-03	1.71E+01	429	2.94E-02	Equation	140	1.17E+01	3.60E+00	2.86E-03	1.53E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

1 $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

2 $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$

4 Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.90 EU-09 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River from Howardsville to Minnie Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	34.8	1.25E-03	Equation	1.01	8.47E-02	2.92E-01	1.22E-04	3.76E-01	28.6	1.19E-03	Equation	0.90	7.59E-02	2.40E-01	1.16E-04	3.16E-01
Cadmium	14.0	1.22E-03	Equation	2.63	2.20E-01	1.18E-01	1.19E-04	3.38E-01	10.7	1.03E-03	Equation	2.27	1.91E-01	9.01E-02	1.00E-04	2.81E-01
Chromium	4.49	2.50E-03	Factor	0.18	1.55E-02	3.77E-02	2.44E-04	5.34E-02	3.85	2.35E-03	Factor	0.16	1.33E-02	3.23E-02	2.30E-04	4.58E-02
Copper	458	2.04E-02	Equation	21.8	1.83E+00	3.84E+00	1.99E-03	5.67E+00	348	1.35E-02	Equation	19.6	1.64E+00	2.92E+00	1.32E-03	4.56E+00
Lead	1940	1.22E-02	Equation	18.5	1.55E+00	1.63E+01	1.19E-03	1.78E+01	1534	5.49E-03	Equation	16.2	1.36E+00	1.29E+01	5.35E-04	1.42E+01
Mercury (inorganic)	0.15	-	Equation	0.13	1.11E-02	1.28E-03	-	1.24E-02	0.06	-	Equation	0.08	6.55E-03	4.82E-04	-	7.03E-03
Nickel	9.87	1.25E-03	Equation	0.60	5.03E-02	8.28E-02	1.22E-04	1.33E-01	7.96	1.24E-03	Equation	0.51	4.28E-02	6.68E-02	1.21E-04	1.10E-01
Selenium	1.28	2.50E-03	Equation	0.67	5.59E-02	1.07E-02	2.44E-04	6.69E-02	0.90	2.38E-03	Equation	0.45	3.80E-02	7.56E-03	2.32E-04	4.58E-02
Silver	5.94	1.25E-03	Factor	0.08	6.98E-03	4.98E-02	1.22E-04	5.69E-02	4.69	1.18E-03	Factor	0.07	5.51E-03	3.93E-02	1.15E-04	4.50E-02
Zinc	3526	4.01E-01	Equation	450	3.77E+01	2.96E+01	3.90E-02	6.73E+01	2472	3.61E-01	Equation	369	3.10E+01	2.07E+01	3.52E-02	5.17E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.91 EU-10 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River from Minnie Gulch to Eureka

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	49.7	1.25E-03	Equation	1.23	1.04E-01	4.17E-01	1.22E-04	5.21E-01	44.1	1.20E-03	Equation	1.15	9.68E-02	3.70E-01	1.17E-04	4.67E-01
Cadmium	33.1	2.01E-03	Equation	4.20	3.52E-01	2.77E-01	1.96E-04	6.30E-01	16.5	1.79E-03	Equation	2.87	2.41E-01	1.38E-01	1.75E-04	3.79E-01
Chromium	4.85	2.50E-03	Factor	0.20	1.67E-02	4.07E-02	2.44E-04	5.76E-02	4.51	2.36E-03	Factor	0.19	1.55E-02	3.79E-02	2.30E-04	5.36E-02
Copper	764	4.10E-02	Equation	26.7	2.24E+00	6.41E+00	3.99E-03	8.65E+00	500	2.90E-02	Equation	22.6	1.90E+00	4.20E+00	2.83E-03	6.10E+00
Lead	1907	9.67E-03	Equation	18.3	1.54E+00	1.60E+01	9.42E-04	1.75E+01	1433	6.17E-03	Equation	15.6	1.31E+00	1.20E+01	6.01E-04	1.33E+01
Mercury (inorganic)	0.12	-	Equation	0.11	9.64E-03	9.82E-04	-	1.06E-02	0.05	-	Equation	0.07	5.94E-03	4.03E-04	-	6.34E-03
Nickel	13.9	1.55E-03	Equation	0.78	6.51E-02	1.17E-01	1.51E-04	1.82E-01	10.0	1.36E-03	Equation	0.61	5.08E-02	8.40E-02	1.32E-04	1.35E-01
Selenium	4.81	2.50E-03	Equation	2.88	2.41E-01	4.04E-02	2.44E-04	2.82E-01	2.16	2.39E-03	Equation	1.19	9.99E-02	1.82E-02	2.33E-04	1.18E-01
Silver	24.5	1.25E-03	Factor	0.34	2.87E-02	2.05E-01	1.22E-04	2.34E-01	8.84	1.18E-03	Factor	0.12	1.04E-02	7.41E-02	1.15E-04	8.46E-02
Zinc	5966	6.07E-01	Equation	602	5.05E+01	5.01E+01	5.92E-02	1.01E+02	3528	5.49E-01	Equation	450	3.77E+01	2.96E+01	5.35E-02	6.74E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.92 EU-11 Estimated Daily Doses (EDDs) for Muskrat Foraging in Upper South Fork Animas River Pp to Confluence with Eureka Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	40.9	1.25E-03	Equation	1.11	9.28E-02	3.43E-01	1.22E-04	4.36E-01	28.6	1.25E-03	Equation	0.90	7.58E-02	2.40E-01	1.22E-04	3.16E-01
Cadmium	1.56	2.50E-04	Equation	0.79	6.64E-02	1.31E-02	2.44E-05	7.96E-02	1.17	2.50E-04	Equation	0.68	5.67E-02	9.79E-03	2.44E-05	6.65E-02
Chromium	6.19	2.50E-03	Factor	0.25	2.13E-02	5.19E-02	2.44E-04	7.35E-02	5.44	2.50E-03	Factor	0.22	1.87E-02	4.56E-02	2.44E-04	6.46E-02
Copper	110	1.23E-02	Equation	12.5	1.04E+00	9.25E-01	1.20E-03	1.97E+00	91.2	8.01E-03	Equation	11.6	9.69E-01	7.65E-01	7.81E-04	1.74E+00
Lead	317	2.16E-03	Equation	6.70	5.62E-01	2.66E+00	2.11E-04	3.22E+00	207	8.32E-04	Equation	5.28	4.43E-01	1.74E+00	8.11E-05	2.18E+00
Mercury (inorganic)	0.01	-	Equation	0.03	2.24E-03	6.73E-05	-	2.31E-03	0.01	-	Equation	0.02	1.96E-03	5.24E-05	-	2.01E-03
Nickel	10.1	1.25E-03	Equation	0.61	5.12E-02	8.47E-02	1.22E-04	1.36E-01	7.40	1.25E-03	Equation	0.48	4.06E-02	6.21E-02	1.22E-04	1.03E-01
Selenium	2.60	2.50E-03	Equation	1.46	1.22E-01	2.18E-02	2.44E-04	1.44E-01	1.63	2.50E-03	Equation	0.87	7.28E-02	1.36E-02	2.44E-04	8.67E-02
Silver	1.54	1.25E-03	Factor	0.02	1.81E-03	1.29E-02	1.22E-04	1.49E-02	1.16	1.25E-03	Factor	0.02	1.36E-03	9.72E-03	1.22E-04	1.12E-02
Zinc	460	8.32E-02	Equation	145	1.22E+01	3.86E+00	8.11E-03	1.60E+01	323	5.76E-02	Equation	119	1.00E+01	2.71E+00	5.62E-03	1.27E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.93 EU-12 Estimated Daily Doses (EDDs) for Muskrat Foraging in Eureka Gulch Up to Confluence with Upper South Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	26.0	1.25E-03	Equation	0.86	7.19E-02	2.18E-01	1.22E-04	2.90E-01	18.5	1.25E-03	Equation	0.71	5.92E-02	1.55E-01	1.22E-04	2.14E-01
Cadmium	14.69	1.82E-03	Equation	2.69	2.26E-01	1.23E-01	1.78E-04	3.49E-01	10.93	1.05E-03	Equation	2.29	1.92E-01	9.17E-02	1.03E-04	2.84E-01
Chromium	4.82	2.50E-03	Factor	0.20	1.66E-02	4.04E-02	2.44E-04	5.72E-02	4.07	2.50E-03	Factor	0.17	1.40E-02	3.41E-02	2.44E-04	4.83E-02
Copper	318	1.66E-02	Equation	18.9	1.59E+00	2.67E+00	1.62E-03	4.26E+00	238.3	9.67E-03	Equation	16.9	1.42E+00	2.00E+00	9.43E-04	3.42E+00
Lead	693	3.99E-03	Equation	10.39	8.72E-01	5.81E+00	3.89E-04	6.68E+00	541	2.15E-03	Equation	9.05	7.59E-01	4.54E+00	2.09E-04	5.30E+00
Mercury (inorganic)	0.04	-	Equation	0.06	5.00E-03	2.94E-04	-	5.30E-03	0.02	-	Equation	0.05	3.90E-03	1.86E-04	-	4.08E-03
Nickel	11.3	1.25E-03	Equation	0.66	5.57E-02	9.48E-02	1.22E-04	1.51E-01	9.90	1.25E-03	Equation	0.60	5.04E-02	8.31E-02	1.22E-04	1.34E-01
Selenium	3.73	2.50E-03	Equation	2.17	1.82E-01	3.13E-02	2.44E-04	2.14E-01	1.67	2.50E-03	Equation	0.90	7.52E-02	1.40E-02	2.44E-04	8.95E-02
Silver	3.65	1.25E-03	Factor	0.05	4.29E-03	3.06E-02	1.22E-04	3.50E-02	2.03	1.25E-03	Factor	0.03	2.38E-03	1.70E-02	1.22E-04	1.95E-02
Zinc	4366	8.54E-01	Equation	506	4.25E+01	3.66E+01	8.33E-02	7.92E+01	2955	4.12E-01	Equation	408	3.42E+01	2.48E+01	4.01E-02	5.90E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.94 EU-13 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mainstem South Fork Animas River Up to Confluence

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	36.2	1.25E-03	Equation	1.03	8.66E-02	3.04E-01	1.22E-04	3.90E-01	25.0	1.13E-03	Equation	0.84	7.03E-02	2.10E-01	1.11E-04	2.80E-01
Cadmium	7.41	1.72E-03	Equation	1.85	1.56E-01	6.22E-02	1.67E-04	2.18E-01	6.98	1.20E-03	Equation	1.79	1.51E-01	5.85E-02	1.17E-04	2.09E-01
Chromium	6.38	2.50E-03	Factor	0.26	2.19E-02	5.35E-02	2.44E-04	7.57E-02	5.66	2.25E-03	Factor	0.23	1.95E-02	4.75E-02	2.20E-04	6.71E-02
Copper	236	6.23E-02	Equation	16.8	1.41E+00	1.98E+00	6.08E-03	3.40E+00	221	2.49E-02	Equation	16.4	1.37E+00	1.86E+00	2.43E-03	3.23E+00
Lead	767	3.63E-03	Equation	11.0	9.23E-01	6.44E+00	3.54E-04	7.36E+00	643	2.19E-03	Equation	9.97	8.37E-01	5.40E+00	2.14E-04	6.23E+00
Mercury (inorganic)	0.50	-	Equation	0.25	2.13E-02	4.21E-03	-	2.55E-02	0.24	-	Equation	0.17	1.43E-02	2.04E-03	-	1.64E-02
Nickel	12.5	1.25E-03	Equation	0.72	6.00E-02	1.05E-01	1.22E-04	1.65E-01	10.4	1.24E-03	Equation	0.62	5.24E-02	8.74E-02	1.20E-04	1.40E-01
Selenium	4.14	2.50E-03	Equation	2.43	2.04E-01	3.47E-02	2.44E-04	2.39E-01	2.15	2.29E-03	Equation	1.18	9.89E-02	1.80E-02	2.24E-04	1.17E-01
Silver	2.80	1.25E-03	Factor	0.04	3.29E-03	2.35E-02	1.22E-04	2.69E-02	2.23	1.13E-03	Factor	0.03	2.62E-03	1.87E-02	1.10E-04	2.14E-02
Zinc	2420	5.37E-01	Equation	365	3.06E+01	2.03E+01	5.24E-02	5.10E+01	1940	4.13E-01	Equation	323	2.71E+01	1.63E+01	4.03E-02	4.34E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.95 EU-14 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River from Eureka to Animas Forks

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)				
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	58.6	1.25E-03	Equation	1.36	1.14E-01	4.92E-01	1.22E-04	6.06E-01	46.2	1.20E-03	Equation	1.18	9.94E-02	3.87E-01	1.17E-04	4.87E-01
Cadmium	12.0	7.36E-03	Equation	2.41	2.02E-01	1.01E-01	7.17E-04	3.04E-01	9.14	3.99E-03	Equation	2.08	1.74E-01	7.67E-02	3.89E-04	2.52E-01
Chromium	4.32	3.07E-03	Factor	0.18	1.48E-02	3.62E-02	2.99E-04	5.14E-02	3.86	2.71E-03	Factor	0.16	1.33E-02	3.24E-02	2.64E-04	4.59E-02
Copper	458	5.54E-02	Equation	21.8	1.83E+00	3.84E+00	5.40E-03	5.68E+00	326	3.93E-02	Equation	19.1	1.60E+00	2.73E+00	3.83E-03	4.34E+00
Lead	1307	1.58E-02	Equation	14.8	1.25E+00	1.10E+01	1.54E-03	1.22E+01	997	9.95E-03	Equation	12.8	1.07E+00	8.37E+00	9.70E-04	9.44E+00
Mercury (inorganic)	0.09	-	Equation	0.10	8.44E-03	7.69E-04	-	9.21E-03	0.06	-	Equation	0.08	6.50E-03	4.75E-04	-	6.97E-03
Nickel	8.51	7.01E-03	Equation	0.54	4.50E-02	7.14E-02	6.83E-04	1.17E-01	6.80	2.98E-03	Equation	0.45	3.81E-02	5.70E-02	2.91E-04	9.54E-02
Selenium	1.22	2.50E-03	Equation	0.63	5.30E-02	1.02E-02	2.44E-04	6.35E-02	0.90	2.36E-03	Equation	0.45	3.78E-02	7.53E-03	2.30E-04	4.55E-02
Silver	5.02	1.25E-03	Factor	0.07	5.90E-03	4.22E-02	1.22E-04	4.82E-02	3.67	1.17E-03	Factor	0.05	4.30E-03	3.07E-02	1.14E-04	3.52E-02
Zinc	3458	1.68E+00	Equation	445	3.73E+01	2.90E+01	1.63E-01	6.65E+01	2385	1.16E+00	Equation	362	3.04E+01	2.00E+01	1.13E-01	5.05E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.96 EU-15 Estimated Daily Doses (EDDs) for Muskrat Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	41.7	1.25E-03	Equation	1.12	9.38E-02	3.50E-01	1.22E-04	4.44E-01	32.1	1.25E-03	Equation	0.96	8.09E-02	2.69E-01	1.22E-04	3.50E-01
Cadmium	10.4	9.11E-03	Equation	2.23	1.87E-01	8.73E-02	8.88E-04	2.75E-01	6.52	5.94E-03	Equation	1.73	1.45E-01	5.47E-02	5.79E-04	2.00E-01
Chromium	4.81	2.50E-03	Factor	0.20	1.65E-02	4.04E-02	2.44E-04	5.71E-02	3.73	2.50E-03	Factor	0.15	1.28E-02	3.13E-02	2.44E-04	4.44E-02
Copper	477	3.62E-02	Equation	22.2	1.86E+00	4.00E+00	3.53E-03	5.87E+00	304	2.84E-02	Equation	18.6	1.56E+00	2.55E+00	2.77E-03	4.11E+00
Lead	2320	3.73E-02	Equation	20.5	1.72E+00	1.95E+01	3.64E-03	2.12E+01	1546	1.56E-02	Equation	16.3	1.37E+00	1.30E+01	1.52E-03	1.43E+01
Mercury (inorganic)	0.23	-	Equation	0.17	1.41E-02	1.96E-03	-	1.60E-02	0.16	-	Equation	0.14	1.15E-02	1.35E-03	-	1.28E-02
Nickel	7.30	7.64E-03	Equation	0.48	4.01E-02	6.12E-02	7.45E-04	1.02E-01	5.14	4.60E-03	Equation	0.37	3.09E-02	4.31E-02	4.49E-04	7.44E-02
Selenium	0.84	2.50E-03	Equation	0.42	3.50E-02	7.02E-03	2.44E-04	4.23E-02	0.55	2.50E-03	Equation	0.26	2.19E-02	4.60E-03	2.44E-04	2.68E-02
Silver	6.19	1.25E-03	Factor	0.09	7.27E-03	5.19E-02	1.22E-04	5.93E-02	3.51	1.25E-03	Factor	0.05	4.12E-03	2.94E-02	1.22E-04	3.36E-02
Zinc	2770	3.30E+00	Equation	393	3.30E+01	2.32E+01	3.21E-01	5.65E+01	1548	2.13E+00	Equation	285	2.39E+01	1.30E+01	2.07E-01	3.71E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

1 $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

2 $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$

4 Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	$[Plant\ tissue] = e^{(-1.992 + 0.564(\ln Sediment\ concentration))}$
Cadmium	$[Plant\ tissue] = e^{(-0.476 + 0.546(\ln Sediment\ concentration))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	$[Plant\ tissue] = e^{(0.669 + 0.394(\ln Sediment\ concentration))}$
Lead	$[Plant\ tissue] = e^{(-1.328 + 0.561(\ln Sediment\ concentration))}$
Mercury	$[Plant\ tissue] = e^{(-0.996 + 0.544(\ln Sediment\ concentration))}$
Nickel	$[Plant\ tissue] = e^{(-2.224 + 0.748(\ln Sediment\ concentration))}$
Selenium	$[Plant\ tissue] = e^{(-0.678 + 1.104(\ln Sediment\ concentration))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	$[Plant\ tissue] = e^{(1.575 + 0.555(\ln Sediment\ concentration))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.97 EU-16 Estimated Daily Doses (EDDs) for Muskrat Foraging in Placer Gulch to Confluence with Upper West Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	66.4	1.25E-03	Equation	1.45	1.22E-01	5.57E-01	1.22E-04	6.79E-01	53.6	1.25E-03	Equation	1.29	1.08E-01	4.50E-01	1.22E-04	5.58E-01
Cadmium	64.2	3.25E-03	Equation	6.03	5.06E-01	5.39E-01	3.17E-04	1.04E+00	36.8	2.90E-03	Equation	4.45	3.73E-01	3.09E-01	2.83E-04	6.83E-01
Chromium	4.33	2.50E-03	Factor	0.18	1.49E-02	3.63E-02	2.44E-04	5.15E-02	3.57	2.50E-03	Factor	0.15	1.23E-02	3.00E-02	2.44E-04	4.25E-02
Copper	1700	3.09E-02	Equation	36.6	3.07E+00	1.43E+01	3.01E-03	1.73E+01	1070	2.45E-02	Equation	30.5	2.56E+00	8.98E+00	2.39E-03	1.15E+01
Lead	9009	2.12E-02	Equation	43.8	3.68E+00	7.56E+01	2.06E-03	7.93E+01	6488	1.66E-02	Equation	36.5	3.06E+00	5.44E+01	1.62E-03	5.75E+01
Mercury (inorganic)	0.98	-	Equation	0.36	3.06E-02	8.18E-03	-	3.87E-02	0.68	-	Equation	0.30	2.50E-02	5.67E-03	-	3.07E-02
Nickel	17.0	3.12E-03	Equation	0.90	7.55E-02	1.42E-01	3.04E-04	2.18E-01	9.53	2.20E-03	Equation	0.58	4.90E-02	8.00E-02	2.15E-04	1.29E-01
Selenium	4.20	2.50E-03	Equation	2.48	2.08E-01	3.53E-02	2.44E-04	2.43E-01	1.88	2.50E-03	Equation	1.02	8.53E-02	1.57E-02	2.44E-04	1.01E-01
Silver	22.2	1.25E-03	Factor	0.31	2.61E-02	1.86E-01	1.22E-04	2.13E-01	12.4	1.25E-03	Factor	0.17	1.46E-02	1.04E-01	1.22E-04	1.19E-01
Zinc	21500	1.45E+00	Equation	1226	1.03E+02	1.80E+02	1.42E-01	2.83E+02	8470	1.18E+00	Equation	731	6.13E+01	7.11E+01	1.15E-01	1.33E+02

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.98 EU-17 Estimated Daily Doses (EDDs) for Muskrat Foraging in Mainstem West Fork Animas River from Placer Gulch Up to its Source

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	39.0	1.25E-03	Equation	1.08	9.04E-02	3.27E-01	1.22E-04	4.18E-01	28.5	1.25E-03	Equation	0.90	7.57E-02	2.39E-01	1.22E-04	3.15E-01
Cadmium	2.70	1.27E-02	Equation	1.07	8.97E-02	2.27E-02	1.24E-03	1.14E-01	1.83	8.64E-03	Equation	0.86	7.25E-02	1.53E-02	8.43E-04	8.86E-02
Chromium	8.52	2.50E-03	Factor	0.35	2.93E-02	7.15E-02	2.44E-04	1.01E-01	5.57	2.50E-03	Factor	0.23	1.92E-02	4.67E-02	2.44E-04	6.61E-02
Copper	277	3.55E-02	Equation	17.9	1.50E+00	2.32E+00	3.46E-03	3.83E+00	193	2.60E-02	Equation	15.5	1.30E+00	1.62E+00	2.54E-03	2.92E+00
Lead	339	6.16E-03	Equation	6.96	5.84E-01	2.84E+00	6.00E-04	3.43E+00	242	3.58E-03	Equation	5.76	4.83E-01	2.03E+00	3.49E-04	2.51E+00
Mercury (inorganic)	0.04	-	Equation	0.06	5.23E-03	3.19E-04	-	5.55E-03	0.03	-	Equation	0.06	4.62E-03	2.54E-04	-	4.88E-03
Nickel	12.3	1.34E-02	Equation	0.71	5.92E-02	1.03E-01	1.30E-03	1.64E-01	7.36	8.69E-03	Equation	0.48	4.04E-02	6.17E-02	8.47E-04	1.03E-01
Selenium	1.71	2.50E-03	Equation	0.92	7.70E-02	1.43E-02	2.44E-04	9.15E-02	0.90	2.50E-03	Equation	0.45	3.80E-02	7.56E-03	2.44E-04	4.58E-02
Silver	2.16	1.25E-03	Factor	0.03	2.54E-03	1.81E-02	1.22E-04	2.08E-02	1.27	1.25E-03	Factor	0.02	1.49E-03	1.06E-02	1.22E-04	1.22E-02
Zinc	834	3.93E+00	Equation	202	1.69E+01	7.00E+00	3.83E-01	2.43E+01	686	2.64E+00	Equation	181	1.52E+01	5.75E+00	2.57E-01	2.12E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.99 EU-18 Estimated Daily Doses (EDDs) for Muskrat Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	57.1	1.25E-03	Equation	1.34	1.12E-01	4.79E-01	1.22E-04	5.91E-01	41.1	1.25E-03	Equation	1.11	9.31E-02	3.45E-01	1.22E-04	4.38E-01
Cadmium	7.62	6.24E-03	Equation	1.88	1.58E-01	6.39E-02	6.08E-04	2.23E-01	6.05	5.10E-03	Equation	1.66	1.39E-01	5.08E-02	4.98E-04	1.91E-01
Chromium	3.27	2.50E-03	Factor	0.13	1.12E-02	2.74E-02	2.44E-04	3.89E-02	2.67	2.50E-03	Factor	0.11	9.17E-03	2.24E-02	2.44E-04	3.18E-02
Copper	101	1.99E-02	Equation	12.0	1.01E+00	8.45E-01	1.94E-03	1.85E+00	85.0	1.69E-02	Equation	11.2	9.43E-01	7.13E-01	1.65E-03	1.66E+00
Lead	502	1.27E-02	Equation	8.68	7.28E-01	4.21E+00	1.24E-03	4.94E+00	372	7.75E-03	Equation	7.33	6.15E-01	3.12E+00	7.56E-04	3.73E+00
Mercury (inorganic)	0.07	-	Equation	0.09	7.43E-03	6.08E-04	-	8.04E-03	0.03	-	Equation	0.05	4.19E-03	2.12E-04	-	4.41E-03
Nickel	5.29	3.75E-03	Equation	0.38	3.16E-02	4.44E-02	3.66E-04	7.63E-02	4.34	2.31E-03	Equation	0.32	2.72E-02	3.64E-02	2.25E-04	6.39E-02
Selenium	3.68	2.50E-03	Equation	2.14	1.80E-01	3.09E-02	2.44E-04	2.11E-01	0.90	2.50E-03	Equation	0.45	3.78E-02	7.53E-03	2.44E-04	4.56E-02
Silver	2.08	1.25E-03	Factor	0.03	2.44E-03	1.74E-02	1.22E-04	2.00E-02	1.46	1.25E-03	Factor	0.02	1.71E-03	1.22E-02	1.22E-04	1.41E-02
Zinc	1423	1.05E+00	Equation	272	2.28E+01	1.19E+01	1.03E-01	3.48E+01	938	8.64E-01	Equation	216	1.81E+01	7.87E+00	8.42E-02	2.60E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.100 EU-19 Estimated Daily Doses (EDDs) for Muskrat Foraging in Burrows Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	54.4	1.25E-03	Equation	1.30	1.09E-01	4.56E-01	1.22E-04	5.66E-01	47.8	1.25E-03	Equation	1.21	1.01E-01	4.01E-01	1.22E-04	5.03E-01
Cadmium	7.70	1.86E-02	Equation	1.89	1.59E-01	6.46E-02	1.81E-03	2.25E-01	7.02	1.40E-02	Equation	1.80	1.51E-01	5.89E-02	1.36E-03	2.11E-01
Chromium	4.21	2.50E-03	Factor	0.17	1.45E-02	3.53E-02	2.44E-04	5.00E-02	3.19	2.50E-03	Factor	0.13	1.10E-02	2.67E-02	2.44E-04	3.80E-02
Copper	224	6.56E-02	Equation	16.5	1.38E+00	1.88E+00	6.40E-03	3.27E+00	204	5.07E-02	Equation	15.9	1.33E+00	1.71E+00	4.95E-03	3.05E+00
Lead	571	9.55E-03	Equation	9.33	7.83E-01	4.79E+00	9.31E-04	5.58E+00	448	7.37E-03	Equation	8.13	6.83E-01	3.75E+00	7.19E-04	4.44E+00
Mercury (inorganic)	0.04	-	Equation	0.06	5.06E-03	3.00E-04	-	5.36E-03	0.02	-	Equation	0.04	3.74E-03	1.72E-04	-	3.91E-03
Nickel	6.95	1.18E-02	Equation	0.46	3.87E-02	5.83E-02	1.15E-03	9.82E-02	5.76	8.18E-03	Equation	0.40	3.36E-02	4.83E-02	7.98E-04	8.27E-02
Selenium	1.28	2.50E-03	Equation	0.66	5.58E-02	1.07E-02	2.44E-04	6.67E-02	0.61	2.50E-03	Equation	0.30	2.48E-02	5.13E-03	2.44E-04	3.01E-02
Silver	1.99	1.25E-03	Factor	0.03	2.34E-03	1.67E-02	1.22E-04	1.92E-02	1.37	1.25E-03	Factor	0.02	1.60E-03	1.15E-02	1.22E-04	1.32E-02
Zinc	850	2.97E+00	Equation	204	1.71E+01	7.13E+00	2.90E-01	2.45E+01	712	2.23E+00	Equation	185	1.55E+01	5.97E+00	2.18E-01	2.17E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.101 EU-DR01 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	13.2	2.47E-03	Equation	0.58	4.90E-02	1.10E-01	2.41E-04	1.60E-01	11.4	9.91E-04	Equation	0.54	4.50E-02	9.52E-02	9.66E-05	1.40E-01
Cadmium	2.78	5.13E-04	Equation	1.09	9.11E-02	2.33E-02	5.00E-05	1.14E-01	2.22	3.83E-04	Equation	0.96	8.05E-02	1.86E-02	3.73E-05	9.92E-02
Chromium	8.18	1.97E-03	Factor	0.34	2.81E-02	6.87E-02	1.92E-04	9.70E-02	6.93	9.75E-04	Factor	0.28	2.38E-02	5.81E-02	9.51E-05	8.20E-02
Copper	94.2	1.59E-02	Equation	11.7	9.82E-01	7.90E-01	1.55E-03	1.77E+00	79.3	7.63E-03	Equation	10.9	9.17E-01	6.65E-01	7.44E-04	1.58E+00
Lead	242	7.39E-02	Equation	5.76	4.83E-01	2.03E+00	7.20E-03	2.52E+00	202	1.28E-02	Equation	5.21	4.37E-01	1.69E+00	1.24E-03	2.13E+00
Mercury (inorganic)	0.02	4.00E-05	Equation	0.04	3.55E-03	1.56E-04	3.90E-06	3.71E-03	0.01	1.96E-05	Equation	0.04	2.94E-03	1.11E-04	1.91E-06	3.06E-03
Nickel	9.59	2.40E-03	Equation	0.59	4.92E-02	8.05E-02	2.34E-04	1.30E-01	8.63	1.99E-03	Equation	0.54	4.55E-02	7.24E-02	1.94E-04	1.18E-01
Selenium	4.80	1.74E-03	Equation	2.87	2.41E-01	4.03E-02	1.70E-04	2.81E-01	1.95	6.58E-04	Equation	1.06	8.92E-02	1.64E-02	6.42E-05	1.06E-01
Silver	1.58	8.70E-04	Factor	0.02	1.85E-03	1.32E-02	8.48E-05	1.52E-02	1.21	2.98E-04	Factor	0.02	1.42E-03	1.01E-02	2.91E-05	1.16E-02
Zinc	883	1.50E-01	Equation	208	1.75E+01	7.41E+00	1.46E-02	2.49E+01	705	1.21E-01	Equation	184	1.54E+01	5.91E+00	1.18E-02	2.14E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.102 EU-DR02 Estimated Daily Doses (EDDs) for Muskrat Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	10.3	1.95E-03	Equation	0.51	4.27E-02	8.68E-02	1.90E-04	1.30E-01	9.49	9.73E-04	Equation	0.49	4.07E-02	7.96E-02	9.49E-05	1.20E-01
Cadmium	2.77	5.07E-04	Equation	1.08	9.10E-02	2.33E-02	4.94E-05	1.14E-01	2.30	2.95E-04	Equation	0.98	8.22E-02	1.93E-02	2.88E-05	1.02E-01
Chromium	8.76	1.28E-03	Factor	0.36	3.01E-02	7.35E-02	1.24E-04	1.04E-01	7.64	7.08E-04	Factor	0.31	2.63E-02	6.41E-02	6.90E-05	9.04E-02
Copper	82.4	8.69E-03	Equation	11.1	9.31E-01	6.91E-01	8.47E-04	1.62E+00	72.2	6.70E-03	Equation	10.5	8.84E-01	6.06E-01	6.53E-04	1.49E+00
Lead	190	2.78E-02	Equation	5.04	4.23E-01	1.60E+00	2.71E-03	2.02E+00	168	9.84E-03	Equation	4.69	3.94E-01	1.41E+00	9.60E-04	1.80E+00
Mercury (inorganic)	0.04	4.00E-05	Equation	0.07	5.58E-03	3.59E-04	3.90E-06	5.94E-03	0.03	1.68E-05	Equation	0.06	4.63E-03	2.55E-04	1.64E-06	4.89E-03
Nickel	11.5	1.88E-03	Equation	0.67	5.64E-02	9.64E-02	1.83E-04	1.53E-01	10.1	1.56E-03	Equation	0.61	5.11E-02	8.46E-02	1.52E-04	1.36E-01
Selenium	2.74	9.89E-04	Equation	1.55	1.30E-01	2.30E-02	9.64E-05	1.53E-01	1.13	4.50E-04	Equation	0.58	4.88E-02	9.50E-03	4.39E-05	5.84E-02
Silver	1.11	4.70E-04	Factor	0.02	1.31E-03	9.33E-03	4.58E-05	1.07E-02	0.95	1.74E-04	Factor	0.01	1.11E-03	7.94E-03	1.70E-05	9.07E-03
Zinc	864	1.29E-01	Equation	206	1.73E+01	7.25E+00	1.26E-02	2.45E+01	749	8.30E-02	Equation	190	1.60E+01	6.28E+00	8.10E-03	2.23E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.103 Reference Exposure Unit Bear Creek Estimated Daily Doses (EDDs) for Muskrat Foraging in Bear Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	14.6	1.25E-03	Equation	0.62	5.19E-02	1.22E-01	1.22E-04	1.75E-01	12.5	1.25E-03	Equation	0.57	4.76E-02	1.05E-01	1.22E-04	1.53E-01
Cadmium	0.95	2.50E-04	Equation	0.60	5.07E-02	7.97E-03	2.44E-05	5.87E-02	0.82	2.50E-04	Equation	0.56	4.68E-02	6.88E-03	2.44E-05	5.37E-02
Chromium	3.83	2.50E-03	Factor	0.16	1.32E-02	3.21E-02	2.44E-04	4.56E-02	3.82	2.50E-03	Factor	0.16	1.31E-02	3.20E-02	2.44E-04	4.54E-02
Copper	25.9	1.25E-03	Equation	7.04	5.90E-01	2.17E-01	1.22E-04	8.08E-01	23.6	1.25E-03	Equation	6.78	5.69E-01	1.98E-01	1.22E-04	7.66E-01
Lead	65.2	2.50E-04	Equation	2.76	2.32E-01	5.47E-01	2.44E-05	7.79E-01	53.5	2.50E-04	Equation	2.47	2.07E-01	4.49E-01	2.44E-05	6.56E-01
Mercury (inorganic)	0.01	-	Equation	0.02	1.92E-03	5.03E-05	-	1.97E-03	0.01	-	Equation	0.02	1.83E-03	4.61E-05	-	1.87E-03
Nickel	7.20	1.25E-03	Equation	0.47	3.97E-02	6.04E-02	1.22E-04	1.00E-01	6.93	1.25E-03	Equation	0.46	3.86E-02	5.81E-02	1.22E-04	9.69E-02
Selenium	1.50	2.50E-03	Equation	0.79	6.66E-02	1.26E-02	2.44E-04	7.95E-02	1.32	2.50E-03	Equation	0.69	5.76E-02	1.10E-02	2.44E-04	6.89E-02
Silver	0.12	1.25E-03	Factor	0.002	1.46E-04	1.04E-03	1.22E-04	1.31E-03	0.07	1.25E-03	Factor	0.001	8.34E-05	5.96E-04	1.22E-04	8.01E-04
Zinc	263	5.00E-03	Equation	106	8.93E+00	2.21E+00	4.88E-04	1.11E+01	257	5.00E-03	Equation	105	8.82E+00	2.16E+00	4.88E-04	1.10E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.104 Reference Exposure Unit Hermosa Creek Estimated Daily Doses (EDDs) for Muskrat Foraging in Hermosa Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	1.10	1.25E-03	Equation	0.14	1.21E-02	9.23E-03	1.22E-04	2.14E-02	1.10	1.25E-03	Equation	0.14	1.21E-02	9.23E-03	1.22E-04	2.14E-02
Cadmium	0.03	2.50E-04	Equation	0.10	8.29E-03	2.89E-04	2.44E-05	8.61E-03	0.03	2.50E-04	Equation	0.10	8.29E-03	2.89E-04	2.44E-05	8.61E-03
Chromium	23.0	2.50E-03	Factor	0.94	7.91E-02	1.93E-01	2.44E-04	2.72E-01	23.0	2.50E-03	Factor	0.94	7.91E-02	1.93E-01	2.44E-04	2.72E-01
Copper	11.5	1.25E-03	Equation	5.11	4.29E-01	9.65E-02	1.22E-04	5.25E-01	11.5	1.25E-03	Equation	5.11	4.29E-01	9.65E-02	1.22E-04	5.25E-01
Lead	11.7	2.50E-04	Equation	1.05	8.84E-02	9.82E-02	2.44E-05	1.87E-01	11.7	2.50E-04	Equation	1.05	8.84E-02	9.82E-02	2.44E-05	1.87E-01
Mercury (inorganic)	0.003	-	Equation	0.01	1.23E-03	2.22E-05	-	1.25E-03	0.003	-	Equation	0.01	1.23E-03	2.22E-05	-	1.25E-03
Nickel	15.0	1.25E-03	Equation	0.82	6.88E-02	1.26E-01	1.22E-04	1.95E-01	15.0	1.25E-03	Equation	0.82	6.88E-02	1.26E-01	1.22E-04	1.95E-01
Selenium	2.40	2.50E-03	Equation	1.33	1.12E-01	2.01E-02	2.44E-04	1.32E-01	2.40	2.50E-03	Equation	1.33	1.12E-01	2.01E-02	2.44E-04	1.32E-01
Silver	0.02	1.25E-03	Factor	0.0003	2.64E-05	1.89E-04	1.22E-04	3.37E-04	0.02	1.25E-03	Factor	0.0003	2.64E-05	1.89E-04	1.22E-04	3.37E-04
Zinc	65.9	5.00E-03	Equation	49.4	4.14E+00	5.53E-01	4.88E-04	4.70E+00	65.9	5.00E-03	Equation	49.4	4.14E+00	5.53E-01	4.88E-04	4.70E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.105 Reference Exposure Unit Mill Creek Estimated Daily Doses (EDDs) for Muskrat Foraging in Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	10.0	1.25E-03	Equation	0.50	4.19E-02	8.39E-02	1.22E-04	1.26E-01	10.0	1.25E-03	Equation	0.50	4.19E-02	8.39E-02	1.22E-04	1.26E-01
Cadmium	2.30	2.50E-04	Equation	0.98	8.21E-02	1.93E-02	2.44E-05	1.01E-01	2.30	2.50E-04	Equation	0.98	8.21E-02	1.93E-02	2.44E-05	1.01E-01
Chromium	0.87	2.50E-03	Factor	0.04	2.99E-03	7.30E-03	2.44E-04	1.05E-02	0.87	2.50E-03	Factor	0.04	2.99E-03	7.30E-03	2.44E-04	1.05E-02
Copper	15.7	1.25E-03	Equation	5.78	4.85E-01	1.32E-01	1.22E-04	6.17E-01	15.7	1.25E-03	Equation	5.78	4.85E-01	1.32E-01	1.22E-04	6.17E-01
Lead	329	1.74E-03	Equation	6.85	5.74E-01	2.76E+00	1.70E-04	3.33E+00	329	1.26E-03	Equation	6.85	5.74E-01	2.76E+00	1.23E-04	3.33E+00
Mercury (inorganic)	0.002	-	Equation	0.01	9.96E-04	1.51E-05	-	1.01E-03	0.002	-	Equation	0.01	9.96E-04	1.51E-05	-	1.01E-03
Nickel	2.70	1.25E-03	Equation	0.23	1.91E-02	2.27E-02	1.22E-04	4.19E-02	2.70	1.25E-03	Equation	0.23	1.91E-02	2.27E-02	1.22E-04	4.19E-02
Selenium	1.20	2.50E-03	Equation	0.62	5.21E-02	1.01E-02	2.44E-04	6.24E-02	1.20	2.50E-03	Equation	0.62	5.21E-02	1.01E-02	2.44E-04	6.24E-02
Silver	0.02	1.25E-03	Factor	0.0002	1.82E-05	1.30E-04	1.22E-04	2.70E-04	0.02	1.25E-03	Factor	0.0002	1.82E-05	1.30E-04	1.22E-04	2.70E-04
Zinc	431	4.21E-02	Equation	140	1.17E+01	3.62E+00	4.10E-03	1.54E+01	431	3.07E-02	Equation	140	1.17E+01	3.62E+00	2.99E-03	1.54E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.106 Reference Exposure Unit Maggie Gulch Estimated Daily Doses (EDDs) for Muskrat Foraging in Maggie Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	12.5	1.25E-03	Equation	0.57	4.76E-02	1.05E-01	1.22E-04	1.53E-01	9.40	1.25E-03	Equation	0.48	4.05E-02	7.89E-02	1.22E-04	1.19E-01
Cadmium	0.79	2.50E-04	Equation	0.55	4.59E-02	6.64E-03	2.44E-05	5.25E-02	0.45	2.50E-04	Equation	0.40	3.36E-02	3.75E-03	2.44E-05	3.74E-02
Chromium	3.20	2.50E-03	Factor	0.13	1.10E-02	2.68E-02	2.44E-04	3.81E-02	2.80	2.50E-03	Factor	0.11	9.63E-03	2.35E-02	2.44E-04	3.34E-02
Copper	33.1	1.25E-03	Equation	7.75	6.50E-01	2.78E-01	1.22E-04	9.28E-01	27.3	1.25E-03	Equation	7.19	6.03E-01	2.29E-01	1.22E-04	8.32E-01
Lead	36.3	4.70E-04	Equation	1.99	1.67E-01	3.05E-01	4.58E-05	4.71E-01	33.0	3.16E-04	Equation	1.89	1.58E-01	2.77E-01	3.08E-05	4.35E-01
Mercury (inorganic)	0.22	-	Equation	0.16	1.35E-02	1.81E-03	-	1.53E-02	0.09	-	Equation	0.10	8.19E-03	7.27E-04	-	8.92E-03
Nickel	6.70	1.25E-03	Equation	0.45	3.77E-02	5.62E-02	1.22E-04	9.40E-02	6.25	1.25E-03	Equation	0.43	3.58E-02	5.25E-02	1.22E-04	8.83E-02
Selenium	2.31	2.50E-03	Equation	1.28	1.07E-01	1.94E-02	2.44E-04	1.27E-01	1.02	2.50E-03	Equation	0.52	4.34E-02	8.54E-03	2.44E-04	5.22E-02
Silver	0.70	1.25E-03	Factor	0.01	8.22E-04	5.87E-03	1.22E-04	6.82E-03	0.32	1.25E-03	Factor	0.004	3.74E-04	2.67E-03	1.22E-04	3.16E-03
Zinc	168	5.00E-03	Equation	83.0	6.96E+00	1.41E+00	4.88E-04	8.37E+00	137	5.00E-03	Equation	74.2	6.23E+00	1.15E+00	4.88E-04	7.38E+00

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.107 Reference Exposure Unit Picayne Gulch Estimated Daily Doses (EDDs) for Muskrat Foraging in Picayne Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	65.7	1.25E-03	Equation	1.45	1.21E-01	5.51E-01	1.22E-04	6.73E-01	49.2	1.25E-03	Equation	1.23	1.03E-01	4.13E-01	1.22E-04	5.16E-01
Cadmium	1.67	2.50E-04	Equation	0.82	6.90E-02	1.40E-02	2.44E-05	8.30E-02	1.56	2.50E-04	Equation	0.79	6.64E-02	1.31E-02	2.44E-05	7.95E-02
Chromium	5.16	2.50E-03	Factor	0.21	1.77E-02	4.33E-02	2.44E-04	6.13E-02	4.75	2.50E-03	Factor	0.19	1.63E-02	3.99E-02	2.44E-04	5.65E-02
Copper	40.4	1.25E-03	Equation	8.38	7.03E-01	3.39E-01	1.22E-04	1.04E+00	36.2	1.25E-03	Equation	8.03	6.74E-01	3.04E-01	1.22E-04	9.78E-01
Lead	134	7.76E-04	Equation	4.14	3.47E-01	1.12E+00	7.57E-05	1.47E+00	85.1	4.25E-04	Equation	3.21	2.69E-01	7.14E-01	4.14E-05	9.83E-01
Mercury (inorganic)	0.01	-	Equation	0.03	2.79E-03	1.01E-04	-	2.90E-03	0.01	-	Equation	0.02	2.08E-03	5.87E-05	-	2.14E-03
Nickel	9.92	1.25E-03	Equation	0.60	5.05E-02	8.32E-02	1.22E-04	1.34E-01	8.87	1.25E-03	Equation	0.55	4.65E-02	7.44E-02	1.22E-04	1.21E-01
Selenium	1.70	2.50E-03	Equation	0.91	7.65E-02	1.43E-02	2.44E-04	9.10E-02	0.85	2.50E-03	Equation	0.42	3.55E-02	7.11E-03	2.44E-04	4.29E-02
Silver	1.36	1.25E-03	Factor	0.02	1.60E-03	1.14E-02	1.22E-04	1.31E-02	1.09	1.25E-03	Factor	0.02	1.28E-03	9.12E-03	1.22E-04	1.05E-02
Zinc	421	4.07E-02	Equation	138	1.16E+01	3.53E+00	3.97E-03	1.51E+01	383	1.93E-02	Equation	131	1.10E+01	3.21E+00	1.88E-03	1.42E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.108 Reference Exposure Unit North Fork Animas River Estimated Daily Doses (EDDs) for Muskrat Foraging in North Fork Animas River Above Burrows Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Plant tissue concentration (C_{plant})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	73.0	1.25E-03	Ref. Eq.	1.53	1.29E-01	6.12E-01	1.22E-04	7.41E-01	57.9	1.25E-03	Ref. Eq.	1.35	1.13E-01	4.86E-01	1.22E-04	5.99E-01
Cadmium	10.8	1.44E-03	Ref. Eq.	2.28	1.91E-01	9.09E-02	1.40E-04	2.82E-01	8.93	1.05E-03	Ref. Eq.	2.05	1.72E-01	7.49E-02	1.02E-04	2.47E-01
Chromium	3.23	2.50E-03	Ref. Factor	0.13	1.11E-02	2.71E-02	2.44E-04	3.84E-02	2.60	2.50E-03	Ref. Factor	0.11	8.93E-03	2.18E-02	2.44E-04	3.09E-02
Copper	43.6	2.02E-03	Ref. Eq.	8.64	7.25E-01	3.66E-01	1.97E-04	1.09E+00	35.7	1.51E-03	Ref. Eq.	7.99	6.70E-01	3.00E-01	1.48E-04	9.70E-01
Lead	290	4.51E-03	Ref. Eq.	6.38	5.35E-01	2.43E+00	4.40E-04	2.97E+00	208	2.32E-03	Ref. Eq.	5.29	4.43E-01	1.74E+00	2.26E-04	2.18E+00
Mercury (inorganic)	0.04	-	Ref. Eq.	0.07	5.59E-03	3.60E-04	-	5.95E-03	0.03	-	Ref. Eq.	0.05	4.52E-03	2.43E-04	-	4.76E-03
Nickel	4.92	1.25E-03	Ref. Eq.	0.36	2.99E-02	4.13E-02	1.22E-04	7.13E-02	4.66	1.25E-03	Ref. Eq.	0.34	2.87E-02	3.91E-02	1.22E-04	6.79E-02
Selenium	1.49	2.50E-03	Ref. Eq.	0.79	6.63E-02	1.25E-02	2.44E-04	7.91E-02	0.62	2.50E-03	Ref. Eq.	0.30	2.53E-02	5.23E-03	2.44E-04	3.07E-02
Silver	2.02	1.25E-03	Ref. Factor	0.03	2.37E-03	1.69E-02	1.22E-04	1.94E-02	1.43	1.25E-03	Ref. Factor	0.02	1.68E-03	1.20E-02	1.22E-04	1.38E-02
Zinc	1180	2.18E-01	Ref. Eq.	245	2.05E+01	9.90E+00	2.13E-02	3.05E+01	897	1.66E-01	Ref. Eq.	210	1.76E+01	7.52E+00	1.62E-02	2.52E+01

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

mg/kg bw-day = milligrams per kilogram of body weight per day

COPECs = Chemicals of Potential Ecological Concern

EDD = Estimated Daily Dose

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

DW = Dry-weight

BW = Body Weight

BSAF = Biota-to-Sediment Accumulation Factor or regression equation

IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{plant} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Sediment-to-plant equations and factors (DW)

Arsenic	[Plant tissue] = $e^{(-1.992 + 0.564(\ln \text{Sediment concentration}))}$
Cadmium	[Plant tissue] = $e^{(-0.476 + 0.546(\ln \text{Sediment concentration}))}$
Chromium	[Plant tissue] = 0.041*Sediment concentration
Copper	[Plant tissue] = $e^{(0.669 + 0.394(\ln \text{Sediment concentration}))}$
Lead	[Plant tissue] = $e^{(-1.328 + 0.561(\ln \text{Sediment concentration}))}$
Mercury	[Plant tissue] = $e^{(-0.996 + 0.544(\ln \text{Sediment concentration}))}$
Nickel	[Plant tissue] = $e^{(-2.224 + 0.748(\ln \text{Sediment concentration}))}$
Selenium	[Plant tissue] = $e^{(-0.678 + 1.104(\ln \text{Sediment concentration}))}$
Silver	[Plant tissue] = 0.014*Sediment concentration
Zinc	[Plant tissue] = $e^{(1.575 + 0.555(\ln \text{Sediment concentration}))}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	1.17	
IR_{diet} (kg/kg BW-day, DW)	0.0839	100% plants
IR_{water} (L/kg BW-day)	0.0975	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.00839	

Table A15.109 EU-01 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mineral Creek from Animas River to South Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	46.8	2.67E-03	0.13	5.90	2.12E-01	1.60E-01	2.21E-04	3.72E-01	34.2	1.58E-03	0.13	4.31	1.55E-01	1.17E-01	1.31E-04	2.72E-01
Cadmium	2.04	7.37E-04	Site-sp. Eq	0.57	2.04E-02	6.97E-03	6.12E-05	2.75E-02	1.58	5.17E-04	Site-sp. Eq.	0.52	1.88E-02	5.39E-03	4.30E-05	2.42E-02
Chromium	6.45	2.52E-03	0.038	0.25	8.82E-03	2.20E-02	2.10E-04	3.11E-02	3.67	2.32E-03	0.038	0.14	5.02E-03	1.25E-02	1.93E-04	1.77E-02
Copper	140	1.13E-02	Site-sp. Eq	9.20	3.31E-01	4.78E-01	9.36E-04	8.10E-01	118	9.75E-03	Site-sp. Eq.	8.46	3.05E-01	4.04E-01	8.10E-04	7.09E-01
Lead	276	1.49E-02	0.07	19.3	6.95E-01	9.41E-01	1.24E-03	1.64E+00	229	9.96E-03	0.07	16.0	5.77E-01	7.81E-01	8.27E-04	1.36E+00
Mercury (inorganic)	0.19	4.00E-05	3.25	0.60	2.16E-02	6.32E-04	3.32E-06	2.23E-02	0.09	2.20E-05	3.25	0.29	1.05E-02	3.06E-04	1.83E-06	1.08E-02
Nickel	7.18	1.96E-03	1	7.18	2.59E-01	2.45E-02	1.63E-04	2.83E-01	5.88	1.64E-03	1	5.88	2.12E-01	2.01E-02	1.36E-04	2.32E-01
Selenium	10.5	2.50E-03	Site-sp. Eq	19.5	7.02E-01	3.57E-02	2.08E-04	7.38E-01	3.85	1.99E-03	Site-sp. Eq.	7.67	2.76E-01	1.32E-02	1.66E-04	2.90E-01
Silver	1.77	1.25E-03	1	1.77	6.37E-02	6.04E-03	1.04E-04	6.98E-02	1.02	1.09E-03	1	1.02	3.66E-02	3.47E-03	9.08E-05	4.02E-02
Zinc	678	1.60E-01	Site-sp. Eq	128	4.61E+00	2.32E+00	1.33E-02	6.94E+00	517	1.40E-01	Site-sp. Eq.	109	3.94E+00	1.76E+00	1.17E-02	5.72E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.110 EU-02 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	62.9	1.77E-03	0.13	7.93	2.85E-01	2.15E-01	1.47E-04	5.00E-01	47.3	1.44E-03	0.13	5.96	2.15E-01	1.62E-01	1.19E-04	3.76E-01
Cadmium	1.80	1.10E-03	Site-sp. Eq	0.54	1.96E-02	6.14E-03	9.15E-05	2.58E-02	1.26	9.00E-04	Site-sp. Eq.	0.48	1.74E-02	4.31E-03	7.48E-05	2.18E-02
Chromium	2.40	2.50E-03	0.038	0.09	3.28E-03	8.19E-03	2.08E-04	1.17E-02	1.72	2.50E-03	0.038	0.07	2.36E-03	5.88E-03	2.08E-04	8.45E-03
Copper	84.0	1.71E-02	Site-sp. Eq	7.14	2.57E-01	2.87E-01	1.42E-03	5.45E-01	76.1	1.56E-02	Site-sp. Eq.	6.80	2.45E-01	2.60E-01	1.29E-03	5.06E-01
Lead	386	2.15E-02	0.07	27.0	9.73E-01	1.32E+00	1.79E-03	2.29E+00	333	1.40E-02	0.07	23.3	8.40E-01	1.14E+00	1.16E-03	1.98E+00
Mercury (inorganic)	0.08	-	3.25	0.27	9.83E-03	2.87E-04	-	1.01E-02	0.05	-	3.25	0.17	6.00E-03	1.75E-04	-	6.18E-03
Nickel	3.43	1.25E-03	1	3.43	1.23E-01	1.17E-02	1.04E-04	1.35E-01	2.85	1.25E-03	1	2.85	1.03E-01	9.73E-03	1.04E-04	1.12E-01
Selenium	1.90	2.50E-03	Site-sp. Eq	4.17	1.50E-01	6.49E-03	2.08E-04	1.57E-01	1.52	2.50E-03	Site-sp. Eq.	3.50	1.26E-01	5.20E-03	2.08E-04	1.31E-01
Silver	0.63	1.25E-03	1	0.63	2.25E-02	2.13E-03	1.04E-04	2.47E-02	0.32	1.25E-03	1	0.32	1.16E-02	1.10E-03	1.04E-04	1.28E-02
Zinc	1328	2.65E-01	Site-sp. Eq	188	6.79E+00	4.53E+00	2.20E-02	1.13E+01	722	2.22E-01	Site-sp. Eq.	133	4.78E+00	2.46E+00	1.84E-02	7.26E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.111 EU-03 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	55.9	6.26E-03	Measured	1.98	7.13E-02	1.91E-01	5.20E-04	2.63E-01	48.2	2.64E-03	Measured	0.70	2.51E-02	1.65E-01	2.19E-04	1.90E-01
Cadmium	10.9	8.55E-04	Measured	0.96	3.46E-02	3.70E-02	7.11E-05	7.17E-02	5.55	6.54E-04	Measured	0.72	2.57E-02	1.90E-02	5.43E-05	4.48E-02
Chromium	3.90	2.50E-03	Measured	5.40	1.94E-01	1.33E-02	2.08E-04	2.08E-01	2.53	2.50E-03	Measured	3.68	1.32E-01	8.64E-03	2.08E-04	1.41E-01
Copper	185	2.30E-02	Measured	14.5	5.20E-01	6.30E-01	1.91E-03	1.15E+00	117	1.80E-02	Measured	10.5	3.76E-01	4.00E-01	1.50E-03	7.78E-01
Lead	778	4.80E-02	Measured	27.5	9.91E-01	2.66E+00	3.99E-03	3.65E+00	456	3.09E-02	Measured	10.3	3.70E-01	1.56E+00	2.57E-03	1.93E+00
Mercury (inorganic)	0.28	-	Measured	0.15	5.54E-03	9.63E-04	-	6.51E-03	0.13	-	Measured	0.10	3.74E-03	4.34E-04	-	4.18E-03
Nickel	5.85	1.25E-03	Measured	0.47	1.68E-02	2.00E-02	1.04E-04	3.69E-02	4.25	1.25E-03	Measured	0.20	7.27E-03	1.45E-02	1.04E-04	2.19E-02
Selenium	1.40	2.50E-03	Measured	4.06	1.46E-01	4.78E-03	2.08E-04	1.51E-01	0.96	2.50E-03	Measured	3.23	1.16E-01	3.27E-03	2.08E-04	1.20E-01
Silver	1.34	1.25E-03	Measured	0.47	1.68E-02	4.57E-03	1.04E-04	2.15E-02	0.96	1.25E-03	Measured	0.20	7.27E-03	3.26E-03	1.04E-04	1.06E-02
Zinc	2920	2.58E-01	Measured	306	1.10E+01	9.97E+00	2.15E-02	2.10E+01	1749	2.09E-01	Measured	222	8.01E+00	5.97E+00	1.73E-02	1.40E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.112 EU-04 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mineral Creek Upstream of Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	160	1.25E-03	0.13	20.2	7.26E-01	5.46E-01	1.04E-04	1.27E+00	126	1.25E-03	0.13	15.9	5.73E-01	4.31E-01	1.04E-04	1.00E+00
Cadmium	12.7	2.39E-03	Site-sp. Eq	1.04	3.73E-02	4.34E-02	1.99E-04	8.09E-02	8.00	1.38E-03	Site-sp. Eq.	0.89	3.20E-02	2.73E-02	1.15E-04	5.95E-02
Chromium	2.43	2.50E-03	0.038	0.09	3.32E-03	8.30E-03	2.08E-04	1.18E-02	1.87	2.50E-03	0.038	0.07	2.56E-03	6.38E-03	2.08E-04	9.15E-03
Copper	439	3.08E-02	Site-sp. Eq	16.2	5.83E-01	1.50E+00	2.56E-03	2.08E+00	304	2.24E-02	Site-sp. Eq.	13.5	4.86E-01	1.04E+00	1.86E-03	1.52E+00
Lead	1890	9.21E-02	0.07	132	4.76E+00	6.45E+00	7.65E-03	1.12E+01	1326	4.57E-02	0.07	93	3.34E+00	4.53E+00	3.80E-03	7.87E+00
Mercury (inorganic)	0.31	-	3.25	0.99	3.57E-02	1.04E-03	-	3.67E-02	0.17	-	3.25	0.54	1.93E-02	5.63E-04	-	1.99E-02
Nickel	8.89	1.25E-03	1	8.89	3.20E-01	3.04E-02	1.04E-04	3.50E-01	5.55	1.25E-03	1	5.55	2.00E-01	1.89E-02	1.04E-04	2.19E-01
Selenium	0.70	2.50E-03	Site-sp. Eq	2.02	7.29E-02	2.39E-03	2.08E-04	7.55E-02	0.70	2.50E-03	Site-sp. Eq.	2.02	7.29E-02	2.39E-03	2.08E-04	7.55E-02
Silver	3.55	1.25E-03	1	3.55	1.28E-01	1.21E-02	1.04E-04	1.40E-01	3.55	1.25E-03	1	3.55	1.28E-01	1.21E-02	1.04E-04	1.40E-01
Zinc	5900	8.70E-01	Site-sp. Eq	445	1.60E+01	2.01E+01	7.23E-02	3.62E+01	5770	4.67E-01	Site-sp. Eq.	439	1.58E+01	1.97E+01	3.88E-02	3.55E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.113 EU-05 Estimated Daily Doses (EDDs) for Raccoon Foraging in South Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	14.5	1.25E-03	Measured	1.23	4.44E-02	4.95E-02	1.04E-04	9.40E-02	12.5	1.25E-03	Measured	0.85	3.07E-02	4.27E-02	1.04E-04	7.35E-02
Cadmium	1.00	2.50E-04	Measured	0.72	2.59E-02	3.41E-03	2.08E-05	2.94E-02	0.60	2.50E-04	Measured	0.55	1.98E-02	2.05E-03	2.08E-05	2.19E-02
Chromium	3.20	2.50E-03	Measured	3.82	1.38E-01	1.09E-02	2.08E-04	1.49E-01	3.11	2.50E-03	Measured	3.60	1.30E-01	1.06E-02	2.08E-04	1.40E-01
Copper	18.9	1.25E-03	Measured	3.82	1.37E-01	6.45E-02	1.04E-04	2.02E-01	18.8	1.25E-03	Measured	3.36	1.21E-01	6.42E-02	1.04E-04	1.85E-01
Lead	106	1.19E-03	Measured	3.15	1.13E-01	3.62E-01	9.86E-05	4.75E-01	87.3	7.41E-04	Measured	1.56	5.63E-02	2.98E-01	6.16E-05	3.54E-01
Mercury (inorganic)	0.09	-	Measured	0.13	4.64E-03	2.90E-04	-	4.93E-03	0.05	-	Measured	0.10	3.60E-03	1.54E-04	-	3.75E-03
Nickel	11.6	1.25E-03	Measured	0.14	5.08E-03	3.96E-02	1.04E-04	4.48E-02	8.45	1.25E-03	Measured	0.13	4.75E-03	2.88E-02	1.04E-04	3.37E-02
Selenium	1.90	2.50E-03	Measured	5.21	1.88E-01	6.49E-03	2.08E-04	1.94E-01	1.32	2.50E-03	Measured	4.59	1.65E-01	4.50E-03	2.08E-04	1.70E-01
Silver	0.72	1.25E-03	Measured	0.14	5.08E-03	2.45E-03	1.04E-04	7.63E-03	0.37	1.25E-03	Measured	0.13	4.75E-03	1.26E-03	1.04E-04	6.11E-03
Zinc	386	2.28E-02	Measured	125	4.48E+00	1.32E+00	1.89E-03	5.80E+00	255	1.96E-02	Measured	87.2	3.14E+00	8.71E-01	1.63E-03	4.01E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.114 EU-06 Estimated Daily Doses (EDDs) for Raccoon Foraging in Middle Fork Mineral Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	16.9	1.25E-03	0.13	2.13	7.67E-02	5.77E-02	1.04E-04	1.34E-01	13.9	1.25E-03	0.13	1.75	6.29E-02	4.73E-02	1.04E-04	1.10E-01
Cadmium	0.60	1.40E-03	Site-sp. Eq.	0.38	1.37E-02	2.06E-03	1.16E-04	1.58E-02	0.40	7.21E-04	Site-sp. Eq.	0.33	1.20E-02	1.37E-03	5.99E-05	1.34E-02
Chromium	1.60	2.50E-03	0.038	0.06	2.19E-03	5.46E-03	2.08E-04	7.86E-03	1.37	2.50E-03	0.038	0.05	1.87E-03	4.67E-03	2.08E-04	6.74E-03
Copper	24.3	6.04E-03	Site-sp. Eq.	3.86	1.39E-01	8.30E-02	5.02E-04	2.23E-01	19.9	3.45E-03	Site-sp. Eq.	3.50	1.26E-01	6.78E-02	2.86E-04	1.94E-01
Lead	100	3.37E-03	0.07	7.00	2.52E-01	3.41E-01	2.80E-04	5.94E-01	83.6	1.58E-03	0.07	5.85	2.11E-01	2.85E-01	1.32E-04	4.96E-01
Mercury (inorganic)	0.01	-	3.25	0.04	1.40E-03	4.10E-05	-	1.44E-03	0.01	-	3.25	0.03	9.91E-04	2.89E-05	-	1.02E-03
Nickel	1.77	2.94E-03	1	1.77	6.37E-02	6.04E-03	2.45E-04	7.00E-02	1.17	1.76E-03	1	1.17	4.19E-02	3.98E-03	1.46E-04	4.61E-02
Selenium	1.50	2.50E-03	Site-sp. Eq.	3.46	1.24E-01	5.12E-03	2.08E-04	1.30E-01	1.33	2.50E-03	Site-sp. Eq.	3.16	1.14E-01	4.55E-03	2.08E-04	1.18E-01
Silver	0.63	1.25E-03	1	0.63	2.25E-02	2.13E-03	1.04E-04	2.47E-02	0.42	1.25E-03	1	0.42	1.52E-02	1.44E-03	1.04E-04	1.68E-02
Zinc	130	1.81E-01	Site-sp. Eq.	49.5	1.78E+00	4.44E-01	1.51E-02	2.24E+00	117	9.45E-02	Site-sp. Eq.	46.4	1.67E+00	3.98E-01	7.85E-03	2.08E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.115 EU-07 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	24.8	1.30E-03	0.13	3.13	1.13E-01	8.47E-02	1.08E-04	1.97E-01	20.7	1.27E-03	0.13	2.61	9.41E-02	7.08E-02	1.06E-04	1.65E-01
Cadmium	12.0	1.02E-03	Site-sp. Eq.	1.02	3.66E-02	4.10E-02	8.46E-05	7.77E-02	9.68	7.95E-04	Site-sp. Eq.	0.95	3.41E-02	3.31E-02	6.61E-05	6.72E-02
Chromium	4.80	2.50E-03	0.038	0.18	6.56E-03	1.64E-02	2.08E-04	2.32E-02	4.12	2.50E-03	0.038	0.16	5.63E-03	1.41E-02	2.08E-04	1.99E-02
Copper	315	1.34E-02	Site-sp. Eq.	13.7	4.94E-01	1.07E+00	1.11E-03	1.57E+00	267	8.89E-03	Site-sp. Eq.	12.7	4.56E-01	9.12E-01	7.39E-04	1.37E+00
Lead	1442	1.27E-02	0.07	101	3.63E+00	4.92E+00	1.06E-03	8.56E+00	1232	6.35E-03	0.07	86.2	3.10E+00	4.21E+00	5.28E-04	7.31E+00
Mercury (inorganic)	0.11	-	3.25	0.34	1.23E-02	3.58E-04	-	1.26E-02	0.07	-	3.25	0.23	8.37E-03	2.44E-04	-	8.61E-03
Nickel	8.03	1.25E-03	1	8.03	2.89E-01	2.74E-02	1.04E-04	3.16E-01	6.96	1.25E-03	1	6.96	2.51E-01	2.38E-02	1.04E-04	2.74E-01
Selenium	1.14	2.51E-03	Site-sp. Eq.	2.80	1.01E-01	3.87E-03	2.08E-04	1.05E-01	0.90	2.46E-03	Site-sp. Eq.	2.39	8.60E-02	3.09E-03	2.05E-04	8.93E-02
Silver	5.79	1.25E-03	1	5.79	2.08E-01	1.98E-02	1.04E-04	2.28E-01	4.55	1.25E-03	1	4.55	1.64E-01	1.55E-02	1.04E-04	1.79E-01
Zinc	3505	3.22E-01	Site-sp. Eq.	330	1.19E+01	1.20E+01	2.68E-02	2.39E+01	2695	3.09E-01	Site-sp. Eq.	283	1.02E+01	9.20E+00	2.56E-02	1.94E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.116 EU-08 Estimated Daily Doses (EDDs) for Raccoon Foraging in Cunningham Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	11.9	1.25E-03	0.13	1.49	5.38E-02	4.05E-02	1.04E-04	9.44E-02	8.90	1.25E-03	0.13	1.12	4.03E-02	3.04E-02	1.04E-04	7.08E-02
Cadmium	2.87	2.50E-04	Site-sp. Eq.	0.64	2.29E-02	9.80E-03	2.08E-05	3.27E-02	2.17	2.50E-04	Site-sp. Eq.	0.58	2.08E-02	7.40E-03	2.08E-05	2.83E-02
Chromium	4.08	2.50E-03	0.038	0.16	5.58E-03	1.39E-02	2.08E-04	1.97E-02	3.36	2.50E-03	0.038	0.13	4.59E-03	1.15E-02	2.08E-04	1.63E-02
Copper	108	1.25E-03	Site-sp. Eq.	8.09	2.91E-01	3.69E-01	1.04E-04	6.61E-01	70.9	1.25E-03	Site-sp. Eq.	6.56	2.36E-01	2.42E-01	1.04E-04	4.78E-01
Lead	636	3.74E-03	0.07	44.5	1.60E+00	2.17E+00	3.11E-04	3.77E+00	441	2.06E-03	0.07	30.8	1.11E+00	1.50E+00	1.71E-04	2.61E+00
Mercury (inorganic)	0.04	-	3.25	0.12	4.43E-03	1.29E-04	-	4.56E-03	0.02	-	3.25	0.06	2.12E-03	6.18E-05	-	2.18E-03
Nickel	4.31	1.25E-03	1	4.31	1.55E-01	1.47E-02	1.04E-04	1.70E-01	3.54	1.25E-03	1	3.54	1.28E-01	1.21E-02	1.04E-04	1.40E-01
Selenium	4.01	2.50E-03	Site-sp. Eq.	7.95	2.86E-01	1.37E-02	2.08E-04	3.00E-01	1.70	2.50E-03	Site-sp. Eq.	3.81	1.37E-01	5.80E-03	2.08E-04	1.43E-01
Silver	1.64	1.25E-03	1	1.64	5.90E-02	5.60E-03	1.04E-04	6.47E-02	1.18	1.25E-03	1	1.18	4.26E-02	4.04E-03	1.04E-04	4.67E-02
Zinc	507	3.70E-02	Site-sp. Eq.	108	3.90E+00	1.73E+00	3.07E-03	5.63E+00	429	2.94E-02	Site-sp. Eq.	98.3	3.54E+00	1.46E+00	2.44E-03	5.01E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.117 EU-09 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River from Howardsville to Minnie Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	34.8	1.25E-03	Measured	0.38	1.36E-02	1.19E-01	1.04E-04	1.32E-01	28.6	1.19E-03	Measured	0.32	1.16E-02	9.77E-02	9.89E-05	1.09E-01
Cadmium	14.0	1.22E-03	Measured	1.12	4.02E-02	4.79E-02	1.01E-04	8.82E-02	10.7	1.03E-03	Measured	1.02	3.68E-02	3.67E-02	8.53E-05	7.36E-02
Chromium	4.49	2.50E-03	Measured	3.63	1.31E-01	1.53E-02	2.08E-04	1.46E-01	3.85	2.35E-03	Measured	3.52	1.27E-01	1.32E-02	1.96E-04	1.40E-01
Copper	458	2.04E-02	Measured	13.1	4.73E-01	1.56E+00	1.69E-03	2.04E+00	348	1.35E-02	Measured	11.8	4.26E-01	1.19E+00	1.12E-03	1.62E+00
Lead	1940	1.22E-02	Measured	4.98	1.79E-01	6.62E+00	1.01E-03	6.80E+00	1534	5.49E-03	Measured	3.86	1.39E-01	5.24E+00	4.56E-04	5.38E+00
Mercury (inorganic)	0.15	-	Measured	0.39	1.41E-02	5.19E-04	-	1.46E-02	0.06	-	Measured	0.17	5.98E-03	1.96E-04	-	6.17E-03
Nickel	9.87	1.25E-03	Measured	2.34	8.43E-02	3.37E-02	1.04E-04	1.18E-01	7.96	1.24E-03	Measured	1.02	3.68E-02	2.72E-02	1.03E-04	6.41E-02
Selenium	1.28	2.50E-03	Measured	2.56	9.20E-02	4.37E-03	2.08E-04	9.66E-02	0.90	2.38E-03	Measured	2.34	8.41E-02	3.08E-03	1.98E-04	8.74E-02
Silver	5.94	1.25E-03	Measured	0.23	8.24E-03	2.03E-02	1.04E-04	2.86E-02	4.69	1.18E-03	Measured	0.22	7.78E-03	1.60E-02	9.78E-05	2.39E-02
Zinc	3526	4.01E-01	Measured	243	8.76E+00	1.20E+01	3.33E-02	2.08E+01	2472	3.61E-01	Measured	222	8.01E+00	8.44E+00	3.00E-02	1.65E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.118 EU-10 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River from Minnie Gulch to Eureka

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	49.7	1.25E-03	0.13	6.26	2.25E-01	1.70E-01	1.04E-04	3.95E-01	44.1	1.20E-03	0.13	5.55	2.00E-01	1.50E-01	9.98E-05	3.50E-01
Cadmium	33.1	2.01E-03	Site-sp. Eq.	1.42	5.11E-02	1.13E-01	1.67E-04	1.64E-01	16.5	1.79E-03	Site-sp. Eq.	1.13	4.06E-02	5.62E-02	1.49E-04	9.70E-02
Chromium	4.85	2.50E-03	0.038	0.18	6.63E-03	1.66E-02	2.08E-04	2.34E-02	4.51	2.36E-03	0.038	0.17	6.17E-03	1.54E-02	1.96E-04	2.18E-02
Copper	764	4.10E-02	Site-sp. Eq.	21.3	7.67E-01	2.61E+00	3.40E-03	3.38E+00	500	2.90E-02	Site-sp. Eq.	17.3	6.22E-01	1.71E+00	2.41E-03	2.33E+00
Lead	1907	9.67E-03	0.07	133	4.81E+00	6.51E+00	8.03E-04	1.13E+01	1433	6.17E-03	0.07	100	3.61E+00	4.89E+00	5.12E-04	8.50E+00
Mercury (inorganic)	0.12	-	3.25	0.38	1.37E-02	3.99E-04	-	1.41E-02	0.05	-	3.25	0.16	5.62E-03	1.64E-04	-	5.78E-03
Nickel	13.9	1.55E-03	1	13.9	5.01E-01	4.76E-02	1.29E-04	5.49E-01	10.0	1.36E-03	1	10.0	3.60E-01	3.42E-02	1.13E-04	3.95E-01
Selenium	4.81	2.50E-03	Site-sp. Eq.	9.39	3.38E-01	1.64E-02	2.08E-04	3.55E-01	2.16	2.39E-03	Site-sp. Eq.	4.65	1.67E-01	7.39E-03	1.98E-04	1.75E-01
Silver	24.5	1.25E-03	1	24.5	8.80E-01	8.35E-02	1.04E-04	9.64E-01	8.84	1.18E-03	1	8.84	3.18E-01	3.02E-02	9.81E-05	3.48E-01
Zinc	5966	6.07E-01	Site-sp. Eq.	448	1.61E+01	2.04E+01	5.04E-02	3.65E+01	3528	5.49E-01	Site-sp. Eq.	331	1.19E+01	1.20E+01	4.56E-02	2.40E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.119 EU-11 Estimated Daily Doses (EDDs) for Raccoon Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	40.9	1.25E-03	0.13	5.15	1.86E-01	1.40E-01	1.04E-04	3.25E-01	28.6	1.25E-03	0.13	3.60	1.30E-01	9.76E-02	1.04E-04	2.27E-01
Cadmium	1.56	2.50E-04	Site-sp. Eq.	0.52	1.87E-02	5.33E-03	2.08E-05	2.40E-02	1.17	2.50E-04	Site-sp. Eq.	0.47	1.70E-02	3.98E-03	2.08E-05	2.10E-02
Chromium	6.19	2.50E-03	0.038	0.24	8.47E-03	2.11E-02	2.08E-04	2.98E-02	5.44	2.50E-03	0.038	0.21	7.44E-03	1.86E-02	2.08E-04	2.62E-02
Copper	110	1.23E-02	Site-sp. Eq.	8.17	2.94E-01	3.77E-01	1.03E-03	6.72E-01	91.2	8.01E-03	Site-sp. Eq.	7.44	2.68E-01	3.11E-01	6.65E-04	5.80E-01
Lead	317	2.16E-03	0.07	22.2	7.99E-01	1.08E+00	1.79E-04	1.88E+00	207	8.32E-04	0.07	14.5	5.22E-01	7.07E-01	6.91E-05	1.23E+00
Mercury (inorganic)	0.01	-	3.25	0.03	9.38E-04	2.74E-05	-	9.66E-04	0.01	-	3.25	0.02	7.31E-04	2.13E-05	-	7.53E-04
Nickel	10.1	1.25E-03	1	10.1	3.64E-01	3.45E-02	1.04E-04	3.98E-01	7.40	1.25E-03	1	7.40	2.66E-01	2.53E-02	1.04E-04	2.92E-01
Selenium	2.60	2.50E-03	Site-sp. Eq.	5.43	1.95E-01	8.88E-03	2.08E-04	2.04E-01	1.63	2.50E-03	Site-sp. Eq.	3.68	1.33E-01	5.55E-03	2.08E-04	1.38E-01
Silver	1.54	1.25E-03	1	1.54	5.54E-02	5.26E-03	1.04E-04	6.08E-02	1.16	1.25E-03	1	1.16	4.17E-02	3.96E-03	1.04E-04	4.58E-02
Zinc	460	8.32E-02	Site-sp. Eq.	102	3.69E+00	1.57E+00	6.91E-03	5.26E+00	323	5.76E-02	Site-sp. Eq.	83.4	3.00E+00	1.10E+00	4.79E-03	4.11E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.120 EU-12 Estimated Daily Doses (EDDs) for Raccoon Foraging in Eureka Gulch Up to Confluence with Upper South Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	26.0	1.25E-03	0.13	3.28	1.18E-01	8.88E-02	1.04E-04	2.07E-01	18.5	1.25E-03	0.13	2.32	8.37E-02	6.30E-02	1.04E-04	1.47E-01
Cadmium	14.7	1.82E-03	Site-sp. Eq.	1.09	3.91E-02	5.02E-02	1.52E-04	8.94E-02	10.9	1.05E-03	Site-sp. Eq.	0.99	3.55E-02	3.73E-02	8.75E-05	7.29E-02
Chromium	4.82	2.50E-03	0.038	0.18	6.59E-03	1.64E-02	2.08E-04	2.32E-02	4.07	2.50E-03	0.038	0.15	5.56E-03	1.39E-02	2.08E-04	1.96E-02
Copper	318	1.66E-02	Site-sp. Eq.	13.8	4.97E-01	1.09E+00	1.38E-03	1.58E+00	238	9.67E-03	Site-sp. Eq.	12.0	4.31E-01	8.13E-01	8.03E-04	1.25E+00
Lead	693	3.99E-03	0.07	48.5	1.75E+00	2.36E+00	3.32E-04	4.11E+00	541	2.15E-03	0.07	37.9	1.36E+00	1.85E+00	1.78E-04	3.21E+00
Mercury (inorganic)	0.04	-	3.25	0.11	4.10E-03	1.19E-04	-	4.21E-03	0.02	-	3.25	0.07	2.59E-03	7.55E-05	-	2.66E-03
Nickel	11.3	1.25E-03	1	11.3	4.07E-01	3.86E-02	1.04E-04	4.45E-01	9.90	1.25E-03	1	9.90	3.56E-01	3.38E-02	1.04E-04	3.90E-01
Selenium	3.73	2.50E-03	Site-sp. Eq.	7.46	2.68E-01	1.27E-02	2.08E-04	2.81E-01	1.67	2.50E-03	Site-sp. Eq.	3.77	1.36E-01	5.72E-03	2.08E-04	1.42E-01
Silver	3.65	1.25E-03	1	3.65	1.31E-01	1.25E-02	1.04E-04	1.44E-01	2.03	1.25E-03	1	2.03	7.30E-02	6.92E-03	1.04E-04	8.00E-02
Zinc	4366	8.54E-01	Site-sp. Eq.	374	1.35E+01	1.49E+01	7.10E-02	2.84E+01	2955	4.12E-01	Site-sp. Eq.	299	1.08E+01	1.01E+01	3.42E-02	2.09E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.121 EU-13 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mainstem South Fork Animas River Up to Confluence

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	36.2	1.25E-03	0.13	4.56	1.64E-01	1.24E-01	1.04E-04	2.88E-01	25.0	1.13E-03	0.13	3.15	1.13E-01	8.53E-02	9.42E-05	1.99E-01
Cadmium	7.41	1.72E-03	Site-sp. Eq.	0.87	3.12E-02	2.53E-02	1.43E-04	5.67E-02	6.98	1.20E-03	Site-sp. Eq.	0.85	3.06E-02	2.38E-02	9.97E-05	5.46E-02
Chromium	6.38	2.50E-03	0.038	0.24	8.73E-03	2.18E-02	2.08E-04	3.07E-02	5.66	2.25E-03	0.038	0.21	7.74E-03	1.93E-02	1.87E-04	2.72E-02
Copper	236	6.23E-02	Site-sp. Eq.	11.9	4.29E-01	8.06E-01	5.18E-03	1.24E+00	221	2.49E-02	Site-sp. Eq.	11.5	4.15E-01	7.55E-01	2.07E-03	1.17E+00
Lead	767	3.63E-03	0.07	53.7	1.93E+00	2.62E+00	3.02E-04	4.55E+00	643	2.19E-03	0.07	45.0	1.62E+00	2.20E+00	1.82E-04	3.82E+00
Mercury (inorganic)	0.50	-	3.25	1.63	5.87E-02	1.71E-03	-	6.04E-02	0.24	-	3.25	0.79	2.84E-02	8.29E-04	-	2.92E-02
Nickel	12.5	1.25E-03	1	12.5	4.50E-01	4.27E-02	1.04E-04	4.93E-01	10.4	1.24E-03	1	10.4	3.75E-01	3.55E-02	1.03E-04	4.11E-01
Selenium	4.14	2.50E-03	Site-sp. Eq.	8.18	2.94E-01	1.41E-02	2.08E-04	3.09E-01	2.15	2.29E-03	Site-sp. Eq.	4.61	1.66E-01	7.32E-03	1.91E-04	1.74E-01
Silver	2.80	1.25E-03	1	2.80	1.01E-01	9.56E-03	1.04E-04	1.10E-01	2.23	1.13E-03	1	2.23	8.03E-02	7.61E-03	9.36E-05	8.80E-02
Zinc	2420	5.37E-01	Site-sp. Eq.	266	9.59E+00	8.26E+00	4.46E-02	1.79E+01	1940	4.13E-01	Site-sp. Eq.	234	8.44E+00	6.62E+00	3.43E-02	1.51E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.122 EU-14 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River from Eureka to Animas Forks

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	58.6	1.25E-03	0.13	7.39	2.66E-01	2.00E-01	1.04E-04	4.66E-01	46.2	1.20E-03	0.13	5.82	2.09E-01	1.58E-01	9.98E-05	3.67E-01
Cadmium	12.0	7.36E-03	Site-sp. Eq.	1.02	3.66E-02	4.10E-02	6.11E-04	7.82E-02	9.14	3.99E-03	Site-sp. Eq.	0.93	3.35E-02	3.12E-02	3.32E-04	6.50E-02
Chromium	4.32	3.07E-03	0.038	0.16	5.90E-03	1.47E-02	2.55E-04	2.09E-02	3.86	2.71E-03	0.038	0.15	5.28E-03	1.32E-02	2.25E-04	1.87E-02
Copper	458	5.54E-02	Site-sp. Eq.	16.5	5.95E-01	1.56E+00	4.60E-03	2.16E+00	326	3.93E-02	Site-sp. Eq.	14.0	5.03E-01	1.11E+00	3.27E-03	1.62E+00
Lead	1307	1.58E-02	0.07	91.5	3.29E+00	4.46E+00	1.31E-03	7.76E+00	997	9.95E-03	0.07	69.8	2.51E+00	3.40E+00	8.27E-04	5.92E+00
Mercury (inorganic)	0.09	-	3.25	0.30	1.07E-02	3.13E-04	-	1.10E-02	0.06	-	3.25	0.18	6.62E-03	1.93E-04	-	6.82E-03
Nickel	8.51	7.01E-03	1	8.51	3.07E-01	2.91E-02	5.82E-04	3.36E-01	6.80	2.98E-03	1	6.80	2.45E-01	2.32E-02	2.48E-04	2.68E-01
Selenium	1.22	2.50E-03	Site-sp. Eq.	2.96	1.06E-01	4.17E-03	2.08E-04	1.11E-01	0.90	2.36E-03	Site-sp. Eq.	2.38	8.56E-02	3.06E-03	1.96E-04	8.88E-02
Silver	5.02	1.25E-03	1	5.02	1.81E-01	1.72E-02	1.04E-04	1.98E-01	3.67	1.17E-03	1	3.67	1.32E-01	1.25E-02	9.70E-05	1.45E-01
Zinc	3458	1.68E+00	Site-sp. Eq.	327	1.18E+01	1.18E+01	1.39E-01	2.37E+01	2385	1.16E+00	Site-sp. Eq.	264	9.51E+00	8.14E+00	9.62E-02	1.77E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.123 EU-15 Estimated Daily Doses (EDDs) for Raccoon Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	41.7	1.25E-03	0.13	5.25	1.89E-01	1.42E-01	1.04E-04	3.32E-01	32.1	1.25E-03	0.13	4.04	1.45E-01	1.10E-01	1.04E-04	2.55E-01
Cadmium	10.4	9.11E-03	Site-sp. Eq.	0.97	3.49E-02	3.55E-02	7.57E-04	7.12E-02	6.52	5.94E-03	Site-sp. Eq.	0.83	2.99E-02	2.22E-02	4.94E-04	5.27E-02
Chromium	4.81	2.50E-03	0.038	0.18	6.58E-03	1.64E-02	2.08E-04	2.32E-02	3.73	2.50E-03	0.038	0.14	5.11E-03	1.27E-02	2.08E-04	1.81E-02
Copper	477	3.62E-02	Site-sp. Eq.	16.9	6.08E-01	1.63E+00	3.01E-03	2.24E+00	304	2.84E-02	Site-sp. Eq.	13.5	4.86E-01	1.04E+00	2.36E-03	1.53E+00
Lead	2320	3.73E-02	0.07	162	5.85E+00	7.92E+00	3.10E-03	1.38E+01	1546	1.56E-02	0.07	108	3.90E+00	5.28E+00	1.30E-03	9.18E+00
Mercury (inorganic)	0.23	-	3.25	0.76	2.74E-02	7.99E-04	-	2.82E-02	0.16	-	3.25	0.52	1.89E-02	5.51E-04	-	1.94E-02
Nickel	7.30	7.64E-03	1	7.30	2.63E-01	2.49E-02	6.35E-04	2.88E-01	5.14	4.60E-03	1	5.14	1.85E-01	1.75E-02	3.83E-04	2.03E-01
Selenium	0.84	2.50E-03	Site-sp. Eq.	2.27	8.17E-02	2.86E-03	2.08E-04	8.48E-02	0.55	2.50E-03	Site-sp. Eq.	1.75	6.30E-02	1.87E-03	2.08E-04	6.51E-02
Silver	6.19	1.25E-03	1	6.19	2.23E-01	2.11E-02	1.04E-04	2.44E-01	3.51	1.25E-03	1	3.51	1.26E-01	1.20E-02	1.04E-04	1.38E-01
Zinc	2770	3.30E+00	Site-sp. Eq.	288	1.04E+01	9.46E+00	2.74E-01	2.01E+01	1548	2.13E+00	Site-sp. Eq.	206	7.41E+00	5.28E+00	1.77E-01	1.29E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.124 EU-16 Estimated Daily Doses (EDDs) for Raccoon Foraging in Placer Gulch to Confluence with Upper West Fork

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	66.4	1.25E-03	0.13	8.37	3.01E-01	2.27E-01	1.04E-04	5.28E-01	53.6	1.25E-03	0.13	6.75	2.43E-01	1.83E-01	1.04E-04	4.26E-01
Cadmium	64.2	3.25E-03	Site-sp. Eq.	1.77	6.36E-02	2.19E-01	2.70E-04	2.83E-01	36.8	2.90E-03	Site-sp. Eq.	1.47	5.30E-02	1.26E-01	2.41E-04	1.79E-01
Chromium	4.33	2.50E-03	0.038	0.16	5.92E-03	1.48E-02	2.08E-04	2.09E-02	3.57	2.50E-03	0.038	0.14	4.89E-03	1.22E-02	2.08E-04	1.73E-02
Copper	1700	3.09E-02	Site-sp. Eq.	31.7	1.14E+00	5.80E+00	2.56E-03	6.95E+00	1070	2.45E-02	Site-sp. Eq.	25.2	9.07E-01	3.65E+00	2.04E-03	4.56E+00
Lead	9009	2.12E-02	0.07	631	2.27E+01	3.08E+01	1.76E-03	5.35E+01	6488	1.66E-02	0.07	454	1.63E+01	2.21E+01	1.38E-03	3.85E+01
Mercury (inorganic)	0.98	-	3.25	3.17	1.14E-01	3.33E-03	-	1.17E-01	0.68	-	3.25	2.20	7.90E-02	2.31E-03	-	8.13E-02
Nickel	17.0	3.12E-03	1	17.0	6.11E-01	5.80E-02	2.59E-04	6.70E-01	9.53	2.20E-03	1	9.53	3.43E-01	3.25E-02	1.83E-04	3.76E-01
Selenium	4.20	2.50E-03	Site-sp. Eq.	8.30	2.99E-01	1.43E-02	2.08E-04	3.13E-01	1.88	2.50E-03	Site-sp. Eq.	4.13	1.49E-01	6.40E-03	2.08E-04	1.55E-01
Silver	22.2	1.25E-03	1	22.2	8.00E-01	7.59E-02	1.04E-04	8.76E-01	12.4	1.25E-03	1	12.4	4.47E-01	4.24E-02	1.04E-04	4.90E-01
Zinc	21500	1.45E+00	Site-sp. Eq.	936	3.37E+01	7.34E+01	1.21E-01	1.07E+02	8470	1.18E+00	Site-sp. Eq.	548	1.97E+01	2.89E+01	9.82E-02	4.87E+01

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.125 EU-17 Estimated Daily Doses (EDDs) for Raccoon Foraging in Mainstem West Fork Animas River from Placer Gulch Up to its Source

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	39.0	1.25E-03	0.13	4.91	1.77E-01	1.33E-01	1.04E-04	3.10E-01	28.5	1.25E-03	0.13	3.59	1.29E-01	9.73E-02	1.04E-04	2.27E-01
Cadmium	2.70	1.27E-02	Site-sp. Eq.	0.62	2.24E-02	9.22E-03	1.06E-03	3.27E-02	1.83	8.64E-03	Site-sp. Eq.	0.55	1.97E-02	6.24E-03	7.18E-04	2.67E-02
Chromium	8.52	2.50E-03	0.038	0.32	1.17E-02	2.91E-02	2.08E-04	4.10E-02	5.57	2.50E-03	0.038	0.21	7.62E-03	1.90E-02	2.08E-04	2.68E-02
Copper	277	3.55E-02	Site-sp. Eq.	12.9	4.64E-01	9.46E-01	2.95E-03	1.41E+00	193	2.60E-02	Site-sp. Eq.	10.8	3.88E-01	6.59E-01	2.16E-03	1.05E+00
Lead	339	6.16E-03	0.07	23.7	8.54E-01	1.16E+00	5.12E-04	2.01E+00	242	3.58E-03	0.07	16.9	6.09E-01	8.26E-01	2.98E-04	1.44E+00
Mercury (inorganic)	0.04	-	3.25	0.12	4.45E-03	1.30E-04	-	4.58E-03	0.03	-	3.25	0.10	3.55E-03	1.03E-04	-	3.65E-03
Nickel	12.3	1.34E-02	1	12.3	4.42E-01	4.19E-02	1.11E-03	4.85E-01	7.36	8.69E-03	1	7.36	2.65E-01	2.51E-02	7.22E-04	2.91E-01
Selenium	1.71	2.50E-03	Site-sp. Eq.	3.83	1.38E-01	5.83E-03	2.08E-04	1.44E-01	0.90	2.50E-03	Site-sp. Eq.	2.38	8.58E-02	3.08E-03	2.08E-04	8.91E-02
Silver	2.16	1.25E-03	1	2.16	7.78E-02	7.37E-03	1.04E-04	8.52E-02	1.27	1.25E-03	1	1.27	4.55E-02	4.32E-03	1.04E-04	5.00E-02
Zinc	834	3.93E+00	Site-sp. Eq.	144	5.19E+00	2.85E+00	3.27E-01	8.37E+00	686	2.64E+00	Site-sp. Eq.	129	4.64E+00	2.34E+00	2.19E-01	7.20E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.126 EU-18 Estimated Daily Doses (EDDs) for Raccoon Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	57.1	1.25E-03	0.13	7.20	2.59E-01	1.95E-01	1.04E-04	4.54E-01	41.1	1.25E-03	0.13	5.18	1.86E-01	1.40E-01	1.04E-04	3.27E-01
Cadmium	7.62	6.24E-03	Site-sp. Eq.	0.88	3.15E-02	2.60E-02	5.18E-04	5.81E-02	6.05	5.10E-03	Site-sp. Eq.	0.81	2.92E-02	2.07E-02	4.24E-04	5.03E-02
Chromium	3.27	2.50E-03	0.038	0.12	4.47E-03	1.11E-02	2.08E-04	1.58E-02	2.67	2.50E-03	0.038	0.10	3.65E-03	9.10E-03	2.08E-04	1.30E-02
Copper	101	1.99E-02	Site-sp. Eq.	7.81	2.81E-01	3.44E-01	1.65E-03	6.27E-01	85.0	1.69E-02	Site-sp. Eq.	7.18	2.59E-01	2.90E-01	1.40E-03	5.50E-01
Lead	502	1.27E-02	0.07	35.2	1.27E+00	1.71E+00	1.06E-03	2.98E+00	372	7.75E-03	0.07	26.0	9.36E-01	1.27E+00	6.44E-04	2.21E+00
Mercury (inorganic)	0.07	-	3.25	0.24	8.48E-03	2.48E-04	-	8.73E-03	0.03	-	3.25	0.08	2.96E-03	8.64E-05	-	3.05E-03
Nickel	5.29	3.75E-03	1	5.29	1.91E-01	1.81E-02	3.12E-04	2.09E-01	4.34	2.31E-03	1	4.34	1.56E-01	1.48E-02	1.92E-04	1.71E-01
Selenium	3.68	2.50E-03	Site-sp. Eq.	7.37	2.65E-01	1.26E-02	2.08E-04	2.78E-01	0.90	2.50E-03	Site-sp. Eq.	2.38	8.56E-02	3.07E-03	2.08E-04	8.89E-02
Silver	2.08	1.25E-03	1	2.08	7.48E-02	7.09E-03	1.04E-04	8.20E-02	1.46	1.25E-03	1	1.46	5.25E-02	4.98E-03	1.04E-04	5.76E-02
Zinc	1423	1.05E+00	Site-sp. Eq.	196	7.06E+00	4.86E+00	8.76E-02	1.20E+01	938	8.64E-01	Site-sp. Eq.	154	5.56E+00	3.20E+00	7.18E-02	8.83E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.127 EU-19 Estimated Daily Doses (EDDs) for Raccoon Foraging in Burrows Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	54.4	1.25E-03	0.13	6.85	2.47E-01	1.86E-01	1.04E-04	4.33E-01	47.8	1.25E-03	0.13	6.03	2.17E-01	1.63E-01	1.04E-04	3.80E-01
Cadmium	7.70	1.86E-02	Site-sp. Eq.	0.88	3.16E-02	2.63E-02	1.55E-03	5.95E-02	7.02	1.40E-02	Site-sp. Eq.	0.85	3.07E-02	2.39E-02	1.16E-03	5.58E-02
Chromium	4.21	2.50E-03	0.038	0.16	5.76E-03	1.44E-02	2.08E-04	2.03E-02	3.19	2.50E-03	0.038	0.12	4.36E-03	1.09E-02	2.08E-04	1.55E-02
Copper	224	6.56E-02	Site-sp. Eq.	11.6	4.18E-01	7.65E-01	5.45E-03	1.19E+00	204	5.07E-02	Site-sp. Eq.	11.1	3.99E-01	6.96E-01	4.22E-03	1.10E+00
Lead	571	9.55E-03	0.07	40.0	1.44E+00	1.95E+00	7.93E-04	3.39E+00	448	7.37E-03	0.07	31.3	1.13E+00	1.53E+00	6.13E-04	2.66E+00
Mercury (inorganic)	0.04	-	3.25	0.12	4.18E-03	1.22E-04	-	4.30E-03	0.02	-	3.25	0.07	2.40E-03	7.01E-05	-	2.47E-03
Nickel	6.95	1.18E-02	1	6.95	2.50E-01	2.37E-02	9.81E-04	2.75E-01	5.76	8.18E-03	1	5.76	2.07E-01	1.96E-02	6.80E-04	2.28E-01
Selenium	1.28	2.50E-03	Site-sp. Eq.	3.06	1.10E-01	4.36E-03	2.08E-04	1.15E-01	0.61	2.50E-03	Site-sp. Eq.	1.87	6.72E-02	2.09E-03	2.08E-04	6.95E-02
Silver	1.99	1.25E-03	1	1.99	7.17E-02	6.80E-03	1.04E-04	7.86E-02	1.37	1.25E-03	1	1.37	4.91E-02	4.66E-03	1.04E-04	5.39E-02
Zinc	850	2.97E+00	Site-sp. Eq.	146	5.25E+00	2.90E+00	2.47E-01	8.39E+00	712	2.23E+00	Site-sp. Eq.	132	4.74E+00	2.43E+00	1.86E-01	7.35E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.128 EU-DR01 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	13.2	2.47E-03	0.13	1.66	5.97E-02	4.50E-02	2.06E-04	1.05E-01	11.4	9.91E-04	0.13	1.43	5.15E-02	3.87E-02	8.24E-05	9.03E-02
Cadmium	2.78	5.13E-04	Site-sp. Eq.	0.63	2.26E-02	9.48E-03	4.26E-05	3.21E-02	2.22	3.83E-04	Site-sp. Eq.	0.58	2.10E-02	7.58E-03	3.18E-05	2.86E-02
Chromium	8.18	1.97E-03	0.038	0.31	1.12E-02	2.79E-02	1.64E-04	3.93E-02	6.93	9.75E-04	0.038	0.26	9.47E-03	2.36E-02	8.10E-05	3.32E-02
Copper	94.2	1.59E-02	Site-sp. Eq.	7.56	2.72E-01	3.22E-01	1.32E-03	5.95E-01	79.3	7.63E-03	Site-sp. Eq.	6.94	2.50E-01	2.71E-01	6.34E-04	5.21E-01
Lead	242	7.39E-02	0.07	16.9	6.09E-01	8.25E-01	6.14E-03	1.44E+00	202	1.28E-02	0.07	14.1	5.09E-01	6.89E-01	1.06E-03	1.20E+00
Mercury (inorganic)	0.02	4.00E-05	3.25	0.06	2.18E-03	6.35E-05	3.32E-06	2.24E-03	0.01	1.96E-05	3.25	0.04	1.54E-03	4.51E-05	1.63E-06	1.59E-03
Nickel	9.59	2.40E-03	1	9.59	3.45E-01	3.27E-02	2.00E-04	3.78E-01	8.63	1.99E-03	1	8.63	3.11E-01	2.94E-02	1.66E-04	3.40E-01
Selenium	4.80	1.74E-03	Site-sp. Eq.	9.38	3.38E-01	1.64E-02	1.45E-04	3.54E-01	1.95	6.58E-04	Site-sp. Eq.	4.27	1.54E-01	6.67E-03	5.47E-05	1.60E-01
Silver	1.58	8.70E-04	1	1.58	5.68E-02	5.39E-03	7.23E-05	6.23E-02	1.21	2.98E-04	1	1.21	4.34E-02	4.11E-03	2.48E-05	4.75E-02
Zinc	883	1.50E-01	Site-sp. Eq.	149	5.37E+00	3.02E+00	1.25E-02	8.39E+00	705	1.21E-01	Site-sp. Eq.	131	4.71E+00	2.41E+00	1.00E-02	7.13E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.129 EU-DR02 Estimated Daily Doses (EDDs) for Raccoon Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	10.3	1.95E-03	0.13	1.30	4.69E-02	3.53E-02	1.62E-04	8.24E-02	9.49	9.73E-04	0.13	1.20	4.30E-02	3.24E-02	8.09E-05	7.55E-02
Cadmium	2.77	5.07E-04	Site-sp. Eq.	0.63	2.26E-02	9.46E-03	4.21E-05	3.21E-02	2.30	2.95E-04	Site-sp. Eq.	0.59	2.13E-02	7.87E-03	2.45E-05	2.92E-02
Chromium	8.76	1.28E-03	0.038	0.33	1.20E-02	2.99E-02	1.06E-04	4.20E-02	7.64	7.08E-04	0.038	0.29	1.04E-02	2.61E-02	5.88E-05	3.66E-02
Copper	82.4	8.69E-03	Site-sp. Eq.	7.07	2.55E-01	2.81E-01	7.22E-04	5.36E-01	72.2	6.70E-03	Site-sp. Eq.	6.63	2.39E-01	2.47E-01	5.57E-04	4.86E-01
Lead	190	2.78E-02	0.07	13.3	4.80E-01	6.50E-01	2.31E-03	1.13E+00	168	9.84E-03	0.07	11.7	4.23E-01	5.73E-01	8.18E-04	9.96E-01
Mercury (inorganic)	0.04	4.00E-05	3.25	0.14	5.01E-03	1.46E-04	3.32E-06	5.16E-03	0.03	1.68E-05	3.25	0.10	3.56E-03	1.04E-04	1.40E-06	3.66E-03
Nickel	11.5	1.88E-03	1	11.5	4.14E-01	3.92E-02	1.56E-04	4.53E-01	10.1	1.56E-03	1	10.1	3.63E-01	3.44E-02	1.30E-04	3.97E-01
Selenium	2.74	9.89E-04	Site-sp. Eq.	5.68	2.05E-01	9.36E-03	8.22E-05	2.14E-01	1.13	4.50E-04	Site-sp. Eq.	2.80	1.01E-01	3.86E-03	3.74E-05	1.05E-01
Silver	1.11	4.70E-04	1	1.11	4.00E-02	3.80E-03	3.91E-05	4.39E-02	0.95	1.74E-04	1	0.95	3.41E-02	3.23E-03	1.45E-05	3.73E-02
Zinc	864	1.29E-01	Site-sp. Eq.	147	5.30E+00	2.95E+00	1.07E-02	8.26E+00	749	8.30E-02	Site-sp. Eq.	136	4.88E+00	2.56E+00	6.90E-03	7.44E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.130 Reference Exposure Unit Bear Creek Estimated Daily Doses (EDDs) for Raccoon Foraging in Bear Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	14.6	1.25E-03	0.13	1.84	6.62E-02	4.98E-02	1.04E-04	1.16E-01	12.5	1.25E-03	0.13	1.58	5.67E-02	4.27E-02	1.04E-04	9.95E-02
Cadmium	0.95	2.50E-04	Site-sp. Eq.	0.44	1.59E-02	3.24E-03	2.08E-05	1.91E-02	0.82	2.50E-04	Site-sp. Eq.	0.42	1.51E-02	2.80E-03	2.08E-05	1.80E-02
Chromium	3.83	2.50E-03	0.038	0.15	5.24E-03	1.31E-02	2.08E-04	1.85E-02	3.82	2.50E-03	0.038	0.14	5.22E-03	1.30E-02	2.08E-04	1.85E-02
Copper	25.9	1.25E-03	Site-sp. Eq.	3.99	1.44E-01	8.84E-02	1.04E-04	2.32E-01	23.6	1.25E-03	Site-sp. Eq.	3.80	1.37E-01	8.04E-02	1.04E-04	2.17E-01
Lead	65.2	2.50E-04	0.07	4.56	1.64E-01	2.23E-01	2.08E-05	3.87E-01	53.5	2.50E-04	0.07	3.75	1.35E-01	1.83E-01	2.08E-05	3.17E-01
Mercury (inorganic)	0.01	-	3.25	0.02	7.02E-04	2.05E-05	-	7.22E-04	0.01	-	3.25	0.02	6.44E-04	1.88E-05	-	6.62E-04
Nickel	7.20	1.25E-03	1	7.20	2.59E-01	2.46E-02	1.04E-04	2.84E-01	6.93	1.25E-03	1	6.93	2.49E-01	2.37E-02	1.04E-04	2.73E-01
Selenium	1.50	2.50E-03	Site-sp. Eq.	3.46	1.24E-01	5.12E-03	2.08E-04	1.30E-01	1.32	2.50E-03	Site-sp. Eq.	3.13	1.13E-01	4.49E-03	2.08E-04	1.17E-01
Silver	0.12	1.25E-03	1	0.12	4.46E-03	4.23E-04	1.04E-04	4.99E-03	0.07	1.25E-03	1	0.07	2.56E-03	2.42E-04	1.04E-04	2.90E-03
Zinc	263	5.00E-03	Site-sp. Eq.	74.2	2.67E+00	8.98E-01	4.16E-04	3.57E+00	257	5.00E-03	Site-sp. Eq.	73.2	2.64E+00	8.77E-01	4.16E-04	3.51E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.131 Reference Exposure Unit Hermosa Creek Estimated Daily Doses (EDDs) for Raccoon Foraging in Hermosa Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	1.10	1.25E-03	0.13	0.14	4.99E-03	3.76E-03	1.04E-04	8.85E-03	1.10	1.25E-03	0.13	0.14	4.99E-03	3.76E-03	1.04E-04	8.85E-03
Cadmium	0.03	2.50E-04	Site-sp. Eq.	0.15	5.33E-03	1.18E-04	2.08E-05	5.47E-03	0.03	2.50E-04	Site-sp. Eq.	0.15	5.33E-03	1.18E-04	2.08E-05	5.47E-03
Chromium	23.0	2.50E-03	0.038	0.87	3.15E-02	7.85E-02	2.08E-04	1.10E-01	23.0	2.50E-03	0.038	0.87	3.15E-02	7.85E-02	2.08E-04	1.10E-01
Copper	11.5	1.25E-03	Site-sp. Eq.	2.67	9.60E-02	3.93E-02	1.04E-04	1.35E-01	11.5	1.25E-03	Site-sp. Eq.	2.67	9.60E-02	3.93E-02	1.04E-04	1.35E-01
Lead	11.7	2.50E-04	0.07	0.82	2.95E-02	3.99E-02	2.08E-05	6.94E-02	11.7	2.50E-04	0.07	0.82	2.95E-02	3.99E-02	2.08E-05	6.94E-02
Mercury (inorganic)	0.003	-	3.25	0.01	3.10E-04	9.05E-06	-	3.19E-04	0.003	-	3.25	0.01	3.10E-04	9.05E-06	-	3.19E-04
Nickel	15.0	1.25E-03	1	15.0	5.40E-01	5.12E-02	1.04E-04	5.91E-01	15.0	1.25E-03	1	15.0	5.40E-01	5.12E-02	1.04E-04	5.91E-01
Selenium	2.40	2.50E-03	Site-sp. Eq.	5.07	1.83E-01	8.19E-03	2.08E-04	1.91E-01	2.40	2.50E-03	Site-sp. Eq.	5.07	1.83E-01	8.19E-03	2.08E-04	1.91E-01
Silver	0.02	1.25E-03	1	0.02	8.10E-04	7.68E-05	1.04E-04	9.91E-04	0.02	1.25E-03	1	0.02	8.10E-04	7.68E-05	1.04E-04	9.91E-04
Zinc	65.9	5.00E-03	Site-sp. Eq.	33.4	1.20E+00	2.25E-01	4.16E-04	1.43E+00	65.9	5.00E-03	Site-sp. Eq.	33.4	1.20E+00	2.25E-01	4.16E-04	1.43E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.132 Reference Exposure Unit Mill Creek Estimated Daily Doses (EDDs) for Raccoon Foraging in Mill Creek

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**	**Sediment (mg/kg, dw)**	**Surface water (mg/L)**	**BSAF**	**Fish tissue concentration (C_{fish})**	**$Dose_{diet}$ [1]**	**$Dose_{sed}$ [2]**	**$Dose_{water}$ [3]**	**Total EDD [4]**
Arsenic	10.0	1.25E-03	Measured	0.47	1.67E-02	3.41E-02	1.04E-04	5.10E-02	10.0	1.25E-03	Measured	0.34	1.22E-02	3.41E-02	1.04E-04	4.64E-02
Cadmium	2.30	2.50E-04	Measured	0.56	2.03E-02	7.85E-03	2.08E-05	2.81E-02	2.30	2.50E-04	Measured	0.43	1.55E-02	7.85E-03	2.08E-05	2.34E-02
Chromium	0.87	2.50E-03	Measured	3.79	1.36E-01	2.97E-03	2.08E-04	1.40E-01	0.87	2.50E-03	Measured	3.51	1.26E-01	2.97E-03	2.08E-04	1.29E-01
Copper	15.7	1.25E-03	Measured	4.52	1.63E-01	5.36E-02	1.04E-04	2.16E-01	15.7	1.25E-03	Measured	3.23	1.16E-01	5.36E-02	1.04E-04	1.70E-01
Lead	329	1.74E-03	Measured	8.12	2.92E-01	1.12E+00	1.45E-04	1.42E+00	329	1.26E-03	Measured	4.95	1.78E-01	1.12E+00	1.05E-04	1.30E+00
Mercury (inorganic)	0.002	-	Measured	0.09	3.08E-03	6.15E-06	-	3.08E-03	0.002	-	Measured	0.06	2.29E-03	6.15E-06	-	2.29E-03
Nickel	2.70	1.25E-03	Measured	0.20	7.24E-03	9.22E-03	1.04E-04	1.66E-02	2.70	1.25E-03	Measured	0.15	5.54E-03	9.22E-03	1.04E-04	1.49E-02
Selenium	1.20	2.50E-03	Measured	3.98	1.43E-01	4.10E-03	2.08E-04	1.48E-01	1.20	2.50E-03	Measured	3.38	1.22E-01	4.10E-03	2.08E-04	1.26E-01
Silver	0.02	1.25E-03	Measured	0.20	7.24E-03	5.29E-05	1.04E-04	7.39E-03	0.02	1.25E-03	Measured	0.15	5.54E-03	5.29E-05	1.04E-04	5.70E-03
Zinc	431	4.21E-02	Measured	171	6.15E+00	1.47E+00	3.50E-03	7.62E+00	431	3.07E-02	Measured	117	4.22E+00	1.47E+00	2.55E-03	5.69E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$

[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$

[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$

[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.133 Reference Exposure Unit Maggie Gulch Estimated Daily Doses (EDDs) for Raccoon Foraging in Maggie Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	12.5	1.25E-03	0.13	1.58	5.67E-02	4.27E-02	1.04E-04	9.95E-02	9.40	1.25E-03	0.13	1.18	4.26E-02	3.21E-02	1.04E-04	7.48E-02
Cadmium	0.79	2.50E-04	Site-sp. Eq.	0.42	1.50E-02	2.70E-03	2.08E-05	1.77E-02	0.45	2.50E-04	Site-sp. Eq.	0.34	1.24E-02	1.53E-03	2.08E-05	1.39E-02
Chromium	3.20	2.50E-03	0.038	0.12	4.38E-03	1.09E-02	2.08E-04	1.55E-02	2.80	2.50E-03	0.038	0.11	3.83E-03	9.56E-03	2.08E-04	1.36E-02
Copper	33.1	1.25E-03	Site-sp. Eq.	4.50	1.62E-01	1.13E-01	1.04E-04	2.75E-01	27.3	1.25E-03	Site-sp. Eq.	4.09	1.47E-01	9.33E-02	1.04E-04	2.41E-01
Lead	36.3	4.70E-04	0.07	2.54	9.15E-02	1.24E-01	3.91E-05	2.15E-01	33.0	3.16E-04	0.07	2.31	8.32E-02	1.13E-01	2.63E-05	1.96E-01
Mercury (inorganic)	0.22	-	3.25	0.70	2.53E-02	7.37E-04	-	2.60E-02	0.09	-	3.25	0.28	1.01E-02	2.96E-04	-	1.04E-02
Nickel	6.70	1.25E-03	1	6.70	2.41E-01	2.29E-02	1.04E-04	2.64E-01	6.25	1.25E-03	1	6.25	2.25E-01	2.13E-02	1.04E-04	2.47E-01
Selenium	2.31	2.50E-03	Site-sp. Eq.	4.91	1.77E-01	7.89E-03	2.08E-04	1.85E-01	1.02	2.50E-03	Site-sp. Eq.	2.59	9.34E-02	3.48E-03	2.08E-04	9.70E-02
Silver	0.70	1.25E-03	1	0.70	2.52E-02	2.39E-03	1.04E-04	2.77E-02	0.32	1.25E-03	1	0.32	1.14E-02	1.09E-03	1.04E-04	1.26E-02
Zinc	168	5.00E-03	Site-sp. Eq.	57.3	2.06E+00	5.74E-01	4.16E-04	2.64E+00	137	5.00E-03	Site-sp. Eq.	51.0	1.84E+00	4.69E-01	4.16E-04	2.31E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
DW = Dry-weight
BW = Body Weight
WB = Whole Body
BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.134 Reference Exposure Unit Picayne Gulch Estimated Daily Doses (EDDs) for Raccoon Foraging in Picayne Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	65.7	1.25E-03	0.13	8.28	2.98E-01	2.24E-01	1.04E-04	5.22E-01	49.2	1.25E-03	0.13	6.20	2.23E-01	1.68E-01	1.04E-04	3.91E-01
Cadmium	1.67	2.50E-04	Site-sp. Eq.	0.53	1.91E-02	5.70E-03	2.08E-05	2.48E-02	1.56	2.50E-04	Site-sp. Eq.	0.52	1.87E-02	5.32E-03	2.08E-05	2.40E-02
Chromium	5.16	2.50E-03	0.038	0.20	7.06E-03	1.76E-02	2.08E-04	2.49E-02	4.75	2.50E-03	0.038	0.18	6.50E-03	1.62E-02	2.08E-04	2.29E-02
Copper	40.4	1.25E-03	Site-sp. Eq.	4.97	1.79E-01	1.38E-01	1.04E-04	3.17E-01	36.2	1.25E-03	Site-sp. Eq.	4.71	1.69E-01	1.24E-01	1.04E-04	2.93E-01
Lead	134	7.76E-04	0.07	9.38	3.38E-01	4.57E-01	6.45E-05	7.95E-01	85.1	4.25E-04	0.07	5.96	2.14E-01	2.91E-01	3.53E-05	5.05E-01
Mercury (inorganic)	0.01	-	3.25	0.04	1.40E-03	4.10E-05	-	1.44E-03	0.01	-	3.25	0.02	8.19E-04	2.39E-05	-	8.43E-04
Nickel	9.92	1.25E-03	1	9.92	3.57E-01	3.39E-02	1.04E-04	3.91E-01	8.87	1.25E-03	1	8.87	3.19E-01	3.03E-02	1.04E-04	3.50E-01
Selenium	1.70	2.50E-03	Site-sp. Eq.	3.82	1.37E-01	5.80E-03	2.08E-04	1.43E-01	0.85	2.50E-03	Site-sp. Eq.	2.29	8.24E-02	2.90E-03	2.08E-04	8.55E-02
Silver	1.36	1.25E-03	1	1.36	4.90E-02	4.64E-03	1.04E-04	5.37E-02	1.09	1.25E-03	1	1.09	3.91E-02	3.71E-03	1.04E-04	4.29E-02
Zinc	421	4.07E-02	Site-sp. Eq.	97.3	3.50E+00	1.44E+00	3.38E-03	4.94E+00	383	1.93E-02	Site-sp. Eq.	92.1	3.32E+00	1.31E+00	1.61E-03	4.63E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
RME = Reasonable Maximum Exposure
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DW = Dry-weight
BW = Body Weight
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BSAF = Biota-to-Sediment Accumulation Factor or Regression Equation
IR = Ingestion Rate

Site-specific sediment-to-fish equations (DW)

Cadmium [WB fish tissue] = 0.4487*Sediment concentration$^{0.3294}$
Copper [WB fish tissue] = 0.7955*Sediment concentration$^{0.4953}$
Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Table A15.135 Reference Exposure Unit North Fork Animas River Estimated Daily Doses (EDDs) for Raccoon Foraging in North Fork Animas River Above Burrows Gulch

	RME exposure point concentration		EDDs (mg/kg bw-day)						CTE exposure point concentration		EDDs (mg/kg bw-day)					
			Dietary items (mg/kg DW)		Diet	Sediment	Water				Dietary items (mg/kg DW)		Diet	Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface water (mg/L)	BSAF	Fish tissue concentration (C_{fish})	$Dose_{diet}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	73.0	1.25E-03	0.13	9.20	3.31E-01	2.49E-01	1.04E-04	5.80E-01	57.9	1.25E-03	0.13	7.29	2.63E-01	1.98E-01	1.04E-04	4.60E-01
Cadmium	10.8	1.44E-03	Site-sp. Eq.	0.98	3.54E-02	3.70E-02	1.19E-04	7.25E-02	8.93	1.05E-03	Site-sp. Eq.	0.92	3.32E-02	3.05E-02	8.73E-05	6.38E-02
Chromium	3.23	2.50E-03	0.038	0.12	4.42E-03	1.10E-02	2.08E-04	1.56E-02	2.60	2.50E-03	0.038	0.10	3.55E-03	8.86E-03	2.08E-04	1.26E-02
Copper	43.6	2.02E-03	Site-sp. Eq.	5.16	1.86E-01	1.49E-01	1.68E-04	3.35E-01	35.7	1.51E-03	Site-sp. Eq.	4.68	1.68E-01	1.22E-01	1.26E-04	2.90E-01
Lead	290	4.51E-03	0.07	20.3	7.31E-01	9.90E-01	3.75E-04	1.72E+00	208	2.32E-03	0.07	14.5	5.23E-01	7.08E-01	1.93E-04	1.23E+00
Mercury (inorganic)	0.04	-	3.25	0.14	5.02E-03	1.46E-04	-	5.17E-03	0.03	-	3.25	0.09	3.39E-03	9.90E-05	-	3.49E-03
Nickel	4.92	1.25E-03	1	4.92	1.77E-01	1.68E-02	1.04E-04	1.94E-01	4.66	1.25E-03	1	4.66	1.68E-01	1.59E-02	1.04E-04	1.84E-01
Selenium	1.49	2.50E-03	Site-sp. Eq.	3.45	1.24E-01	5.10E-03	2.08E-04	1.29E-01	0.62	2.50E-03	Site-sp. Eq.	1.89	6.79E-02	2.13E-03	2.08E-04	7.02E-02
Silver	2.02	1.25E-03	1	2.02	7.27E-02	6.90E-03	1.04E-04	7.97E-02	1.43	1.25E-03	1	1.43	5.15E-02	4.88E-03	1.04E-04	5.65E-02
Zinc	1180	2.18E-01	Site-sp. Eq.	176	6.34E+00	4.03E+00	1.81E-02	1.04E+01	897	1.66E-01	Site-sp. Eq.	150	5.41E+00	3.06E+00	1.38E-02	8.49E+00

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg bw-day = milligrams per kilogram of body weight per day
COPECs = Chemicals of Potential Ecological Concern
EDD = Estimated Daily Dose
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Selenium [WB fish tissue] = 1.7917*Sediment concentration + 0.7695
Zinc [WB fish tissue] = 3.0009*Sediment concentration$^{0.5757}$

Equations

[1] $Dose_{diet} = IR_{diet} \times C_{fish} \times AUF$
[2] $Dose_{sed} = IR_{sediment} \times C_{sediment} \times AUF$
[3] $Dose_{water} = IR_{water} \times C_{water} \times AUF$
[4] Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0	
Body Weight (BW) (kg)	5.78	
IR_{diet} (kg/kg BW-day, DW)	0.036	100% fish
IR_{water} (L/kg BW-day)	0.0831	
$IR_{sediment}$ (kg/kg BW-day, DW)	0.003414	

Appendix 16

Pore Water Aquatic Benthic Invertebrate Community-level Hazard Quotient Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

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Table A16.1 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A.

Table A16.2 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

Table A16.3 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

Table A16.4 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

Table A16.5 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

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Table A16.7 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

Table A16.8 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48.

Table A16.9 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

Table A16.10 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

Table A16.11 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

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Table A16.17 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

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Table A16.20 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

Table A16.21 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs.

Table A16.22 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Bear Creek Reference Exposure Unit Monitoring Site M30.

Table A16.23 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08.

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Table A16.25 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A.

Table A16.26 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

Table A16.27 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

Table A16.28 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

Table A16.29 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

Table A16.30 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

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Table A16.32 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48.

Table A16.33 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

Table A16.34 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

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Table A16.37 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

Table A16.38 Chronic Pore Water Exposure Point Concentrations (EPCs) for Benthic Macroinvertebrate Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

Table A16.39 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

Table A16.40 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

Table A16.41 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

Table A16.42 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-18; North Fork Animas River Burrows Gulch to Animas Forks Monitoring Site A08 and A09.

Table A16.43 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07.

Table A16.44 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

Table A16.45 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-DR02; 32nd Street Bridge to Purple Cliffs.

Table A16.46 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Bear Creek Reference Exposure Unit Monitoring Site M30.

Table A16.47 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08.

Table A16.48 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05.

Table A16.1 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	5.82	5.82	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	3590	2525	-	-	-	116	158	4177	6378	0.86	0.60	0.56	0.40
Cadmium (DM)	1.01	0.40	-	-	-	116	158	1.93	2.53	0.52	0.20	0.40	0.16
Iron (TRM)	8070	6010	-	-	-	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.2 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	3.76	4.05	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	15100	8037	-	-	-	67.6	127	1999	4766	7.55	4.02	3.17	1.69
Cadmium (DM)	0.72	0.38	-	-	-	67.6	127	1.21	2.10	0.59	0.32	0.34	0.18
Copper (DM)	15.7	8.14	-	-	-	67.6	127	9.29	16.9	1.69	0.88	0.93	0.48
Iron (TRM)	72000	39880	-	-	-	-	-	-	-	-	-	-	-
Lead (DM)	85.6	42.8	-	-	-	67.6	127	42.0	84.0	2.04	1.02	1.02	0.51
Zinc (DM)	285	150	-	-	-	67.6	127	112	199	2.54	1.34	1.43	0.75

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.3 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	5.78	6.06	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	10600	5526	-	-	-	126	137	4679	5254	2.27	1.18	2.02	1.05
Cadmium (DM)	1.06	0.94	-	-	-	126	137	2.08	2.24	0.51	0.45	0.47	0.42
Iron (TRM)	16000	8477	-	-	-	-	-	-	-	-	-	-	-
Zinc (DM)	376	347	-	-	-	126	137	197	213	1.91	1.76	1.77	1.63

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.4 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Cadmium (DM)	1.65	1.65	-	-	-	100	100	1.71	1.71	0.97	0.97	0.97	0.97
Copper (DM)	9.99	10.0	-	-	-	100	100	13.5	13.5	0.74	0.74	0.74	0.74
Zinc (DM)	589	589	-	-	-	100	100	160	160	3.67	3.67	3.67	3.67

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.5 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	4.01	4.01	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	7950	7950	-	-	-	248	248	10071	10071	0.79	0.79	0.79	0.79
Cadmium (DM)	1.35	1.35	-	-	-	248	248	3.75	3.75	0.36	0.36	0.36	0.36
Iron (TRM)	27700	27700	-	-	-	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.6 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	3.94	3.94	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	11700	11700	-	-	-	305	305	10071	10071	1.16	1.16	1.16	1.16
Cadmium (DM)	1.20	1.20	-	-	-	305	305	4.49	4.49	0.27	0.27	0.27	0.27
Iron (TRM)	35700	35700	-	-	-	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.7 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	2050	1083	-	-	-	99.3	149	3388	5890	0.61	0.32	0.35	0.18
Cadmium (DM)	1.05	0.73	-	-	-	99.3	149	1.69	2.41	0.62	0.43	0.44	0.30
Copper (DM)	59.4	14.9	-	-	-	99.3	149	13.4	19.5	4.45	1.11	3.04	0.76
Iron (TRM)	2540	1366	-	-	-	-	-	-	-	-	-	-	-
Lead (DM)	32.9	4.89	-	-	-	99.3	149	64.1	99.2	0.51	0.08	0.33	0.05
Manganese (DM)	13300	2494	-	-	-	99.3	149	2979	3408	4.46	0.84	3.90	0.73
Zinc (DM)	423	204	-	-	-	99.3	149	159	230	2.66	1.28	1.84	0.89

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.8 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	3850	3850	-	-	-	97.7	97.7	3312	3312	1.16	1.16	1.16	1.16
Iron (TRM)	4960	4960	-	-	-	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.9 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	2260	1027	-	-	-	94.6	114	3171	4103	0.71	0.32	0.55	0.25
Cadmium (DM)	0.66	0.43	-	-	-	94.6	114	1.62	1.91	0.40	0.26	0.34	0.22
Iron (TRM)	4120	1587	-	-	-	-	-	-	-	-	-	-	-
Zinc (DM)	476	296	-	-	-	94.6	114	152	181	3.13	1.95	2.64	1.64

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.10 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	6.07	6.35	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	886	677	-	-	-	133	135	5050	5180	0.18	0.13	0.17	0.13
Cadmium (DM)	2.50	2.30	-	-	-	133	135	2.18	2.22	1.15	1.05	1.13	1.04
Manganese (DM)	1840	1740	-	-	-	133	135	3282	3303	0.56	0.53	0.56	0.53
Zinc (DM)	662	626	-	-	-	133	135	207	211	3.19	3.02	3.14	2.97

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.11 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	585	585	-	-	-	168	168	6933	6933	0.08	0.08	0.08	0.08
Iron (TRM)	1630	1630	-	-	-	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.12 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	223	223	-	-	-	115	115	4158	4158	0.05	0.05	0.05	0.05
Zinc (DM)	200	200	-	-	-	115	115	182	182	1.10	1.10	1.10	1.10

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.13 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	6.50	6.50	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	169	169	-	-	-	154	154	6170	6170	0.03	0.03	0.03	0.03

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.14 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	5.13	5.40	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	32300	16805	-	-	-	113	119	4034	4341	8.01	4.17	7.44	3.87
Beryllium (TRM)	24.9	13.0	-	-	-	113	119	147	161	0.17	0.09	0.15	0.08
Cadmium (DM)	7.39	5.52	-	-	-	113	119	1.89	1.98	3.91	2.91	3.73	2.78
Copper (DM)	22.3	14.2	-	-	-	113	119	15.1	15.8	1.48	0.94	1.41	0.90
Iron (TRM)	6580	3315	-	-	-	-	-	-	-	-	-	-	-
Lead (DM)	8.55	4.43	-	-	-	113	119	73.6	78.0	0.12	0.06	0.11	0.06
Manganese (DM)	9390	6285	-	-	-	113	119	3108	3164	3.02	2.02	2.97	1.99
Zinc (DM)	2200	1584	-	-	-	113	119	179	187	12.3	8.87	11.7	8.45

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.15 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	5.46	5.46	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	4830	4830	-	-	-	34.4	34.4	793	793	6.09	6.09	6.09	6.09
Beryllium (TRM)	2.01	2.01	-	-	-	34.4	34.4	19.9	19.9	0.10	0.10	0.10	0.10
Cadmium (DM)	2.28	2.28	-	-	-	34.4	34.4	0.67	0.67	3.39	3.39	3.39	3.39
Copper (DM)	8.11	8.11	-	-	-	34.4	34.4	4.92	4.92	1.65	1.65	1.65	1.65
Iron (TRM)	5670	5670	-	-	-	-	-	-	-	-	-	-	-
Lead (DM)	7.46	7.46	-	-	-	34.4	34.4	19.9	19.9	0.38	0.38	0.38	0.38
Zinc (DM)	779	779	-	-	-	34.4	34.4	60.6	60.6	12.8	12.85	12.8	12.8

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.16 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	6.09	6.09	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	1320	1320	-	-	-	88.1	88.1	2875	2875	0.46	0.46	0.46	0.46
Cadmium (DM)	2.54	2.54	-	-	-	88.1	88.1	1.53	1.53	1.66	1.66	1.66	1.66
Copper (DM)	8.72	8.72	-	-	-	88.1	88.1	11.9	11.9	0.73	0.73	0.73	0.73
Lead (DM)	3.56	3.56	-	-	-	88.1	88.1	56.2	56.2	0.06	0.06	0.06	0.06
Zinc (DM)	1120	1120	-	-	-	88.1	88.1	143	143	7.86	7.86	7.86	7.86

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.17 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	11900	11900	-	-	-	151	151	6027	6027	1.97	1.97	1.97	1.97
Beryllium (TRM)	16.3	16.3	-	-	-	151	151	241	241	0.07	0.07	0.07	0.07
Cadmium (DM)	10.8	10.8	-	-	-	151	151	2.44	2.44	4.42	4.42	4.42	4.42
Copper (DM)	30.2	30.2	-	-	-	151	151	19.8	19.8	1.52	1.52	1.52	1.52
Iron (TRM)	1790	1790	-	-	-	-	-	-	-	-	-	-	-
Manganese (DM)	23000	23000	-	-	-	151	151	3427	3427	6.71	6.71	6.71	6.71
Zinc (DM)	3380	3380	-	-	-	151	151	233	233	14.5	14.5	14.5	14.5

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.18 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-18; North Fork Animas River Burrows Gulch to Animas Forks Monitoring Site A08 and A09.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	4.74	4.83	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	10500	6845	-	-	-	84.0	84.3	2693	2709	3.90	2.54	3.88	2.53
Cadmium (DM)	9.03	8.19	-	-	-	84.0	84.3	1.46	1.47	6.17	5.60	6.15	5.57
Copper (DM)	16.8	14.6	-	-	-	84.0	84.3	11.4	11.4	1.47	1.28	1.47	1.27
Iron (TRM)	3060	1555	-	-	-	-	-	-	-	-	-	-	-
Lead (DM)	14.0	7.18	-	-	-	84.0	84.3	53.4	53.6	0.26	0.13	0.26	0.13
Manganese (DM)	1680	1500	-	-	-	84.0	84.3	2817	2821	0.60	0.53	0.60	0.53
Zinc (DM)	1300	1240	-	-	-	84.0	84.3	136	137	9.52	9.08	9.49	9.05

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.19 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	4.63	4.63	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	14200	14200	-	-	-	67.8	67.8	2011	2011	7.06	7.06	7.06	7.06
Beryllium (TRM)	3.70	3.70	-	-	-	67.8	67.8	62.44	62.44	0.06	0.06	0.06	0.06
Cadmium (DM)	16.9	16.9	-	-	-	67.8	67.8	1.22	1.22	13.9	13.9	13.9	13.9
Copper (DM)	52.1	52.1	-	-	-	67.8	67.8	9.32	9.32	5.59	5.59	5.59	5.59
Iron (TRM)	1480	1480	-	-	-	-	-	-	-	-	-	-	-
Lead (DM)	5.52	5.52	-	-	-	67.8	67.8	42.2	42.2	0.13	0.13	0.13	0.13
Manganese (DM)	4720	4720	-	-	-	67.8	67.8	2624	2624	1.80	1.80	1.80	1.80
Zinc (DM)	2940	2940	-	-	-	67.8	67.8	112	112	26.1	26.1	26.1	26.1

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.20 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Copper (DM)	18.2	6.74	-	-	-	93.0	177	12.5	23.1	1.45	0.54	0.79	0.29
Manganese (DM)	9300	4001	-	-	-	93.0	177	2914	3614	3.19	1.37	2.57	1.11

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.21 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EEU-DR02; 32nd Street Bridge to Purple Cliffs.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Manganese (DM)	5870	3318	-	-	-	271	434	4161	4867	1.41	0.80	1.21	0.68

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.22 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Bear Creek Reference Exposure Unit Monitoring Site M30.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	6.30	6.30	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	641	641	-	-	-	72.5	72.5	2201	2201	0.29	0.29	0.29	0.29

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.23 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	6.02	6.02	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	211	211	-	-	-	65.1	65.1	1899	1899	0.11	0.11	0.11	0.11

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.24 Acute Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	5.78	5.78	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Cadmium (DM)	0.66	0.66	-	-	-	99.7	100	1.70	1.70	0.39	0.39	0.39	0.39
Iron (TRM)	1780	1780	-	-	-	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.25 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	5.82	5.82	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	3590	2525	87.0	41.3	29.0	116	158	596	910	6.02	4.23	3.94	2.77
Cadmium (DM)	1.01	0.40	-	-	-	116	158	0.47	0.60	2.13	0.84	1.69	0.66
Iron (TRM)	8070	6010	1000	8.07	6.01	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.26 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	3.76	4.05	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	15100	8037	87.0	174	92.4	67.6	127	285	680	52.9	28.2	22.2	11.8
Cadmium (DM)	0.72	0.38	-	-	-	67.6	127	0.32	0.51	2.27	1.21	1.41	0.75
Copper (DM)	15.7	8.14	-	-	-	67.6	127	6.41	11.0	2.45	1.27	1.43	0.74
Iron (TRM)	72000	39880	1000	72.0	39.9	-	-	-	-	-	-	-	-
Lead (DM)	85.6	42.8	-	-	-	67.6	127	1.64	3.27	52.3	26.1	26.2	13.1
Zinc (DM)	285	150	-	-	-	67.6	127	84.8	151	3.36	1.77	1.89	0.99

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.27 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	5.78	6.06	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	10600	5526	87.0	122	63.5	126	137	668	750	15.9	8.27	14.1	7.37
Cadmium (DM)	1.06	0.94	-	-	-	126	137	0.50	0.54	2.10	1.86	1.97	1.74
Iron (TRM)	16000	8477	1000	16.0	8.48	-	-	-	-	-	-	-	-
Zinc (DM)	376	347	-	-	-	126	137	149	161	2.52	2.32	2.33	2.15

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.28 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Cadmium (DM)	1.65	1.65	-	-	-	100	100	0.43	0.43	3.88	3.88	3.88	3.88
Copper (DM)	9.99	10.0	-	-	-	100	100	8.98	8.98	1.11	1.11	1.11	1.11
Zinc (DM)	589	589	-	-	-	100	100	122	122	4.85	4.85	4.85	4.85

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.29 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	4.01	4.01	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	7950	7950	87.0	91.4	91.4	248	248	1438	1438	5.53	5.53	5.53	5.53
Cadmium (DM)	1.35	1.35	-	-	-	248	248	0.84	0.84	1.61	1.61	1.61	1.61
Iron (TRM)	27700	27700	1000	27.7	27.7	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.30 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	3.94	3.94	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	11700	11700	87.0	134	134	305	305	1438	1438	8.14	8.14	8.14	8.14
Cadmium (DM)	1.20	1.20	-	-	-	305	305	0.98	0.98	1.22	1.22	1.22	1.22
Iron (TRM)	35700	35700	1000	35.7	35.7	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.31 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	2050	1083	87.0	23.6	12.4	99.3	149	484	841	4.24	2.24	2.44	1.29
Cadmium (DM)	1.05	0.73	-	-	-	99.3	149	0.42	0.57	2.49	1.72	1.83	1.27
Copper (DM)	59.4	14.9	-	-	-	99.3	149	8.90	12.6	6.67	1.67	4.73	1.18
Iron (TRM)	2540	1366	1000	2.54	1.37	-	-	-	-	-	-	-	-
Lead (DM)	32.9	4.89	-	-	-	99.3	149	2.50	3.87	13.2	1.96	8.52	1.27
Manganese (DM)	13300	2494	-	-	-	99.3	149	1646	1883	8.08	1.52	7.06	1.32
Zinc (DM)	423	204	-	-	-	99.3	149	120	174	3.51	1.69	2.43	1.17

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.32 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	3850	3850	87.0	44.3	44.3	97.7	97.7	473	473	8.14	8.14	8.14	8.14
Iron (TRM)	4960	4960	1000	4.96	4.96	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.33 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	2260	1027	87.0	26.0	11.8	94.6	114	453	586	4.99	2.27	3.86	1.75
Cadmium (DM)	0.66	0.43	-	-	-	94.6	114	0.41	0.47	1.61	1.04	1.40	0.91
Iron (TRM)	4120	1587	1000	4.12	1.59	-	-	-	-	-	-	-	-
Zinc (DM)	476	296	-	-	-	94.6	114	115	137	4.13	2.57	3.48	2.17

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.34 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	6.07	6.35	6.50	>1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	886	677	87.0	10.2	7.78	133	135	721	740	1.23	0.94	1.20	0.91
Cadmium (DM)	2.50	2.30	-	-	-	133	135	0.53	0.53	4.76	4.37	4.69	4.31
Manganese (DM)	1840	1740	-	-	-	133	135	1814	1825	1.01	0.96	1.01	0.95
Zinc (DM)	662	626	-	-	-	133	135	157	160	4.22	3.99	4.15	3.92

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.35 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	585	585	87.0	6.72	6.72	168	168	990	990	0.59	0.59	0.59	0.59
Iron (TRM)	1630	1630	1000	1.63	1.63	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.36 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	223	223	87.0	2.56	2.56	115	115	594	594	0.38	0.38	0.38	0.38
Zinc (DM)	200	200	-	-	-	115	115	138	138	1.45	1.45	1.45	1.45

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.37 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	6.50	6.50	6.50	1.00	1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	169	169	87.0	1.94	1.94	154	154	881	881	0.19	0.19	0.19	0.19

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.38 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	5.13	5.40	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	32300	16805	87.0	371	193	113	119	576	620	56.1	29.2	52.1	27.1
Beryllium (TRM)	24.9	13.0	-	-	-	113	119	8.17	8.94	3.05	1.59	2.79	1.45
Cadmium (DM)	7.39	5.52	-	-	-	113	119	0.46	0.48	15.9	11.9	15.3	11.4
Copper (DM)	22.3	14.2	-	-	-	113	119	9.93	10.4	2.25	1.43	2.15	1.36
Iron (TRM)	6580	3315	1000	6.58	3.32	-	-	-	-	-	-	-	-
Lead (DM)	8.55	4.43	-	-	-	113	119	2.87	3.04	2.98	1.54	2.81	1.46
Manganese (DM)	9390	6285	-	-	-	113	119	1717	1748	5.47	3.66	5.37	3.60
Zinc (DM)	2200	1584	-	-	-	113	119	135	142	16.3	11.7	15.5	11.2

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.39 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	5.46	5.46	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	4830	4830	87.0	55.5	55.5	34.4	34.4	113	113	42.6	42.6	42.6	42.6
Beryllium (TRM)	2.01	2.01	-	-	-	34.4	34.4	1.11	1.11	1.82	1.82	1.82	1.82
Cadmium (DM)	2.28	2.28	-	-	-	34.4	34.4	0.19	0.19	12.0	12.0	12.0	12.0
Copper (DM)	8.11	8.11	-	-	-	34.4	34.4	3.60	3.60	2.25	2.25	2.25	2.25
Iron (TRM)	5670	5670	1000	5.67	5.67	-	-	-	-	-	-	-	-
Lead (DM)	7.46	7.46	-	-	-	34.4	34.4	0.77	0.77	9.63	9.63	9.63	9.63
Zinc (DM)	779	779	-	-	-	34.4	34.4	45.9	45.9	17.0	17.0	17.0	17.0

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.40 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	6.09	6.09	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	1320	1320	87.0	15.2	15.2	88.1	88.1	410	410	3.22	3.22	3.22	3.22
Cadmium (DM)	2.54	2.54	-	-	-	88.1	88.1	0.39	0.39	6.59	6.59	6.59	6.59
Copper (DM)	8.72	8.72	-	-	-	88.1	88.1	8.04	8.04	1.09	1.09	1.09	1.09
Lead (DM)	3.56	3.56	-	-	-	88.1	88.1	2.19	2.19	1.62	1.62	1.62	1.62
Zinc (DM)	1120	1120	-	-	-	88.1	88.1	108	108	10.4	10.4	10.4	10.4

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.41 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Aluminum (TRM)	11900	11900	87.0	137	137	151	151	860	860	13.8	13.8	13.8	13.8
Beryllium (TRM)	16.3	16.3	-	-	-	151	151	13.4	13.4	1.22	1.22	1.22	1.22
Cadmium (DM)	10.8	10.8	-	-	-	151	151	0.58	0.58	18.6	18.6	18.6	18.6
Copper (DM)	30.2	30.2	-	-	-	151	151	12.8	12.8	2.37	2.37	2.37	2.37
Iron (TRM)	1790	1790	1000	1.79	1.79	-	-	-	-	-	-	-	-
Manganese (DM)	23000	23000	-	-	-	151	151	1893	1893	12.1	12.1	12.1	12.1
Zinc (DM)	3380	3380	-	-	-	151	151	177	177	19.1	19.1	19.1	19.1

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.42 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-18; North Fork Animas River Burrows Gulch to Animas Forks Monitoring Site A08 and A09.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	4.74	4.83	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	10500	6845	87.0	121	78.7	84.0	84.3	384	387	27.3	17.8	27.2	17.7
Cadmium (DM)	9.03	8.19	-	-	-	84.0	84.3	0.37	0.37	24.3	22.0	24.2	21.9
Copper (DM)	16.8	14.6	-	-	-	84.0	84.3	7.71	7.74	2.18	1.89	2.17	1.88
Iron (TRM)	3060	1555	1000	3.06	1.56	-	-	-	-	-	-	-	-
Lead (DM)	14.0	7.18	-	-	-	84.0	84.3	2.08	2.09	6.73	3.45	6.70	3.44
Manganese (DM)	1680	1500	-	-	-	84.0	84.3	1556	1559	1.08	0.96	1.08	0.96
Zinc (DM)	1300	1240	-	-	-	84.0	84.3	103	104	12.6	12.0	12.5	11.9

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.43 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	4.63	4.63	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	14200	14200	87.0	163	163	67.8	67.8	287	287	49.5	49.5	49.5	49.5
Beryllium (TRM)	3.70	3.70	-	-	-	67.8	67.8	3.47	3.47	1.07	1.07	1.07	1.07
Cadmium (DM)	16.9	16.9	-	-	-	67.8	67.8	0.32	0.32	53.4	53.4	53.4	53.4
Copper (DM)	52.1	52.1	-	-	-	67.8	67.8	6.43	6.43	8.10	8.10	8.10	8.10
Iron (TRM)	1480	1480	1000	1.48	1.48	-	-	-	-	-	-	-	-
Lead (DM)	5.52	5.52	-	-	-	67.8	67.8	1.65	1.65	3.35	3.35	3.35	3.35
Manganese (DM)	4720	4720	-	-	-	67.8	67.8	1450	1450	3.26	3.26	3.26	3.26
Zinc (DM)	2940	2940	-	-	-	67.8	67.8	85.2	85.2	34.5	34.5	34.5	34.5

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.44 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EU-DR01; James Ranch to 32nd Street Bridge.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Copper (DM)	18.2	6.74	-	-	-	93.0	177	8.42	14.6	2.16	0.80	1.25	0.46
Manganese (DM)	9300	4001	-	-	-	93.0	177	1610	1997	5.78	2.48	4.66	2.00

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.45 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in EEU-DR02; 32nd Street Bridge to Purple Cliffs.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Manganese (DM)	5870	3318	-	-	-	271	434	2299	2689	2.55	1.44	2.18	1.23

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.46 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Bear Creek Reference Exposure Unit Monitoring Site M30.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	6.30	6.30	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	641	641	87.0	7.37	7.37	72.5	72.5	314	314	2.04	2.04	2.04	2.04

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.47 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	6.02	6.02	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum (TRM)	211	211	87.0	2.43	2.43	65.1	65.1	271	271	0.78	0.78	0.78	0.78

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Table A16.48 Chronic Pore Water Hazard Quotients (HQs) for Benthic Macroinvertebrate Community-level Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05.

COPEC	Pore water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
pH	5.78	5.78	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Cadmium (DM)	0.66	0.66	-	-	-	99.7	100	0.42	0.42	1.57	1.57	1.57	1.57
Iron (TRM)	1780	1780	1000	1.78	1.78	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurement in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

TRM = Total Recoverable Metal

DM = Dissolved Metal

Appendix 17

Surface Water Aquatic Community-Level Hazard Quotient Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

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Table A17.21 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-DR02; Animas River lower Durango Reach.

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Table A17.29 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

Table A17.30 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

Table A17.31 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

Table A17.32 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

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Table A17.35 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

Table A17.36 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

Table A17.37 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

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Table A17.41 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

Table A17.42 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

Table A17.43 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-18; North Fork Animas River Burrows Gulch to Animas Forks Monitoring Site A08 and A09.

Table A17.44 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07.

Table A17.45 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-DR01; Animas River Upper Durango Reach.

Table A17.46 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-DR02; Animas River lower Durango Reach.

Table A17.47 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in Maggie Gulch Reference Exposure Unit Monitoring Site A43.

Table A17.48 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08.

Table A17.49 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in Picayne Gulch Reference Exposure Unit Monitoring Site A26.

Table A17.50 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05.

Table A17.1 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
pH	4.97	5.42	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	4627	3516	-	-	-	153	205	6102	9112	0.76	0.58	0.51	0.39
Cadmium	1.60	1.05	-	-	-	153	205	2.46	3.18	0.65	0.42	0.50	0.33
Iron	5880	4806	-	-	-	-	-	-	-	-	-	-	-
Mercury (DM)	0.04	0.04	2.80	0.01	0.01	-	-	-	-	-	-	-	-
Zinc	351	280	-	-	-	153	205	235	307	1.49	1.19	1.14	0.91
Runoff Hydroperiod													
pH	6.49	7.06	6.50	>1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	2030	1466	-	-	-	56.0	69.8	1545	2089	1.31	0.95	0.97	0.70
Cadmium	0.39	0.31	-	-	-	56.0	69.8	1.03	1.25	0.38	0.30	0.32	0.25
Iron	3822	2887	-	-	-	-	-	-	-	-	-	-	-
Mercury (DM)	0.001	0.001	2.80	0.0004	0.0004	-	-	-	-	-	-	-	-
Zinc	95.5	60.7	-	-	-	56.0	69.8	94.4	115	1.01	0.64	0.83	0.53
Post-runoff Hydroperiod													
pH	5.62	5.42	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	2743	2330	-	-	-	146	166	5733	6853	0.48	0.41	0.40	0.34
Cadmium	0.67	0.59	-	-	-	146	166	2.37	2.65	0.28	0.25	0.25	0.22
Iron	3814	3222	-	-	-	-	-	-	-	-	-	-	-
Mercury (DM)	0.04	0.02	2.80	0.01	0.01	-	-	-	-	-	-	-	-
Zinc	166	147	-	-	-	146	166	225	254	0.74	0.65	0.65	0.58

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

DM = Dissolved Metal

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.2 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
pH	4.36	4.66	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	6570	4017	-	-	-	104	169	3595	7029	1.83	1.12	0.93	0.57
Cadmium	1.55	1.25	-	-	-	104	169	1.76	2.69	0.88	0.71	0.58	0.47
Copper	17.4	15.0	-	-	-	104	169	13.9	22.1	1.25	1.08	0.79	0.68
Iron	8810	5613	-	-	-	-	-	-	-	-	-	-	-
Lead	8.62	6.65	-	-	-	104	169	67.2	114	0.13	0.10	0.08	0.06
Zinc	401	327	-	-	-	104	169	165	258	2.43	1.98	1.55	1.27
Runoff Hydroperiod													
pH	4.65	5.40	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	3058	1967	-	-	-	47.5	80.6	1233	2546	2.48	1.60	1.20	0.77
Cadmium	0.99	0.66	-	-	-	47.5	80.6	0.89	1.41	1.11	0.74	0.70	0.47
Copper	10.1	6.96	-	-	-	47.5	80.6	6.66	11.0	1.52	1.05	0.92	0.63
Iron	5702	4038	-	-	-	-	-	-	-	-	-	-	-
Lead	3.10	1.93	-	-	-	47.5	80.6	28.4	51.0	0.11	0.07	0.06	0.04
Zinc	332	155	-	-	-	47.5	80.6	81.2	132	4.08	1.90	2.52	1.18
Post-runoff Hydroperiod													
pH	4.41	4.73	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	6830	5373	-	-	-	179	228	7569	10071	0.90	0.71	0.68	0.53
Cadmium	1.26	1.13	-	-	-	179	228	2.82	3.48	0.45	0.40	0.36	0.32
Copper	14.5	11.7	-	-	-	179	228	23.2	29.2	0.62	0.50	0.50	0.40
Iron	9427	6903	-	-	-	-	-	-	-	-	-	-	-
Lead	5.01	3.24	-	-	-	179	228	121	156	0.04	0.03	0.03	0.02
Zinc	290	245	-	-	-	179	228	271	338	1.07	0.90	0.86	0.72

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.3 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	6.73	7.02	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	1696	580	-	-	-	33.9	40.0	777	975	2.18	0.75	1.74	0.59
Cadmium	0.55	0.47	-	-	-	33.9	40.0	0.66	0.77	0.82	0.71	0.71	0.62
Copper	12.0	9.94	-	-	-	33.9	40.0	4.85	5.67	2.47	2.05	2.12	1.75
Iron	3216	1032	-	-	-	-	-	-	-	-	-	-	-
Lead	5.75	4.80	-	-	-	33.9	40.0	19.5	23.5	0.29	0.25	0.24	0.20
Zinc	156	128	-	-	-	33.9	40.0	59.8	69.5	2.60	2.14	2.24	1.84
Post-runoff Hydroperiod													
pH	6.05	6.53	6.50	>1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	1539	715	-	-	-	116	149	4182	5890	0.37	0.17	0.26	0.12
Cadmium	1.06	0.92	-	-	-	116	149	1.94	2.41	0.55	0.47	0.44	0.38
Copper	10.9	7.48	-	-	-	116	149	15.4	19.5	0.71	0.48	0.56	0.38
Iron	782	404	-	-	-	-	-	-	-	-	-	-	-
Lead	10.5	4.28	-	-	-	116	149	75.7	99.2	0.14	0.06	0.11	0.04
Zinc	374	282	-	-	-	116	149	183	230	2.05	1.54	1.63	1.23

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.4 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	315	282				32.3	33.1	727	754	0.43	0.39	0.42	0.37
Beryllium	1.00	1.00	-	-	-	32.3	33.1	17.9	18.7	0.06	0.06	0.05	0.05
Cadmium	0.89	0.73	-	-	-	32.3	33.1	0.64	0.65	1.40	1.15	1.36	1.13
Copper	20.7	15.5	-	-	-	32.3	33.1	4.63	4.75	4.47	3.35	4.36	3.26
Lead	9.83	8.79	-	-	-	32.3	33.1	18.5	19.1	0.53	0.48	0.52	0.46
Zinc	270	214	-	-	-	32.3	33.1	57.2	58.6	4.72	3.73	4.61	3.64
Post-runoff Hydroperiod													
Aluminum	172	165				93.7	93.7	3128	3128	0.05	0.05	0.05	0.05
Beryllium	1.00	1.00	-	-	-	93.7	93.7	107.5	107.5	0.01	0.01	0.01	0.01
Cadmium	2.53	1.97	-	-	-	93.7	93.7	1.61	1.61	1.57	1.22	1.57	1.22
Copper	16.3	13.7	-	-	-	93.7	93.7	12.6	12.6	1.29	1.08	1.29	1.08
Lead	43.9	27.4	-	-	-	93.7	93.7	60.1	60.1	0.73	0.46	0.73	0.46
Zinc	987	731	-	-	-	93.7	93.7	151	151	6.55	4.85	6.55	4.85

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.5 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	546	505	-	-	-	54.8	60.0	1500	1698	0.36	0.34	0.32	0.30
Iron	394	313	-	-	-	-	-	-	-	-	-	-	-
Post-runoff Hydroperiod													
Aluminum	628	613	-	-	-	91.2	110	3014	3912	0.21	0.20	0.16	0.16
Iron	1280	864	-	-	-	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.6 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	5.89	6.08	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	2830	2515				74.4	85.0	2279	2738	1.24	1.10	1.03	0.92
Cadmium	0.27	0.24	-	-	-	74.4	85.0	1.32	1.48	0.21	0.18	0.18	0.16
Iron	7670	6355				-	-	-	-	-	-	-	-
Post-runoff Hydroperiod													
pH	4.16	4.34	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	15000	12800				300	338	10071	10071	1.49	1.27	1.49	1.27
Cadmium	1.29	1.17	-	-	-	300	338	4.43	4.91	0.29	0.26	0.26	0.24
Iron	20300	18750				-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.7 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
Aluminum	189	111	-	-	-	126	131	4669	4925	0.04	0.02	0.04	0.02
Cadmium	0.92	0.79	-	-	-	126	131	2.08	2.15	0.44	0.38	0.43	0.37
Copper	4.76	3.36	-	-	-	126	131	16.6	17.3	0.29	0.20	0.28	0.19
Iron	301	209	-	-	-	-	-	-	-	-	-	-	-
Zinc	329	314	-	-	-	126	131	197	204	1.67	1.59	1.61	1.54
Runoff Hydroperiod													
Aluminum	476	337	-	-	-	85.9	84.5	2780	2716	0.17	0.12	0.18	0.12
Cadmium	0.94	0.89	-	-	-	85.9	84.5	1.49	1.47	0.63	0.60	0.64	0.60
Copper	8.97	7.68	-	-	-	85.9	84.5	11.7	11.5	0.77	0.66	0.78	0.67
Iron	475	327	-	-	-	-	-	-	-	-	-	-	-
Zinc	322	306	-	-	-	85.9	84.5	139	137	2.31	2.19	2.34	2.23
Post-runoff Hydroperiod													
Aluminum	158	92.2	-	-	-	124	133	4603	5071	0.03	0.02	0.03	0.02
Cadmium	0.68	0.59	-	-	-	124	133	2.06	2.19	0.33	0.29	0.31	0.27
Copper	2.18	1.89	-	-	-	124	133	16.5	17.6	0.13	0.11	0.12	0.11
Iron	203	103	-	-	-	-	-	-	-	-	-	-	-
Zinc	251	230	-	-	-	124	133	195	208	1.29	1.18	1.21	1.11

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.8 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	217	141	-	-	-	43.7	64.2	1100	1864	0.20	0.13	0.12	0.08
Post-runoff Hydroperiod													
Aluminum	38.6	26.5	-	-	-	98.2	123	3337	4522	0.01	0.01	0.01	0.01

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.9 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
pH	7.11	7.11	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	150	105.9	-	-	-	102	125	3505	4618	0.04	0.03	0.03	0.02
Cadmium	0.97	0.71	-	-	-	102	125	1.73	2.06	0.56	0.41	0.47	0.34
Copper	7.88	4.78	-	-	-	102	125	13.7	16.5	0.58	0.35	0.48	0.29
Zinc	401	333	-	-	-	102	125	163	195	2.47	2.04	2.05	1.70
Runoff Hydroperiod													
pH	6.77	7.15	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	451	357	-	-	-	46.2	62.9	1189	1813	0.38	0.30	0.25	0.20
Cadmium	1.24	1.06	-	-	-	46.2	62.9	0.87	1.14	1.43	1.22	1.09	0.93
Copper	16.45	9.24	-	-	-	46.2	62.9	6.50	8.68	2.53	1.42	1.89	1.06
Zinc	396	341	-	-	-	46.2	62.9	79.3	105	5.00	4.30	3.78	3.25
Post-runoff Hydroperiod													
pH	5.78	6.43	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	340	227	-	-	-	115	130	4152	4874	0.08	0.05	0.07	0.05
Cadmium	1.57	1.17	-	-	-	115	130	1.93	2.13	0.81	0.61	0.73	0.55
Copper	4.77	3.42	-	-	-	115	130	15.4	17.1	0.31	0.22	0.28	0.20
Zinc	451	367	-	-	-	115	130	182	202	2.48	2.02	2.23	1.81

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.10 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
Aluminum	834	505	-	-	-	106	122	3724	4501	0.22	0.14	0.19	0.11
Cadmium	2.70	1.76	-	-	-	106	122	1.80	2.03	1.50	0.98	1.33	0.87
Copper	17.9	12.0	-	-	-	106	122	14.2	16.2	1.26	0.84	1.10	0.74
Lead	0.05	0.05	-	-	-	106	122	69.1	80.3	0.00	0.00	0.00	0.00
Manganese	573	353	-	-	-	106	122	3048	3192	0.19	0.12	0.18	0.11
Zinc	828	573	-	-	-	106	122	169	192	4.89	3.38	4.31	2.98
Runoff Hydroperiod													
Aluminum	618	506	-	-	-	44.3	53.5	1123	1452	0.55	0.45	0.43	0.35
Cadmium	1.70	1.59	-	-	-	44.3	53.5	0.84	0.99	2.02	1.89	1.72	1.61
Copper	24.4	14.2	-	-	-	44.3	53.5	6.24	7.45	3.91	2.28	3.28	1.91
Lead	1.26	1.01	-	-	-	44.3	53.5	26.4	32.5	0.05	0.04	0.04	0.03
Manganese	586	516	-	-	-	44.3	53.5	2277	2424	0.26	0.23	0.24	0.21
Zinc	510	471	-	-	-	44.3	53.5	76.4	90.6	6.68	6.17	5.63	5.20
Post-runoff Hydroperiod													
Aluminum	703	467				170	166	7075	6853	0.10	0.07	0.10	0.07
Cadmium	2.30	2.01	-	-	-	170	166	2.70	2.65	0.85	0.74	0.87	0.76
Copper	7.00	5.74	-	-	-	170	166	22.2	21.7	0.32	0.26	0.32	0.26
Lead	0.55	0.18	-	-	-	170	166	114	112	0.00	0.00	0.00	0.00
Manganese	1646	1382	-	-	-	170	166	3563	3535	0.46	0.39	0.47	0.39
Zinc	671	595	-	-	-	170	166	259	254	2.59	2.29	2.64	2.34

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.11 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	213	212	-	-	-	49.4	50.4	1302	1339	0.16	0.16	0.16	0.16
Post-runoff Hydroperiod													
Aluminum	821	511	-	-	-	75.0	175	2306	7332	0.36	0.22	0.11	0.07

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.12 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	262	254	-	-	-	50.6	51.0	1345	1361	0.19	0.19	0.19	0.19
Cadmium	2.53	2.40	-	-	-	50.6	51.0	0.94	0.95	2.69	2.55	2.67	2.53
Copper	14.1	12.6	-	-	-	50.6	51.0	7.07	7.13	1.99	1.77	1.98	1.76
Zinc	880	837	-	-	-	50.6	51.0	86.1	86.8	10.2	9.72	10.1	9.64
Post-runoff Hydroperiod													
Aluminum	83.6	54.8	-	-	-	63.6	121	1841	4416	0.05	0.03	0.02	0.01
Cadmium	0.75	0.50	-	-	-	63.6	121	1.15	2.00	0.65	0.43	0.37	0.25
Copper	6.01	3.82	-	-	-	63.6	121	8.77	16.0	0.68	0.44	0.38	0.24
Zinc	263	209	-	-	-	63.6	121	106	190	2.48	1.97	1.39	1.10

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.13 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
Aluminum	946	946	-	-	-	197	197	8657	8657	0.11	0.11	0.11	0.11
Cadmium	3.37	3.37	-	-	-	197	197	3.07	3.07	1.10	1.10	1.10	1.10
Copper	21.9	21.9	-	-	-	197	197	25.5	25.5	0.86	0.86	0.86	0.86
Iron	573	573	-	-	-	-	-	-	-	-	-	-	-
Lead	0.05	0.05	-	-	-	197	197	134	134	0.0004	0.0004	0.0004	0.0004
Zinc	950	950	-	-	-	197	197	296	296	3.20	3.20	3.20	3.20
Runoff Hydroperiod													
Aluminum	902	519	-	-	-	49.7	71.7	1312	2167	0.69	0.40	0.42	0.24
Cadmium	1.47	1.22	-	-	-	49.7	71.7	0.93	1.27	1.59	1.32	1.16	0.96
Copper	11.9	9.45	-	-	-	49.7	71.7	6.95	9.82	1.71	1.36	1.21	0.96
Iron	992	581	-	-	-	-	-	-	-	-	-	-	-
Lead	3.87	1.18	-	-	-	49.7	71.7	29.9	44.8	0.13	0.04	0.09	0.03
Zinc	461	410	-	-	-	49.7	71.7	84.7	118	5.44	4.84	3.90	3.47
Post-runoff Hydroperiod													
Aluminum	266	161	-	-	-	119	168	4336	6978	0.06	0.04	0.04	0.02
Cadmium	0.99	0.64	-	-	-	119	168	1.98	2.68	0.50	0.32	0.37	0.24
Copper	7.13	5.46	-	-	-	119	168	15.8	21.9	0.45	0.34	0.33	0.25
Iron	134	99.2	-	-	-	-	-	-	-	-	-	-	-
Lead	0.05	0.04	-	-	-	119	168	77.9	113	0.001	0.001	0.0004	0.0004
Zinc	307	252	-	-	-	119	168	187	257	1.64	1.34	1.20	0.98

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.14 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
pH	7.21	7.21	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	654	654	-	-	-	87.7	87.7	2858	2858	0.23	0.23	0.23	0.23
Beryllium	1.00	1.00	-	-	-	87.7	87.7	96.2	96.2	0.01	0.01	0.01	0.01
Cadmium	2.16	2.16	-	-	-	87.7	87.7	1.52	1.52	1.42	1.42	1.42	1.42
Copper	18.1	18.1	-	-	-	87.7	87.7	11.9	11.9	1.52	1.52	1.52	1.52
Lead	0.17	0.17	-	-	-	87.7	87.7	56.0	56.0	0.003	0.003	0.003	0.003
Manganese	593	593	-	-	-	87.7	87.7	2858	2858	0.21	0.21	0.21	0.21
Zinc	753	753	-	-	-	87.7	87.7	142	142	5.30	5.30	5.30	5.30
Runoff Hydroperiod													
pH	6.34	6.75	6.50	>1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	1249	957	-	-	-	30.5	35.9	674	842	1.85	1.42	1.48	1.14
Beryllium	1.00	1.00	-	-	-	30.5	35.9	16.3	21.4	0.06	0.06	0.05	0.05
Cadmium	2.68	2.24	-	-	-	30.5	35.9	0.61	0.70	4.42	3.70	3.83	3.21
Copper	33.5	15.0	-	-	-	30.5	35.9	4.40	5.12	7.62	3.41	6.54	2.92
Lead	2.14	1.52	-	-	-	30.5	35.9	17.4	20.9	0.12	0.09	0.10	0.07
Manganese	1657	1149	-	-	-	30.5	35.9	2011	2123	0.82	0.57	0.78	0.54
Zinc	742	601	-	-	-	30.5	35.9	54.4	63.1	13.6	11.1	11.8	9.53
Post-runoff Hydroperiod													
pH	3.48	4.31	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	4205	2505	-	-	-	115	133	4137	5055	1.02	0.61	0.83	0.50
Beryllium	6.55	3.21	-	-	-	115	133	152	194	0.04	0.02	0.03	0.02
Cadmium	10.4	5.43	-	-	-	115	133	1.92	2.18	5.43	2.82	4.78	2.49
Copper	25.7	16.7	-	-	-	115	133	15.3	17.6	1.68	1.09	1.46	0.95
Lead	11.3	3.48	-	-	-	115	133	75.1	88.0	0.15	0.05	0.13	0.04
Manganese	13600	6399	-	-	-	115	133	3127	3283	4.35	2.05	4.14	1.95
Zinc	2803	1830	-	-	-	115	133	182	207	15.4	10.1	13.5	8.82

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.15 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	6.18	6.19	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	1480	1250	-	-	-	30.6	33.3	676	758	2.19	1.85	1.95	1.65
Beryllium	1.00	1.00	-	-	-	30.6	33.3	16.4	18.8	0.06	0.06	0.05	0.05
Cadmium	3.02	2.77	-	-	-	30.6	33.3	0.61	0.65	4.97	4.57	4.62	4.25
Copper	16.2	14.1	-	-	-	30.6	33.3	4.41	4.77	3.68	3.19	3.40	2.95
Lead	3.97	3.05	-	-	-	30.6	33.3	17.4	19.1	0.23	0.17	0.21	0.16
Manganese	3100	2557	-	-	-	30.6	33.3	2013	2070	1.54	1.27	1.50	1.24
Zinc	1033	910	-	-	-	30.6	33.3	54.5	58.8	18.9	16.7	17.6	15.5
Post-runoff Hydroperiod													
pH	5.13	5.37	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	8566	6575				127	159	4761	6439	1.80	1.38	1.33	1.02
Beryllium	10.7	9.24	-	-	-	127	159	180	261	0.06	0.05	0.04	0.04
Cadmium	11.6	9.50	-	-	-	127	159	2.10	2.55	5.52	4.52	4.55	3.73
Copper	39.4	30.0	-	-	-	127	159	16.9	20.8	2.34	1.78	1.90	1.45
Lead	7.22	5.86	-	-	-	127	159	83.9	106	0.09	0.07	0.07	0.06
Manganese	18000	15500	-	-	-	127	159	3236	3482	5.6	4.79	5.17	4.45
Zinc	4560	3473	-	-	-	127	159	199	244	22.9	17.4	18.7	14.3

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.16 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	6.95	6.95	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	873	690	-	-	-	33.5	48.3	766	1262	1.14	0.90	0.69	0.55
Cadmium	2.81	2.32	-	-	-	33.5	48.3	0.66	0.90	4.28	3.53	3.11	2.57
Copper	19.3	18.5	-	-	-	33.5	48.3	4.80	6.77	4.02	3.84	2.85	2.73
Lead	3.98	3.27	-	-	-	33.5	48.3	19.3	29.0	0.21	0.17	0.14	0.11
Manganese	2320	1582	-	-	-	33.5	48.3	2075	2343	1.12	0.76	0.99	0.68
Zinc	1110	915	-	-	-	33.5	48.3	59.2	82.5	18.7	15.4	13.5	11.1
Post-runoff Hydroperiod													
pH	5.87	6.04	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	1202	921	-	-	-	64.6	92.2	1879	3060	0.64	0.49	0.39	0.30
Cadmium	3.65	3.08	-	-	-	64.6	92.2	1.16	1.59	3.13	2.65	2.30	1.94
Copper	19.5	16.6	-	-	-	64.6	92.2	8.90	12.4	2.19	1.86	1.57	1.33
Lead	20.3	11.6	-	-	-	64.6	92.2	40.0	59.1	0.51	0.29	0.34	0.20
Manganese	2055	1328	-	-	-	64.6	92.2	2581	2906	0.80	0.51	0.71	0.46
Zinc	1710	1380	-	-	-	64.6	92.2	108	149	15.9	12.8	11.5	9.29

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.17 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	5.33	5.53	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	3140	3070	-	-	-	37.2	42.3	884	1053	3.55	3.47	2.98	2.92
Beryllium	4.36	3.53	-	-	-	37.2	42.3	22.7	28.2	0.19	0.16	0.15	0.13
Cadmium	3.86	3.71	-	-	-	37.2	42.3	0.72	0.80	5.36	5.14	4.80	4.60
Copper	10.0	9.80	-	-	-	37.2	42.3	5.30	5.97	1.89	1.85	1.67	1.64
Lead	1.82	1.56	-	-	-	37.2	42.3	21.7	25.0	0.08	0.07	0.07	0.06
Manganese	6980	5805	-	-	-	37.2	42.3	2149	2242	3.25	2.70	3.11	2.59
Zinc	1260	1230	-	-	-	37.2	42.3	65.2	73.2	19.3	18.9	17.2	16.8
Post-runoff Hydroperiod													
pH	5.17	5.29	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	13100	9900	-	-	-	103	166	3557	6836	3.68	2.78	1.92	1.45
Beryllium	17.4	14.1	-	-	-	103	166	126	281	0.14	0.11	0.06	0.05
Cadmium	15.5	11.5	-	-	-	103	166	1.75	2.65	8.87	6.57	5.86	4.34
Copper	36.2	25.8	-	-	-	103	166	13.8	21.6	2.62	1.87	1.67	1.19
Lead	1.58	0.91	-	-	-	103	166	66.6	111	0.02	0.01	0.01	0.01
Manganese	29700	22820	-	-	-	103	166	3014	3533	9.85	7.57	8.41	6.46
Zinc	5100	3605	-	-	-	103	166	164	253	31.1	22.0	20.1	14.2

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.18 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-18; North Fork Animas River Burrows Gulch to Animas Forks Monitoring Site A08 and A09.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	4.80	5.38	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	1338	1106	-	-	-	22.0	23.6	430	473	3.11	2.57	2.83	2.34
Beryllium	1.00	1.00	-	-	-	22.0	23.6	9.38	10.5	0.11	0.11	0.09	0.09
Cadmium	3.298	2.942	-	-	-	22.0	23.6	0.46	0.48	7.25	6.46	6.82	6.09
Copper	7.23	6.516	-	-	-	22.0	23.6	3.23	3.45	2.24	2.02	2.10	1.89
Lead	2.30	1.591	-	-	-	22.0	23.6	12.0	13.0	0.19	0.13	0.18	0.12
Manganese	524	440	-	-	-	22.0	23.6	1803	1845	0.29	0.24	0.28	0.24
Zinc	586	523	-	-	-	22.0	23.6	40.4	43.0	14.5	12.9	13.6	12.2
Post-runoff Hydroperiod													
pH	4.74	5.02	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	4529	3514	-	-	-	60.8	77.3	1732	2404	2.62	2.03	1.88	1.46
Beryllium	1.00	1.00	-	-	-	60.8	77.3	52.0	77.8	0.02	0.02	0.01	0.01
Cadmium	7.77	6.85	-	-	-	60.8	77.3	1.11	1.36	7.03	6.20	5.70	5.03
Copper	21.5	18.6	-	-	-	60.8	77.3	8.41	10.5	2.55	2.22	2.04	1.77
Lead	12.8	7.33	-	-	-	60.8	77.3	37.4	48.7	0.34	0.20	0.26	0.15
Manganese	1862	1505	-	-	-	60.8	77.3	2530	2740	0.74	0.59	0.68	0.55
Zinc	1331	1144	-	-	-	60.8	77.3	102	127	13.1	11.2	10.5	9.04

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.19 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07.													
COPEC	**Surface water EPCs (µg/L)**		**Benchmark (µg/L)**	**HQs**		**Hardness (mg/L)**		**Hardness adjusted benchmark (µg/L)**		**Low hardness HQs**		**High hardness HQs**	
	RME	**CTE**		**RME**	**CTE**	**Low**	**Avg.**	**Low**	**Avg.**	**RME**	**CTE**	**RME**	**CTE**
Runoff Hydroperiod													
pH	5.85	5.85	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	3470	3470	-	-	-	25.1	25.1	516	516	6.73	6.73	6.73	6.73
Beryllium	1.00	1.00	-	-	-	25.1	25.1	11.7	11.7	0.09	0.09	0.09	0.09
Cadmium	6.78	6.78	-	-	-	25.1	25.1	0.51	0.51	13.3	13.3	13.3	13.3
Copper	23.6	23.6	-	-	-	25.1	25.1	3.66	3.66	6.45	6.45	6.45	6.45
Lead	5.27	5.27	-	-	-	25.1	25.1	14.0	14.0	0.38	0.38	0.38	0.38
Manganese	1460	1460	-	-	-	25.1	25.1	1884	1884	0.77	0.77	0.77	0.77
Zinc	1200	1200	-	-	-	25.1	25.1	45.6	45.6	26.3	26.3	26.3	26.3
Post-runoff Hydroperiod													
pH	4.37	4.57	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	11900	9600	-	-	-	31.7	65.5	708	1916	16.8	13.6	6.21	5.01
Beryllium	4.01	3.68	-	-	-	31.7	65.5	17.3	58.8	0.23	0.21	0.07	0.06
Cadmium	19.6	16.21	-	-	-	31.7	65.5	0.63	1.18	31.3	25.9	16.6	13.8
Copper	69.42	56.35	-	-	-	31.7	65.5	4.55	9.02	15.3	12.4	7.70	6.25
Lead	10.05	7.195	-	-	-	31.7	65.5	18.1	40.6	0.56	0.40	0.25	0.18
Manganese	5980	4490	-	-	-	31.7	65.5	2036	2593	2.94	2.21	2.31	1.73
Zinc	3240	2610	-	-	-	31.7	65.5	56.2	109	57.6	46.4	29.8	24.0

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.20 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-DR01; Animas River Upper Durango Reach.													
COPEC	**Surface water EPCs (µg/L)**		**Benchmark (µg/L)**	**HQs**		**Hardness (mg/L)**		**Hardness adjusted benchmark (µg/L)**		**Low hardness HQs**		**High hardness HQs**	
	RME	**CTE**		**RME**	**CTE**	**Low**	**Avg.**	**Low**	**Avg.**	**RME**	**CTE**	**RME**	**CTE**
Pre-runoff Hydroperiod													
Aluminum	2088	890	-	-	-	184	205	7885	9112	0.26	0.11	0.23	0.10
Iron	2900	1487	-	-	-	-	-	-	-	-	-	-	-
Mercury (DM)	0.04	0.04	2.80	0.01	0.01	-	-	-	-	-	-	-	-
Runoff Hydroperiod													
Aluminum	2800	2700	-	-	-	184	205	7885	9112	0.36	0.34	0.31	0.30
Iron	4700	4650	-	-	-	-	-	-	-	-	-	-	-
Mercury (DM)	0.001	0.001	2.80	0.0005	0.0005	-	-	-	-	-	-	-	-
Post-runoff Hydroperiod													
Aluminum	378	279	-	-	-	184	205	7885	9112	0.05	0.04	0.04	0.03
Iron	474	370	-	-	-	-	-	-	-	-	-	-	-
Mercury (DM)	0.04	0.02	2.80	0.01	0.01	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

DM = Dissolved Metal

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.21 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-DR02; Animas River Lower Durango Reach.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
pH	6.67	7.34	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	486	435	-	-	-	144	171	5642	7120	0.09	0.08	0.07	0.06
Cadmium	0.19	0.13				144	171	2.34	2.72	0.08	0.06	0.07	0.05
Iron	765	654	-	-	-	-	-	-	-	-	-	-	-
Mercury (DM)	0.04	0.04	2.8	0.01	0.01	-	-	-	-	-	-	-	-
Runoff Hydroperiod													
pH	6.00	6.79	6.50	>1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	3798	1473	-	-	-	65.4	81.8	1911	2596	1.99	0.77	1.46	0.57
Cadmium	0.17	0.13				65.4	81.8	1.18	1.43	0.15	0.11	0.12	0.09
Iron	6923	2525	-	-	-	-	-	-	-	-	-	-	-
Mercury (DM)	0.002	0.001	2.8	0.00	0.00	-	-	-	-	-	-	-	-
Post-runoff Hydroperiod													
pH	6.63	7.54	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	1374	478.4	-	-	-	170	189	7058	8156	0.19	0.07	0.17	0.06
Cadmium	0.43	0.20				170	189	2.70	2.96	0.16	0.07	0.14	0.07
Iron	1048	509	-	-	-	-	-	-	-	-	-	-	-
Mercury (DM)	0.04	0.02	2.8	0.01	0.01	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

DM = Dissolved Metal

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.22 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in Maggie Gulch Reference Exposure Unit Monitoring Site A43.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	372	300	-	-	-	42.5	42.9	1059	1073	0.35	0.28	0.35	0.28
Post-runoff Hydroperiod													
Aluminum	73.5	41.8	-	-	-	100	118	3399	4271	0.02	0.01	0.02	0.01

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.23 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	117	117	-	-	-	24.8	24.8	507	507	0.23	0.23	0.23	0.23
Beryllium	1.00	1.00	-	-	-	24.8	24.8	11.5	11.5	0.09	0.09	0.09	0.09
Lead	0.83	0.83	-	-	-	24.8	24.8	13.8	13.8	0.06	0.06	0.06	0.06
Post-runoff Hydroperiod													
Aluminum	265	265	-	-	-	56.1	56.1	1550	1550	0.17	0.17	0.17	0.17
Beryllium	1.00	1.00	-	-	-	56.1	56.1	45.3	45.3	0.02	0.02	0.02	0.02
Lead	0.25	0.25	-	-	-	56.1	56.1	34.2	34.2	0.01	0.01	0.01	0.01

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.24 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in Picayne Gulch Reference Exposure Unit Monitoring Site A26.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	200	200	-	-	-	39.7	39.7	964	964	0.21	0.21	0.21	0.21
Post-runoff Hydroperiod													
Aluminum	81.9	46.0	-	-	-	183	234	7808	10071	0.01	0.01	0.01	0.00

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.25 Acute Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	767	415	-	-	-	23.0	24.7	458	505	1.68	0.91	1.52	0.82
Beryllium	1.00	1.00	-	-	-	23.0	24.7	10.1	11.4	0.10	0.10	0.09	0.09
Cadmium	1.84	1.56	-	-	-	23.0	24.7	0.47	0.50	3.89	3.30	3.65	3.10
Lead	0.75	0.62	-	-	-	23.0	24.7	12.6	13.7	0.06	0.05	0.05	0.05
Zinc	268	231	-	-	-	23.0	24.7	42.1	44.9	6.37	5.48	5.97	5.14
Post-runoff Hydroperiod													
Aluminum	73.5	40.1	-	-	-	28.7	75.1	618	2313	0.12	0.06	0.03	0.02
Beryllium	1.00	1.00	-	-	-	28.7	75.1	14.6	74.2	0.07	0.07	0.01	0.01
Cadmium	0.82	0.66	-	-	-	28.7	75.1	0.57	1.33	1.43	1.16	0.62	0.50
Lead	0.17	0.09	-	-	-	28.7	75.1	16.2	47.2	0.01	0.01	0.00	0.00
Zinc	142	116	-	-	-	28.7	75.1	51.3	123	2.77	2.26	1.15	0.94

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.26 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-01; Mineral Creek from Animas River to South Fork Mineral Creek Monitoring Sites M34 and M29A.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
pH	4.97	5.42	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	4627	3516	87.0	53.2	40.4	153	205	871	1301	5.31	4.04	3.56	2.70
Cadmium	1.60	1.05	-	-	-	153	205	0.58	0.73	2.74	1.79	2.20	1.44
Iron	5880	4806	1000	5.88	4.81	-	-	-	-	-	-	-	-
Mercury (TRM)	0.04	0.04	0.01	4.00	4.00	-	-	-	-	-	-	-	-
Zinc	351	280	-	-	-	153	205	178	232	1.97	1.58	1.51	1.21
Runoff Hydroperiod													
pH	6.49	7.06	6.50	>1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	2030	1466	87.0	23.3	16.9	56.0	69.8	221	298	9.21	6.65	6.81	4.92
Cadmium	0.39	0.31	-	-	-	56.0	69.8	0.27	0.32	1.44	1.14	1.22	0.96
Iron	3822	2887	1000	3.82	2.89	-	-	-	-	-	-	-	-
Mercury (TRM)	0.01	0.01	0.01	0.75	0.75	-	-	-	-	-	-	-	-
Zinc	96	60.7	-	-	-	56.0	69.8	71.5	87.3	1.34	0.85	1.09	0.70
Post-runoff Hydroperiod													
pH	5.62	5.42	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	2743	2330	87.0	31.5	26.8	146	166	818	978	3.35	2.85	2.80	2.38
Cadmium	0.67	0.59	-	-	-	146	166	0.56	0.62	1.18	1.05	1.07	0.95
Iron	3814	3222	1000	3.81	3.22	-	-	-	-	-	-	-	-
Mercury (TRM)	0.04	0.02	0.01	4.00	2.02	-	-	-	-	-	-	-	-
Zinc	166	147	-	-	-	146	166	171	192	0.97	0.86	0.86	0.77

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

TRM = Total Recoverable Metal

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.27 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-02; Mineral Creek from South Fork to Middle Fork Mineral Creek Monitoring Sites M27 and M27A.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
pH	4.36	4.66	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	6570	4017	87.0	75.5	46.2	104	169	513	1003	12.8	7.83	6.55	4.00
Cadmium	1.55	1.25	-	-	-	104	169	0.44	0.63	3.55	2.87	2.46	1.99
Copper	17.4	15.0	-	-	-	104	169	9.24	14.0	1.88	1.62	1.24	1.07
Iron	8810	5613	1000	8.81	5.61	-	-	-	-	-	-	-	-
Lead	8.62	6.65	-	-	-	104	169	2.62	4.44	3.29	2.54	1.94	1.50
Zinc	401	327	-	-	-	104	169	125	196	3.20	2.61	2.05	1.67
Runoff Hydroperiod													
pH	4.65	5.40	6.50	>1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	3058	1967	87.0	35.1	22.6	47.5	80.6	176	363	17.4	11.2	8.4	5.41
Cadmium	0.99	0.66	-	-	-	47.5	80.6	0.24	0.36	4.09	2.73	2.75	1.83
Copper	10.1	6.96	-	-	-	47.5	80.6	4.74	7.45	2.14	1.47	1.36	0.93
Iron	5702	4038	1000	5.70	4.04	-	-	-	-	-	-	-	-
Lead	3.10	1.93	-	-	-	47.5	80.6	1.11	1.99	2.80	1.74	1.56	0.97
Zinc	332	155	-	-	-	47.5	80.6	61.5	99.6	5.39	2.51	3.33	1.55
Post-runoff Hydroperiod													
pH	4.41	4.73	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	6830	5373	87.0	78.5	61.8	179	228	1081	1438	6.32	4.97	4.75	3.74
Cadmium	1.26	1.13	-	-	-	179	228	0.66	0.79	1.91	1.71	1.59	1.43
Copper	14.5	11.7	-	-	-	179	228	14.7	18.1	0.98	0.80	0.80	0.65
Iron	9427	6903	1000	9.43	6.90	-	-	-	-	-	-	-	-
Lead	5.01	3.24	-	-	-	179	228	4.70	6.08	1.07	0.69	0.82	0.53
Zinc	290	245	-	-	-	179	228	205	256	1.41	1.19	1.13	0.96

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.28 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-03; Mineral Creek from Middle Fork Mineral Creek to Mill Creek Monitoring Sites M14B and M11.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	6.73	7.02	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	1696	580	87.0	19.5	6.66	33.9	40.0	111	139	15.3	5.23	12.2	4.16
Cadmium	0.55	0.47	-	-	-	33.9	40.0	0.19	0.21	2.91	2.53	2.56	2.23
Copper	12.0	9.94	-	-	-	33.9	40.0	3.55	4.09	3.38	2.80	2.93	2.43
Iron	3216	1032	1000	3.22	1.03	-	-	-	-	-	-	-	-
Lead	5.75	4.80	-	-	-	33.9	40.0	0.76	0.92	7.56	6.31	6.27	5.24
Zinc	156	128	-	-	-	33.9	40.0	45.3	52.7	3.44	2.83	2.96	2.43
Post-runoff Hydroperiod													
pH	6.05	6.53	6.50	>1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	1539	715	87.0	17.7	8.22	116	149	597	841	2.58	1.20	1.83	0.85
Cadmium	1.06	0.92	-	-	-	116	149	0.47	0.57	2.24	1.94	1.85	1.60
Copper	10.9	7.48	-	-	-	116	149	10.2	12.6	1.07	0.74	0.87	0.60
Iron	782	404	1000	0.78	0.40	-	-	-	-	-	-	-	-
Lead	10.5	4.28	-	-	-	116	149	2.95	3.87	3.55	1.45	2.71	1.11
Zinc	374	282	-	-	-	116	149	138	174	2.70	2.04	2.15	1.62

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.29 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-04; Mineral Creek Upstream of Mill Creek Monitoring Site M10A.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	315	282	87.0	3.62	3.24	32.3	33.1	104	108	3.03	2.72	2.93	2.62
Beryllium	1.00	1.00	-	-	-	32.3	33.1	0.99	1.04	1.01	1.01	0.96	0.96
Cadmium	0.89	0.73	-	-	-	32.3	33.1	0.18	0.18	4.91	4.05	4.82	3.97
Copper	20.7	15.5	-	-	-	32.3	33.1	3.41	3.49	6.07	4.55	5.94	4.45
Lead	9.83	8.79	-	-	-	32.3	33.1	0.72	0.74	13.6	12.2	13.2	11.8
Zinc	270	214	-	-	-	32.3	33.1	43.3	44.4	6.23	4.93	6.08	4.81
Post-runoff Hydroperiod													
Aluminum	172	165	87.0	1.98	1.90	93.7	93.7	447	447	0.39	0.37	0.39	0.37
Beryllium	1.00	1.00	-	-	-	93.7	93.7	5.97	5.97	0.17	0.17	0.17	0.17
Cadmium	2.53	1.97	-	-	-	93.7	93.7	0.40	0.40	6.26	4.88	6.26	4.88
Copper	16.3	13.7	-	-	-	93.7	93.7	8.47	8.47	1.92	1.61	1.92	1.61
Lead	43.9	27.4	-	-	-	93.7	93.7	2.34	2.34	18.73	11.69	18.73	11.69
Zinc	987	731	-	-	-	93.7	93.7	114	114	8.64	6.40	8.64	6.40

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.30 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-05; South Fork Mineral Creek Monitoring Site M28.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	546	505	87.0	6.28	5.81	54.8	60.0	214	242	2.55	2.36	2.25	2.08
Iron	394	313	1000	0.39	0.31	-	-	-	-	-	-	-	-
Post-runoff Hydroperiod													
Aluminum	628	613	87.0	7.22	7.05	91.2	110	430	558	1.46	1.42	1.12	1.10
Iron	1280	864	1000	1.28	0.86	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.31 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-06; Middle Fork Mineral Creek Monitoring Site M20.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	5.89	6.08	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	2830	2515	87.0	32.5	28.9	74.4	85.0	325	391	8.70	7.73	7.24	6.44
Cadmium	0.27	0.24	-	-	-	74.4	85.0	0.34	0.38	0.80	0.70	0.72	0.63
Iron	7670	6355	1000	7.67	6.36	-	-	-	-	-	-	-	-
Post-runoff Hydroperiod													
pH	4.16	4.34	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	15000	12800	87.0	172	147	300	338	1438	1438	10.4	8.90	10.4	8.90
Cadmium	1.29	1.17	-	-	-	300	338	1.06	1.06	1.22	1.10	1.22	1.10
Iron	20300	18750	1000	20.3	18.8	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.32 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-07; Animas River from the Confluence with Arrastra Creek to Howardsville Monitoring Sites A56 and A55.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
Aluminum	189	111	87.0	2.18	1.27	126	131	667	703	0.28	0.17	0.27	0.16
Cadmium	0.92	0.79	-	-	-	126	131	0.50	0.52	1.82	1.57	1.77	1.53
Copper	4.76	3.36	-	-	-	126	131	10.9	11.2	0.44	0.31	0.42	0.30
Iron	301	209	1000	0.30	0.21	-	-	-	-	-	-	-	-
Zinc	329	314	-	-	-	126	131	149	154	2.21	2.10	2.13	2.03
Runoff Hydroperiod													
Aluminum	476	337	87.0	5.47	3.87	85.9	84.5	397	388	1.20	0.85	1.23	0.87
Cadmium	0.94	0.89	-	-	-	85.9	84.5	0.38	0.37	2.48	2.35	2.51	2.38
Copper	8.97	7.68	-	-	-	85.9	84.5	7.87	7.8	1.14	0.98	1.16	0.99
Iron	475	327	1000	0.47	0.33	-	-	-	-	-	-	-	-
Zinc	322	306	-	-	-	85.9	84.5	106	104	3.05	2.90	3.09	2.94
Post-runoff Hydroperiod													
Aluminum	158	92	87.0	1.82	1.06	124	133	657	724	0.24	0.14	0.22	0.13
Cadmium	0.68	0.59	-	-	-	124	133	0.50	0.53	1.36	1.18	1.29	1.12
Copper	2.18	1.89	-	-	-	124	133	10.8	11.4	0.20	0.18	0.19	0.17
Iron	203	103	1000	0.20	0.10	-	-	-	-	-	-	-	-
Zinc	251	230	-	-	-	124	133	148	157	1.70	1.56	1.59	1.46

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.33 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-08; Cunningham Creek Monitoring Site A48.													
COPEC	**Surface water EPCs (µg/L)**		**Benchmark (µg/L)**	**HQs**		**Hardness (mg/L)**		**Hardness adjusted benchmark (µg/L)**		**Low hardness HQs**		**High hardness HQs**	
	RME	**CTE**		**RME**	**CTE**	**Low**	**Avg.**	**Low**	**Avg.**	**RME**	**CTE**	**RME**	**CTE**
Runoff Hydroperiod													
Aluminum	217	141	87.0	2.49	1.63	43.7	64.2	157	266	1.38	0.90	0.82	0.53
Post-runoff Hydroperiod													
Aluminum	38.6	26.5	87.0	0.44	0.30	98.2	123	476	646	0.08	0.06	0.06	0.04

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.34 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-09; Animas River from Howardsville to Minnie Gulch Monitoring Sites A45 and A41A.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
pH	7.11	7.11	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	150	106	87.0	1.72	1.22	102	125	500	659	0.30	0.21	0.23	0.16
Cadmium	0.97	0.71	-	-	-	102	125	0.43	0.50	2.26	1.65	1.94	1.42
Copper	7.88	4.78	-	-	-	102	125	9.09	10.8	0.87	0.53	0.73	0.44
Zinc	401	333	-	-	-	102	125	123	148	3.26	2.70	2.71	2.25
Runoff Hydroperiod													
pH	6.77	7.15	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	451	357	87.0	5.19	4.10	46.2	62.9	170	259	2.66	2.10	1.74	1.38
Cadmium	1.24	1.06	-	-	-	46.2	62.9	0.24	0.30	5.24	4.48	4.15	3.55
Copper	16.5	9.24	-	-	-	46.2	62.9	4.63	6.03	3.55	2.00	2.73	1.53
Zinc	396	341	-	-	-	46.2	62.9	60.1	79.5	6.60	5.68	4.99	4.29
Post-runoff Hydroperiod													
pH	5.78	6.43	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	340	227	87.0	3.90	2.61	115	130	593	696	0.57	0.38	0.49	0.33
Cadmium	1.57	1.17	-	-	-	115	130	0.47	0.52	3.32	2.49	3.04	2.28
Copper	4.77	3.42	-	-	-	115	130	10.1	11.2	0.47	0.34	0.43	0.31
Zinc	451	367	-	-	-	115	130	138	153	3.27	2.66	2.94	2.39

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.35 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-10; Animas River from Minnie Gulch to Eureka Monitoring Site A35.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
Aluminum	834	505	87.0	9.59	5.80	106	122	532	643	1.57	0.95	1.30	0.79
Cadmium	2.70	1.76	-	-	-	106	122	0.44	0.49	6.07	3.97	5.47	3.57
Copper	17.9	12.0	-	-	-	106	122	9.44	10.6	1.90	1.27	1.68	1.13
Lead	0.05	0.05	-	-	-	106	122	2.69	3.13	0.02	0.02	0.02	0.02
Manganese	573	353	-	-	-	106	122	1684	1764	0.34	0.21	0.32	0.20
Zinc	828	573	-	-	-	106	122	128	145	6.46	4.46	5.69	3.94
Runoff Hydroperiod													
Aluminum	618	506	87.0	7.11	5.81	44.3	53.5	160	207	3.86	3.16	2.98	2.44
Cadmium	1.70	1.59	-	-	-	44.3	53.5	0.23	0.26	7.38	6.92	6.40	6.00
Copper	24.4	14.2	-	-	-	44.3	53.5	4.47	5.25	5.47	3.18	4.66	2.71
Lead	1.26	1.01	-	-	-	44.3	53.5	1.03	1.27	1.22	0.99	0.99	0.80
Manganese	586	516	-	-	-	44.3	53.5	1258	1339	0.47	0.41	0.44	0.38
Zinc	510	471	-	-	-	44.3	53.5	57.8	68.6	8.82	8.15	7.44	6.87
Post-runoff Hydroperiod													
Aluminum	703	467	87.0	8.08	5.37	170	166	1010	978	0.70	0.46	0.72	0.48
Cadmium	2.30	2.01	-	-	-	170	166	0.63	0.62	3.63	3.18	3.70	3.23
Copper	7.00	5.74	-	-	-	170	166	14.1	13.8	0.50	0.41	0.51	0.42
Lead	0.55	0.18	-	-	-	170	166	4.46	4.35	0.12	0.04	0.13	0.04
Manganese	1646	1382	-	-	-	170	166	1969	1953	0.84	0.70	0.84	0.71
Zinc	671	595	-	-	-	170	166	196	192	3.42	3.03	3.49	3.09

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.36 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-11; Upper South Fork Animas River Up to Confluence with Eureka Gulch Monitoring Site A36.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	213	212	87.0	2.45	2.44	49.4	50.4	186	191	1.15	1.14	1.11	1.11
Post-runoff Hydroperiod													
Aluminum	821	511	87.0	9.44	5.88	75.0	175	329	1047	2.49	1.55	0.78	0.49

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.37 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-12; Eureka Gulch Up to Confluence with Upper South Fork Animas River Monitoring Site A37.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	262	254	87.0	3.01	2.92	50.6	51.0	192	194	1.36	1.32	1.35	1.31
Cadmium	2.53	2.40	-	-	-	50.6	51.0	0.25	0.26	9.97	9.46	9.91	9.40
Copper	14.1	12.6	-	-	-	50.6	51.0	5.00	5.04	2.82	2.51	2.80	2.49
Zinc	880	837	-	-	-	50.6	51.0	65.2	65.7	13.5	12.8	13.4	12.7
Post-runoff Hydroperiod													
Aluminum	83.6	54.8	87.0	0.96	0.63	63.6	121	263	630	0.32	0.21	0.13	0.09
Cadmium	0.75	0.50	-	-	-	63.6	121	0.30	0.49	2.48	1.64	1.53	1.01
Copper	6.01	3.82	-	-	-	63.6	121	6.08	10.5	0.99	0.63	0.57	0.36
Zinc	263	209	-	-	-	63.6	121	80.3	144	3.28	2.60	1.83	1.45

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.38 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-13; Mainstem South Fork Animas River Up to Confluence with Animas River in Eureka Monitoring Site A34.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
Aluminum	946	946	87.0	10.9	10.9	197	197	1236	1236	0.77	0.77	0.77	0.77
Cadmium	3.37	3.37	-	-	-	197	197	0.71	0.71	4.77	4.77	4.77	4.77
Copper	21.9	21.9	-	-	-	197	197	16.0	16.0	1.37	1.37	1.37	1.37
Iron	573	573	1000	0.57	0.57	-	-	-	-	-	-	-	-
Lead	0.05	0.05	-	-	-	197	197	5.22	5.22	0.01	0.01	0.01	0.01
Zinc	950	950	-	-	-	197	197	225	225	4.23	4.23	4.23	4.23
Runoff Hydroperiod													
Aluminum	902	519	87.0	10.4	5.96	49.7	71.7	187	309	4.81	2.77	2.91	1.68
Cadmium	1.47	1.22	-	-	-	49.7	71.7	0.25	0.33	5.89	4.88	4.46	3.70
Copper	11.9	9.45	-	-	-	49.7	71.7	4.93	6.74	2.42	1.92	1.77	1.40
Iron	992	581	1000	0.99	0.58	-	-	-	-	-	-	-	-
Lead	3.87	1.18	-	-	-	49.7	71.7	1.17	1.75	3.32	1.01	2.21	0.67
Zinc	461	410	-	-	-	49.7	71.7	64.1	89.5	7.18	6.39	5.15	4.58
Post-runoff Hydroperiod													
Aluminum	266	161	87.0	3.06	1.85	119	168	619	996	0.43	0.26	0.27	0.16
Cadmium	0.99	0.64	-	-	-	119	168	0.48	0.63	2.05	1.33	1.58	1.02
Copper	7.13	5.46	-	-	-	119	168	10.4	14.0	0.69	0.53	0.51	0.39
Iron	134	99	1000	0.13	0.10	-	-	-	-	-	-	-	-
Lead	0.05	0.04	-	-	-	119	168	3.04	4.41	0.02	0.01	0.01	0.01
Zinc	307	252	-	-	-	119	168	142	195	2.16	1.77	1.58	1.29

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.39 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-14; Animas River from Eureka to Animas Forks Monitoring Sites A33 and A14.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
pH	7.21	7.21	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	654	654	87.0	7.52	7.52	87.7	87.7	408	408	1.60	1.60	1.60	1.60
Beryllium	1.00	1.00	-	-	-	87.7	87.7	5.35	5.35	0.19	0.19	0.19	0.19
Cadmium	2.16	2.16	-	-	-	87.7	87.7	0.38	0.38	5.62	5.62	5.62	5.62
Copper	18.1	18.1	-	-	-	87.7	87.7	8.01	8.01	2.26	2.26	2.26	2.26
Lead	0.17	0.17	-	-	-	87.7	87.7	2.18	2.18	0.08	0.08	0.08	0.08
Manganese	593	593	-	-	-	87.7	87.7	1579	1579	0.38	0.38	0.38	0.38
Zinc	753	753	-	-	-	87.7	87.7	108	108	7.00	7.00	7.00	7.00
Runoff Hydroperiod													
pH	6.34	6.75	6.50	>1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	1249	957	87.0	14.4	11.0	30.5	35.9	96.2	120	13.0	9.95	10.39	7.96
Beryllium	1.00	1.00	-	-	-	30.5	35.9	0.90	1.19	1.11	1.11	0.84	0.84
Cadmium	2.68	2.24	-	-	-	30.5	35.9	0.17	0.20	15.4	12.9	13.7	11.4
Copper	33.5	15.0	-	-	-	30.5	35.9	3.25	3.74	10.3	4.61	8.97	4.01
Lead	2.14	1.52	-	-	-	30.5	35.9	0.68	0.81	3.16	2.25	2.63	1.87
Manganese	1657	1149	-	-	-	30.5	35.9	1111	1173	1.49	1.03	1.41	0.98
Zinc	742	601	-	-	-	30.5	35.9	41.2	47.8	18.0	14.6	15.5	12.6
Post-runoff Hydroperiod													
pH	3.48	4.31	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	4205	2505	87.0	48.3	28.8	115	133	591	722	7.12	4.24	5.83	3.47
Beryllium	6.55	3.21	-	-	-	115	133	8.42	10.8	0.78	0.38	0.61	0.30
Cadmium	10.4	5.43	-	-	-	115	133	0.47	0.53	22.2	11.5	19.8	10.3
Copper	25.7	16.7	-	-	-	115	133	10.1	11.4	2.55	1.66	2.25	1.46
Lead	11.3	3.48	-	-	-	115	133	2.93	3.43	3.86	1.19	3.30	1.01
Manganese	13600	6399	-	-	-	115	133	1728	1814	7.87	3.70	7.50	3.53
Zinc	2803	1830	-	-	-	115	133	138	157	20.4	13.3	17.8	11.7

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.40 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-15; Lower West Fork Animas River to Confluence with Placer Gulch Monitoring Site A10.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	6.18	6.19	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	1480	1250	87.0	17.0	14.4	30.6	33.3	96.6	108	15.3	12.9	13.7	11.5
Beryllium	1.00	1.00	-	-	-	30.6	33.3	0.91	1.05	1.10	1.10	0.96	0.96
Cadmium	3.02	2.77	-	-	-	30.6	33.3	0.17	0.18	17.4	16.0	16.3	15.0
Copper	16.2	14.1	-	-	-	30.6	33.3	3.26	3.50	4.97	4.32	4.63	4.02
Lead	3.97	3.05	-	-	-	30.6	33.3	0.68	0.75	5.84	4.48	5.31	4.08
Manganese	3100	2557	-	-	-	30.6	33.3	1112	1144	2.79	2.30	2.71	2.24
Zinc	1033	910	-	-	-	30.6	33.3	41.3	44.6	25.0	22.0	23.2	20.4
Post-runoff Hydroperiod													
pH	5.13	5.37	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	8566	6575	87.0	98.5	75.6	127	159	680	919	12.6	9.67	9.32	7.15
Beryllium	10.7	9.24	-	-	-	127	159	10.0	14.5	1.07	0.92	0.74	0.64
Cadmium	11.6	9.50	-	-	-	127	159	0.51	0.60	22.8	18.7	19.3	15.8
Copper	39.4	30.0	-	-	-	127	159	11.0	13.3	3.58	2.73	2.96	2.26
Lead	7.22	5.86	-	-	-	127	159	3.27	4.15	2.21	1.79	1.74	1.41
Manganese	18000	15500	-	-	-	127	159	1788	1924	10.1	8.67	9.36	8.06
Zinc	4560	3473	-	-	-	127	159	151	184	30.2	23.0	24.7	18.8

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.41 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-16; Placer Gulch to Confluence with Upper West Fork Animas River Monitoring Site A20.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	6.95	6.95	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	873	690	87.0	10.0	7.93	33.5	48.3	109	180	7.98	6.31	4.85	3.83
Cadmium	2.81	2.32	-	-	-	33.5	48.3	0.19	0.24	15.1	12.5	11.5	9.47
Copper	19.3	18.5	-	-	-	33.5	48.3	3.52	4.81	5.48	5.24	4.01	3.84
Lead	3.98	3.265	-	-	-	33.5	48.3	0.75	1.13	5.29	4.34	3.52	2.89
Manganese	2320	1582	-	-	-	33.5	48.3	1146	1294	2.02	1.38	1.79	1.22
Zinc	1110	915	-	-	-	33.5	48.3	44.9	62.5	24.7	20.4	17.8	14.6
Post-runoff Hydroperiod													
pH	5.87	6.04	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	1202	921	87.0	13.8	10.6	64.6	92.2	268	437	4.48	3.43	2.75	2.11
Cadmium	3.65	3.08	-	-	-	64.6	92.2	0.31	0.40	11.9	10.1	9.13	7.72
Copper	19.5	16.6	-	-	-	64.6	92.2	6.16	8.35	3.16	2.69	2.33	1.98
Lead	20.3	11.6	-	-	-	64.6	92.2	1.56	2.30	13.0	7.43	8.81	5.03
Manganese	2055	1328	-	-	-	64.6	92.2	1426	1606	1.44	0.93	1.28	0.83
Zinc	1710	1380	-	-	-	64.6	92.2	81.4	113	21.0	16.9	15.2	12.3

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.42 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-17; West Fork Animas River from Placer Gulch Up to its Source Monitoring Site A15.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	5.33	5.53	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	3140	3070	87.0	36.1	35.3	37.2	42.3	126	150	24.9	24.3	20.9	20.4
Beryllium	4.36	3.53	-	-	-	37.2	42.3	1.26	1.57	3.45	2.79	2.78	2.25
Cadmium	3.86	3.71	-	-	-	37.2	42.3	0.20	0.22	19.2	18.4	17.4	16.7
Copper	10.00	9.80	-	-	-	37.2	42.3	3.85	4.29	2.60	2.54	2.33	2.28
Lead	1.82	1.56	-	-	-	37.2	42.3	0.85	0.98	2.15	1.84	1.87	1.59
Manganese	6980	5805	-	-	-	37.2	42.3	1187	1239	5.88	4.89	5.64	4.69
Zinc	1260	1230	-	-	-	37.2	42.3	49.4	55.4	25.5	24.9	22.7	22.2
Post-runoff Hydroperiod													
pH	5.17	5.29	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	13100	9900	87.0	151	114	103	166	508	976	25.8	19.5	13.4	10.1
Beryllium	17.4	14.1	-	-	-	103	166	7.00	15.6	2.49	2.01	1.11	0.90
Cadmium	15.5	11.5	-	-	-	103	166	0.43	0.62	35.8	26.5	25.0	18.5
Copper	36.2	25.8	-	-	-	103	166	9.18	13.8	3.95	2.81	2.63	1.87
Lead	1.58	0.91	-	-	-	103	166	2.60	4.34	0.61	0.35	0.36	0.21
Manganese	29700	22820	-	-	-	103	166	1665	1952	17.8	13.7	15.2	11.7
Zinc	5100	3605	-	-	-	103	166	124	192	41.0	29.0	26.6	18.8

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.43 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-18; North Fork Animas River Burrows Gulch to Animas Forks Monitoring Site A08 and A09.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
pH	4.80	5.38	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	1338	1106	87.0	15.4	12.7	22.0	23.6	61.4	67.5	21.8	18.0	19.8	16.4
Beryllium	1.00	1.00	-	-	-	22.0	23.6	0.52	0.59	1.92	1.92	1.71	1.71
Cadmium	3.30	2.94	-	-	-	22.0	23.6	0.14	0.14	24.4	21.8	23.1	20.6
Copper	7.23	6.52	-	-	-	22.0	23.6	2.46	2.61	2.94	2.65	2.77	2.50
Lead	2.30	1.59	-	-	-	22.0	23.6	0.47	0.51	4.91	3.40	4.54	3.14
Manganese	524	440	-	-	-	22.0	23.6	996	1019	0.53	0.44	0.51	0.43
Zinc	586	523	-	-	-	22.0	23.6	30.6	32.6	19.1	17.1	18.0	16.1
Post-runoff Hydroperiod													
pH	4.74	5.02	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	4529	3514	87.0	52.1	40.4	60.8	77.3	247	343	18.3	14.2	13.2	10.2
Beryllium	1.00	1.00	-	-	-	60.8	77.3	2.89	4.32	0.35	0.35	0.23	0.23
Cadmium	7.77	6.85	-	-	-	60.8	77.3	0.29	0.35	26.6	23.5	22.2	19.6
Copper	21.5	18.6	-	-	-	60.8	77.3	5.86	7.19	3.67	3.18	2.99	2.59
Lead	12.8	7.33	-	-	-	60.8	77.3	1.46	1.90	8.74	5.02	6.71	3.86
Manganese	1862	1505	-	-	-	60.8	77.3	1398	1514	1.33	1.08	1.23	0.99
Zinc	1331	1144	-	-	-	60.8	77.3	77.1	95.9	17.3	14.8	13.9	11.9

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.44 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-19; Burrows Gulch Monitoring Site A07.													
COPEC	**Surface water EPCs (µg/L)**		**Benchmark (µg/L)**	**HQs**		**Hardness (mg/L)**		**Hardness adjusted benchmark (µg/L)**		**Low hardness HQs**		**High hardness HQs**	
	RME	**CTE**		**RME**	**CTE**	**Low**	**Avg.**	**Low**	**Avg.**	**RME**	**CTE**	**RME**	**CTE**
Runoff Hydroperiod													
pH	5.85	5.85	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	3470	3470	87.0	39.9	39.9	25.1	25.1	73.6	73.6	47.1	47.1	47.1	47.1
Beryllium	1.00	1.00	-	-	-	25.1	25.1	0.65	0.65	1.54	1.54	1.54	1.54
Cadmium	6.78	6.78	-	-	-	25.1	25.1	0.15	0.15	45.4	45.4	45.4	45.4
Copper	23.6	23.6	-	-	-	25.1	25.1	2.75	2.8	8.58	8.58	8.58	8.58
Lead	5.27	5.27	-	-	-	25.1	25.1	0.54	0.54	9.69	9.69	9.69	9.69
Manganese	1460	1460	-	-	-	25.1	25.1	1041	1041	1.40	1.40	1.40	1.40
Zinc	1200	1200	-	-	-	25.1	25.1	34.5	34.5	34.8	34.8	34.8	34.8
Post-runoff Hydroperiod													
pH	4.37	4.57	6.50	>1.00	>1.00	-	-	-	-	-	-	-	-
Aluminum	11900	9600	87.0	137	110	31.7	65.5	101	274	118	94.9	43.5	35.1
Beryllium	4.01	3.68	-	-	-	31.7	65.5	0.96	3.27	4.17	3.82	1.23	1.12
Cadmium	19.6	16.2	-	-	-	31.7	65.5	0.18	0.31	110	91.0	63.6	52.6
Copper	69.4	56.4	-	-	-	31.7	65.5	3.35	6.24	20.7	16.8	11.1	9.03
Lead	10.1	7.20	-	-	-	31.7	65.5	0.71	1.58	14.2	10.2	6.35	4.55
Manganese	5980	4490	-	-	-	31.7	65.5	1125	1433	5.32	3.99	4.17	3.13
Zinc	3240	2610	-	-	-	31.7	65.5	42.6	82.5	76.1	61.3	39.3	31.6

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.45 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-DR01; Animas River Upper Durango Reach.													
COPEC	**Surface water EPCs (µg/L)**		**Benchmark (µg/L)**	**HQs**		**Hardness (mg/L)**		**Hardness adjusted benchmark (µg/L)**		**Low hardness HQs**		**High hardness HQs**	
	RME	**CTE**		**RME**	**CTE**	**Low**	**Avg.**	**Low**	**Avg.**	**RME**	**CTE**	**RME**	**CTE**
Pre-runoff Hydroperiod													
Aluminum	2088	890	87.0	24.0	10.2	184	192	1126	1191	1.86	0.79	1.75	0.75
Iron	2900	1487	1000	2.90	2.90	-	-	-	-	-	-	-	-
Mercury (TRM)	0.04	0.04	0.01	4.00	4.00	-	-	-	-	-	-	-	-
Runoff Hydroperiod													
Aluminum	2800	2700	87.0	32.2	31.0	60.2	65.0	244	271	11.5	11.1	10.3	10.0
Iron	4700	4650	1000	4.70	4.70	-	-	-	-	-	-	-	-
Mercury (TRM)	0.008	0.007	0.01	0.75	0.75	-	-	-	-	-	-	-	-
Post-runoff Hydroperiod													
Aluminum	378	279	87.0	4.35	3.20	144	180	803	1094	0.47	0.35	0.35	0.25
Iron	474	370	1000	0.47	0.47	-	-	-	-	-	-	-	-
Mercury (TRM)	0.02	0.02	0.01	2.42	2.42	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

TRM = Total Recoverable Metal

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.46 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in EU-DR02; Animas River Lower Durango Reach.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Pre-runoff Hydroperiod													
pH	6.67	7.34	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	486	435	87.0	5.59	4.99	144	171	805	1016	0.60	0.54	0.48	0.43
Cadmium	0.19	0.13	-	-	-	144	171	0.56	0.64	0.33	0.24	0.29	0.21
Iron	765	654	1000	0.77	0.77	-	-	-	-	-	-	-	-
Mercury (TRM)	0.04	0.04	0.01	4.00	4.00	-	-	-	-	-	-	-	-
Runoff Hydroperiod													
pH	6.00	6.79	6.50	>1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	3798	1473	87.0	43.7	16.9	65.4	81.8	273	371	13.9	5.40	10.25	3.98
Cadmium	0.17	0.13	-	-	-	65.4	81.8	0.31	0.36	0.56	0.44	0.47	0.37
Iron	6923	2525	1000	6.92	6.92	-	-	-	-	-	-	-	-
Mercury (TRM)	0.02	0.01	0.01	1.50	1.50	-	-	-	-	-	-	-	-
Post-runoff Hydroperiod													
pH	6.63	7.54	6.50	<1.00	<1.00	-	-	-	-	-	-	-	-
Aluminum	1374	478	87.0	15.8	5.50	170	189	1008	1164	1.36	0.47	1.18	0.41
Cadmium	0.43	0.20	-	-	-	170	189	0.63	0.68	0.67	0.31	0.62	0.29
Iron	1048	509	1000	1.05	1.05	-	-	-	-	-	-	-	-
Mercury (TRM)	0.04	0.02	0.01	4.00	4.00	-	-	-	-	-	-	-	-

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

TRM = Total Recoverable Metal

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.47 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in Maggie Gulch Reference Exposure Unit Monitoring Site A43.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	372	300	87.0	4.28	3.44	42.5	42.9	151	153	2.46	1.98	2.43	1.96
Post-runoff Hydroperiod													
Aluminum	73.5	41.8	87.0	0.84	0.48	100	118	485	610	0.15	0.09	0.12	0.07

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.48 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in Mill Creek Reference Exposure Unit Monitoring Site M08.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	117	117	87.0	1.34	1.34	24.8	24.8	72.4	72.4	1.62	1.62	1.62	1.62
Beryllium	1.00	1.00	-	-	-	24.8	24.8	0.64	0.64	1.57	1.57	1.57	1.57
Lead	0.83	0.83	-	-	-	24.8	24.8	0.54	0.54	1.55	1.55	1.55	1.55
Post-runoff Hydroperiod													
Aluminum	265	265	87.0	3.05	3.05	56.1	56.1	221	221	1.20	1.20	1.20	1.20
Beryllium	1.00	1.00	-	-	-	56.1	56.1	2.52	2.52	0.40	0.40	0.40	0.40
Lead	0.25	0.25	-	-	-	56.1	56.1	1.33	1.33	0.19	0.19	0.19	0.19

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.49 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in Picayne Gulch Reference Exposure Unit Monitoring Site A26.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	200	200	87.0	2.30	2.30	39.7	39.7	138	138	1.45	1.45	1.45	1.45
Post-runoff Hydroperiod													
Aluminum	81.9	46.0	87.0	0.94	0.53	183	234	1115	1438	0.07	0.04	0.06	0.03

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Table A17.50 Chronic Surface Water Hazard Quotients (HQs) for Aquatic Community-level Receptors in North Fork Animas River Reference Exposure Unit Monitoring Site A05.

COPEC	Surface water EPCs (µg/L)		Benchmark (µg/L)	HQs		Hardness (mg/L)		Hardness adjusted benchmark (µg/L)		Low hardness HQs		High hardness HQs	
	RME	CTE		RME	CTE	Low	Avg.	Low	Avg.	RME	CTE	RME	CTE
Runoff Hydroperiod													
Aluminum	767	415	87.0	8.82	4.77	23.0	24.7	65.3	72.0	11.7	6.35	10.6	5.76
Beryllium	1.00	1.00	-	-	-	23.0	24.7	0.56	0.63	1.78	1.78	1.58	1.58
Cadmium	1.84	1.56	-	-	-	23.0	24.7	0.14	0.15	13.1	11.2	12.5	10.6
Lead	0.75	0.62	-	-	-	23.0	24.7	0.49	0.53	1.53	1.26	1.41	1.16
Zinc	268	231	-	-	-	23.0	24.7	31.9	34.0	8.41	7.24	7.88	6.78
Post-runoff Hydroperiod													
Aluminum	73.5	40.1	87.0	0.84	0.46	28.7	75.1	88.2	330	0.83	0.45	0.22	0.12
Beryllium	1.00	1.00	-	-	-	28.7	75.1	0.81	4.12	1.23	1.23	0.24	0.24
Cadmium	0.82	0.66	-	-	-	28.7	75.1	0.17	0.34	4.95	4.02	2.39	1.94
Lead	0.17	0.09	-	-	-	28.7	75.1	0.63	1.84	0.27	0.14	0.09	0.05
Zinc	142	116	-	-	-	28.7	75.1	38.9	93.4	3.65	2.99	1.52	1.24

µg/L = microgram per liter

mg/L = milligram per liter

CTE = Central Tendency Exposure

COPEC = Contaminant of Potential Ecological Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient (concentration/benchmark). Note that the pH measurement scale is logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

RME = Reasonable Maximum Exposure; represented by the 95% Upper Confidence Level (UCL). If the 95% UCL was greater than the maximum value or could not be calculated, then the RME represents the greatest measurment in samples collected from an exposure unit during the hydroperiod period. RME values for pH represent the lowest pH values measured during each hydroperiod.

Appendix 18

Surface Water pH, Hardness, and Additional Contaminants of Potential Ecological Concern Hazard Quotient Scatter Plots

List of Appendix 18 Figures:

Figure A18-1 Surface Water pH Measurements for Mineral Creek (a) and Animas River (b) Exposure Units (EUs)

Figure A18-2 Surface Water Hardness (CaCO2) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs)

Figure A18-3 Chronic Beryllium (Be) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs)

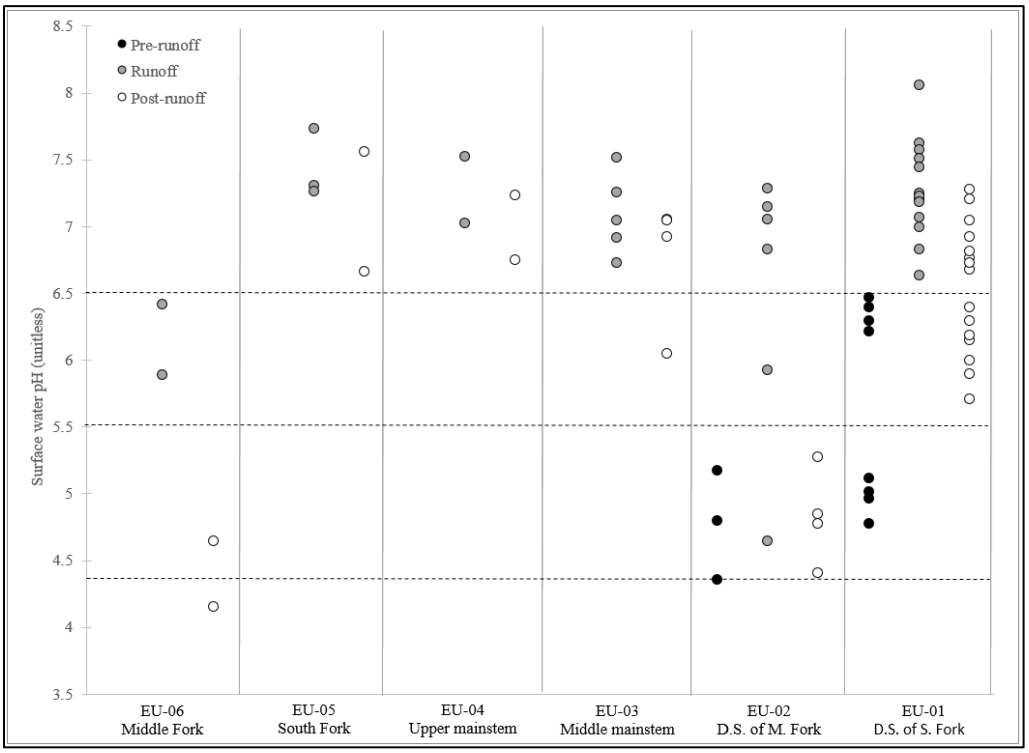
Figure A18-4 Chronic Copper (Cu) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs)

Figure A18-5 Chronic Iron (Fe) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs)

Figure A18-6 Chronic Manganese (Mn) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs)

Figure A18-1 Surface Water pH Measurements for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). The lower 6.5 pH Class 1 cold-water biota physical and biological standard was obtained from CDPHE (2017c). The 5.5 pH threshold corresponded to the lower pH limit for general fish protection, 5.0 pH threshold for mortality of some life stages of certain fish species and reduced primary productivity of freshwater aquatic ecosystems, and 4.4 pH threshold was the lower toxic limit for trout from Robertson-Bryan, Inc (2004).

a)



b)

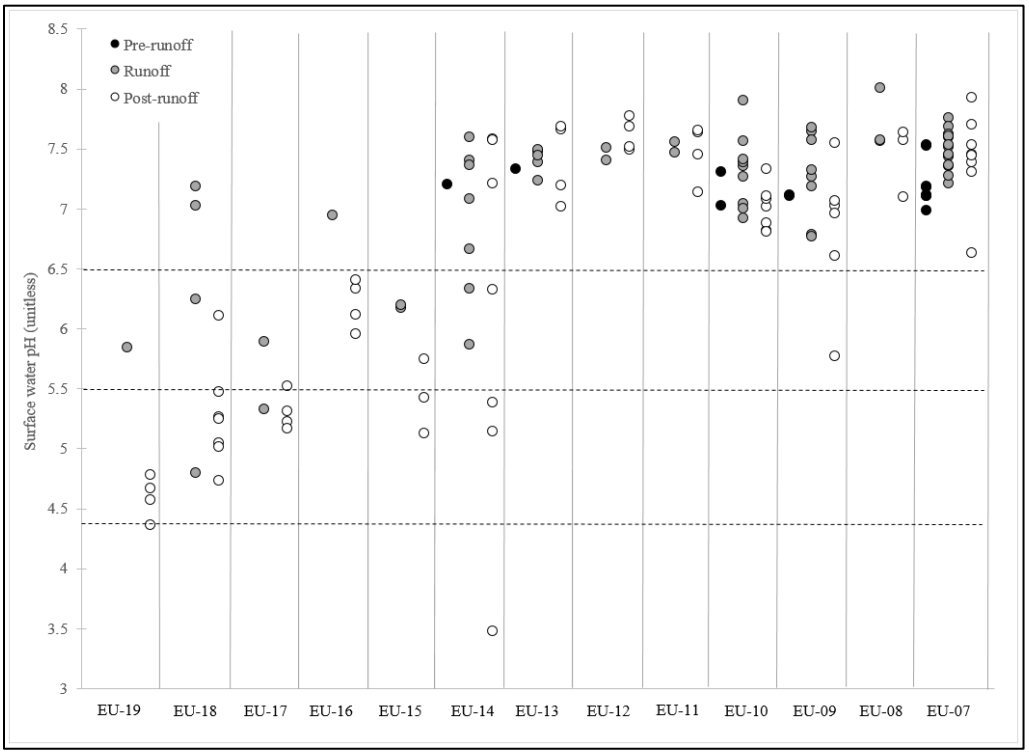
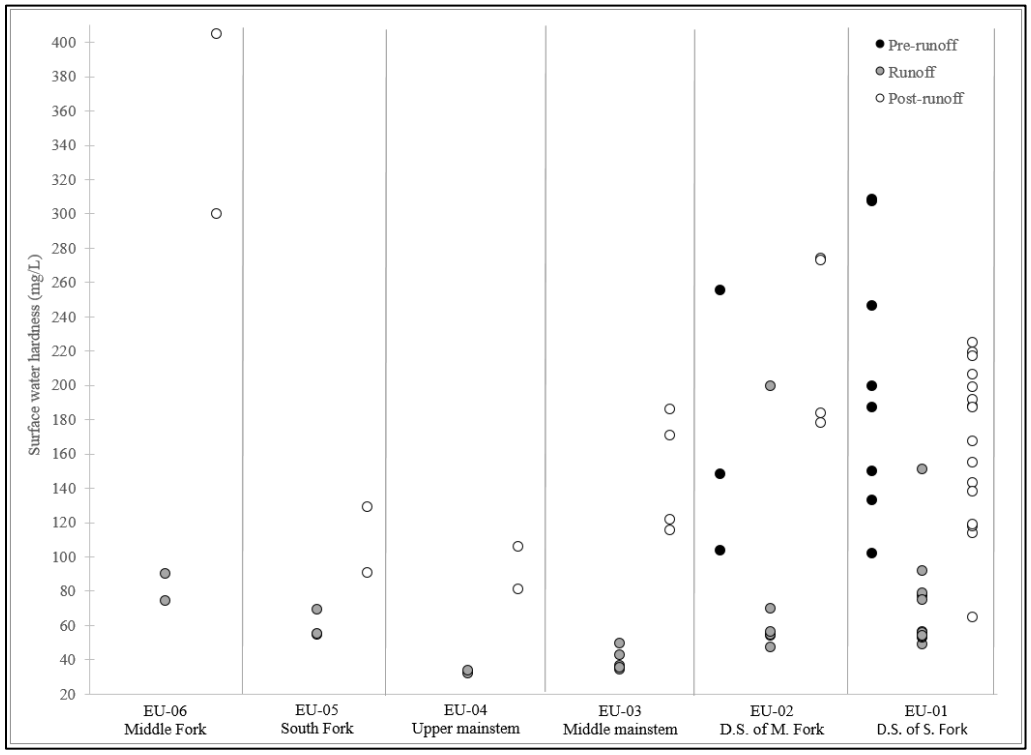


Figure A18-2 Surface Water Hardness ($CaCO_2$) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs).

a)



b)

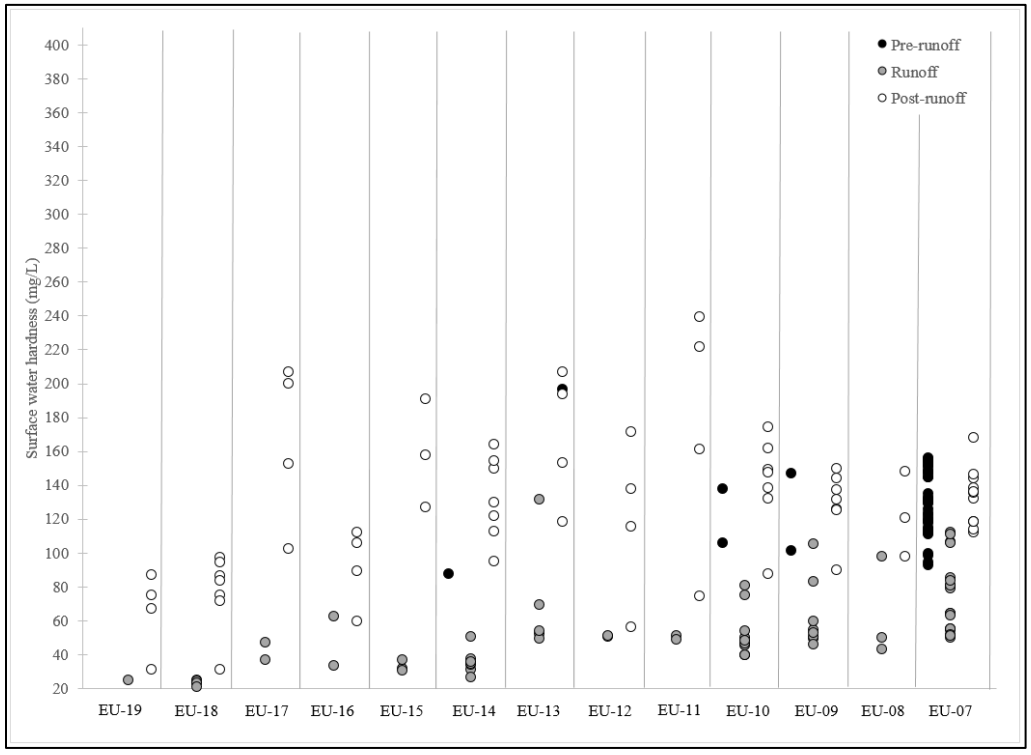
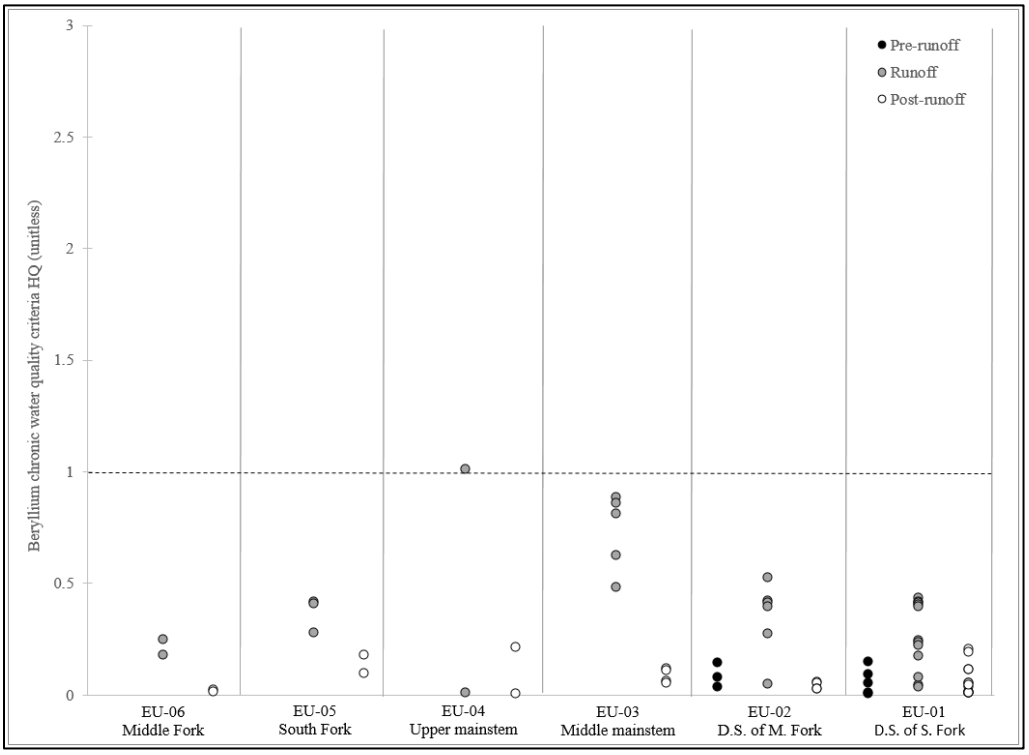


Figure A18-3 Chronic Beryllium (Be) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). Hardness-dependent HQs were derived for each surface water sample collected among the three hydroperiods using MDEQ (2015) chronic water quality criteria. Sampling points that are above the dashed line indicate that Be concentrations were greater than respective chronic criteria; sampling point beneath the dashed line indicate that Be concentrations were less than respective thresholds.

a)



b)

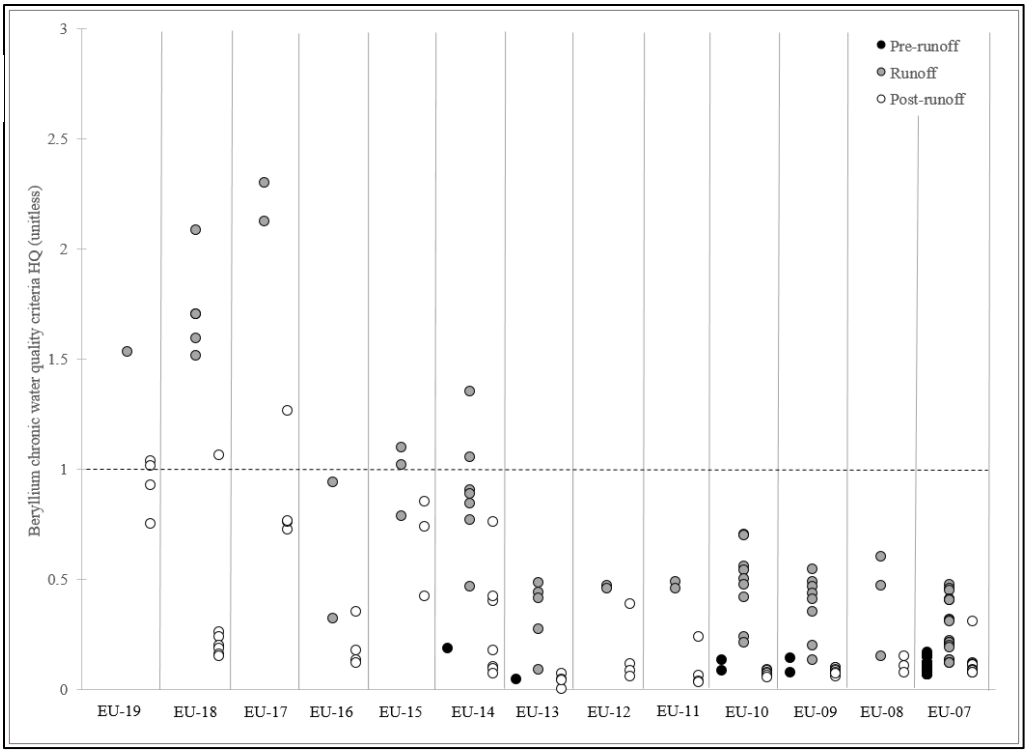
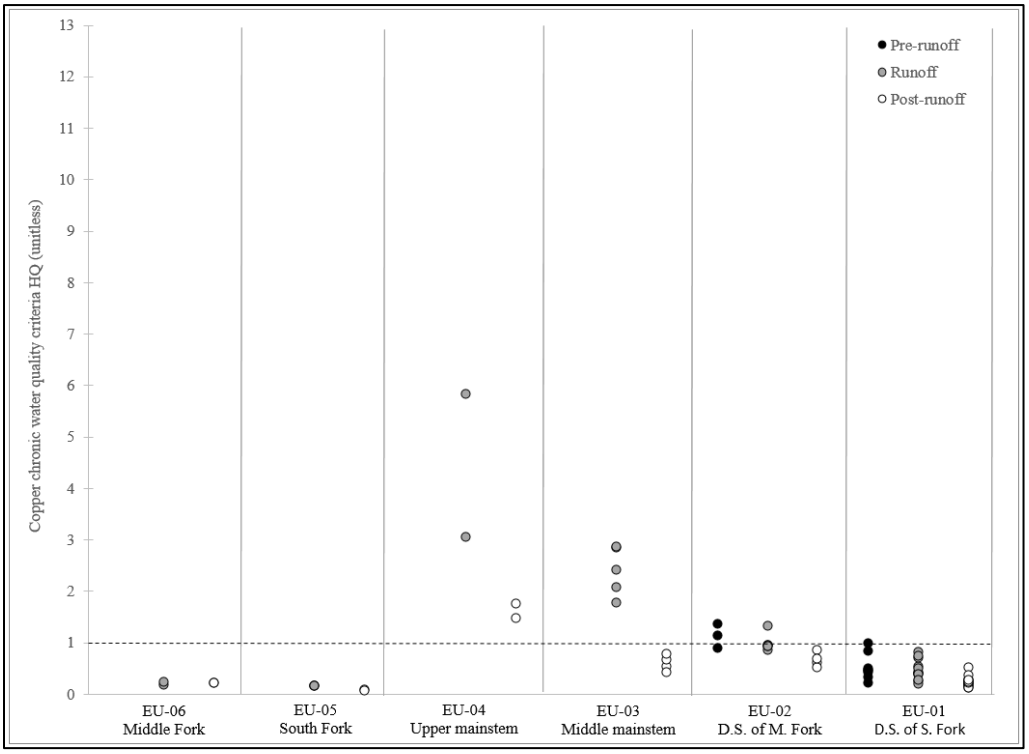


Figure A18-4 Chronic Copper (Cu) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). Hardness-dependent HQs were derived for each surface water sample collected among the three hydroperiods using CDPHE (2017c) chronic water quality criteria. Sampling points that are above the dashed line indicate that Cu concentrations were greater than respective chronic criteria; sampling point beneath the dashed line indicate that Cu concentrations were less than respective thresholds.

a)



b)

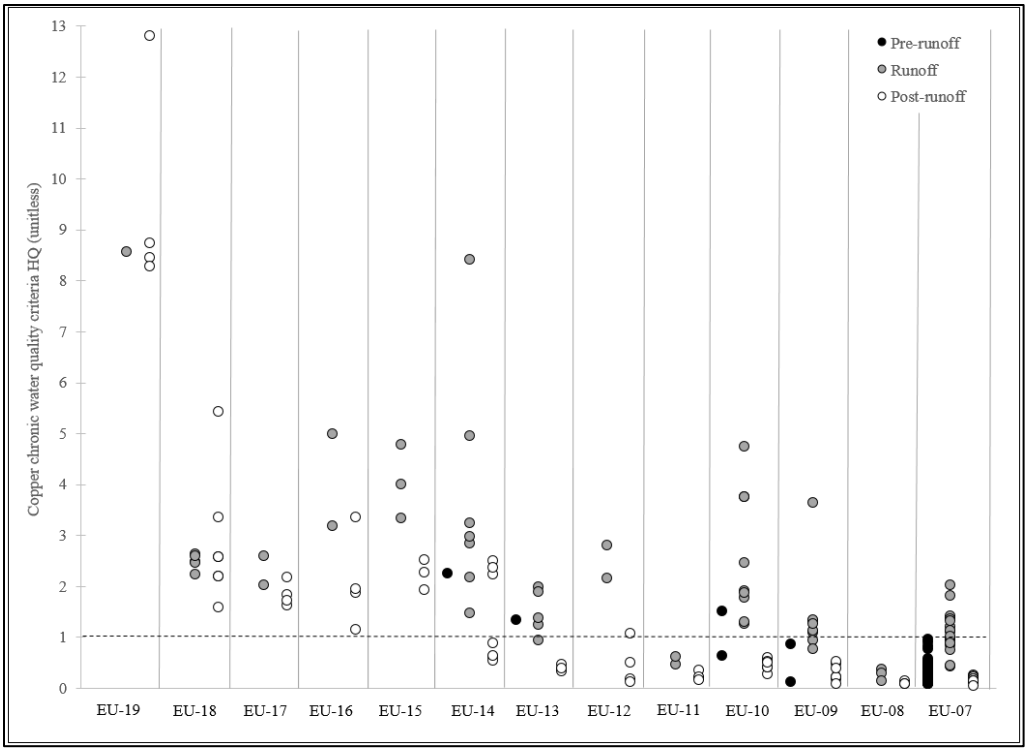
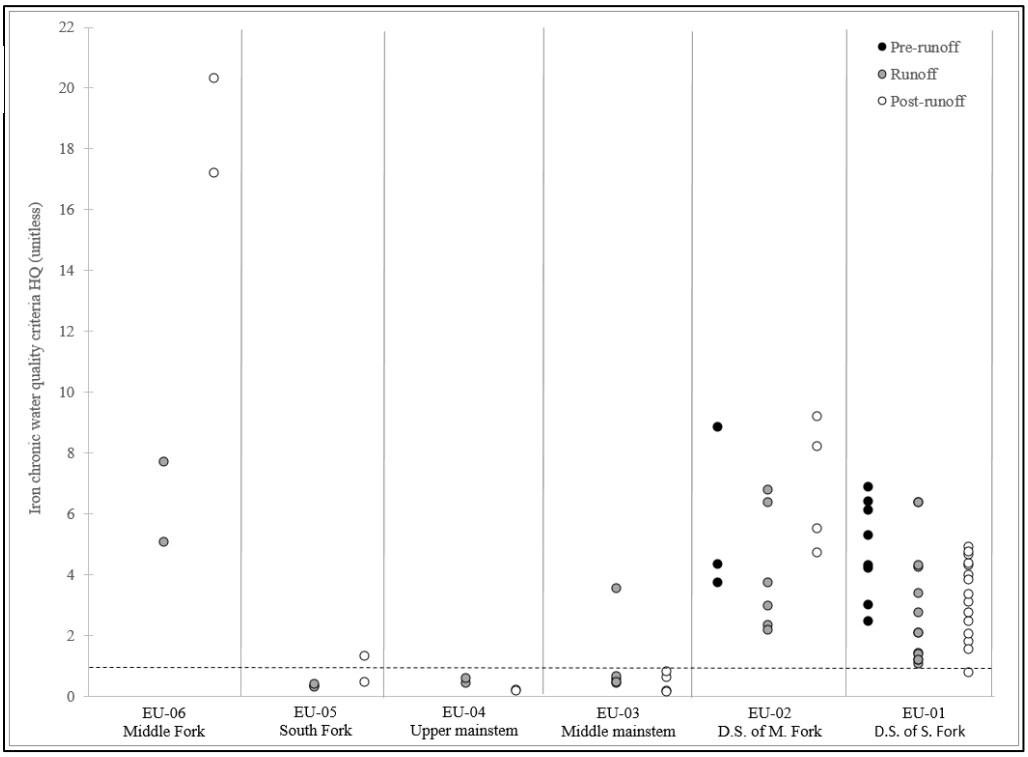


Figure A18-5 Chronic Iron (Fe) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). HQs were derived for each surface water sample collected among the three hydroperiods using CDPHE (2017c) chronic water quality criteria. Sampling points that are above the dashed line indicate that Fe concentrations were greater than respective chronic criteria; sampling point beneath the dashed line indicate that Fe concentrations were less than respective thresholds.

a)



b)

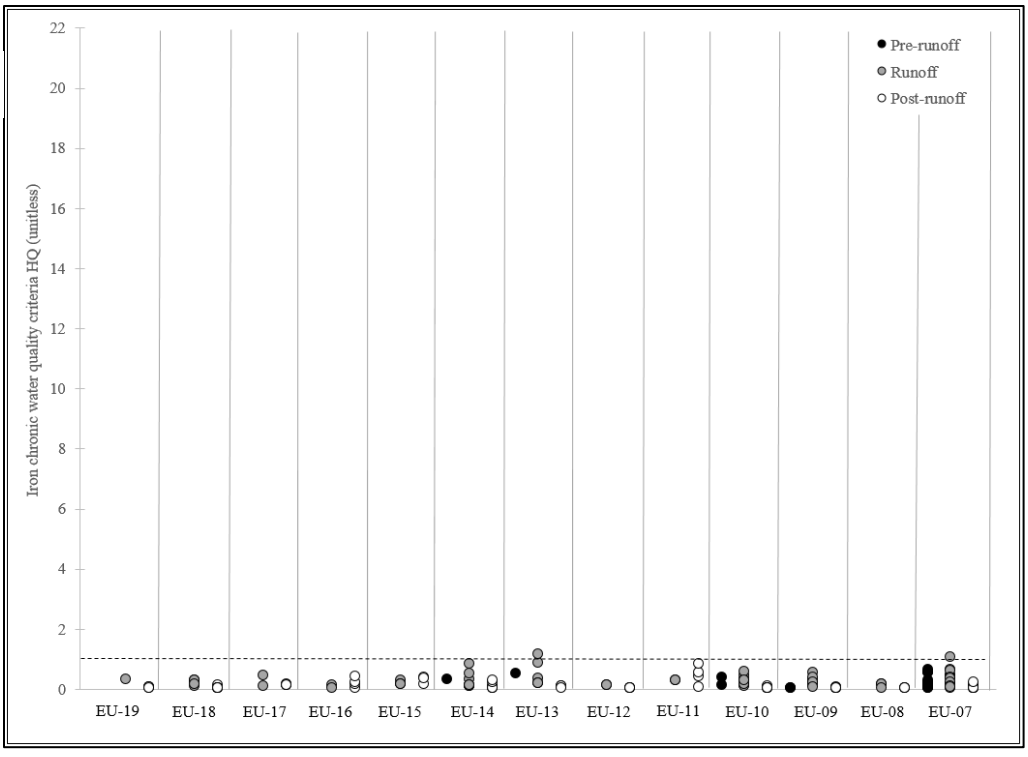
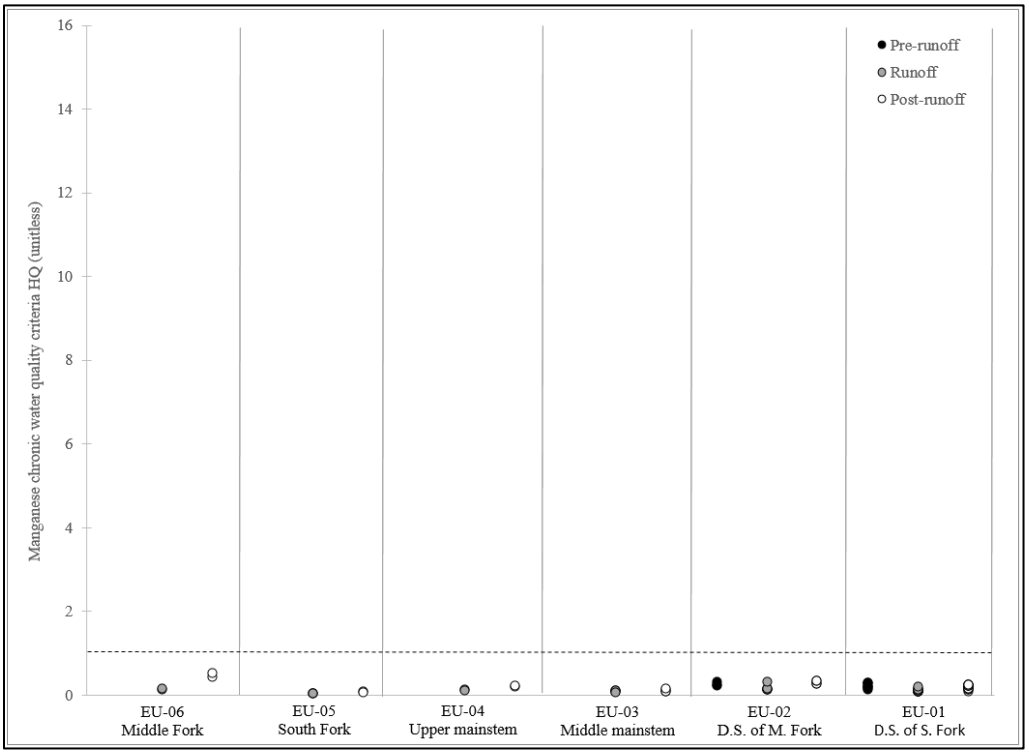
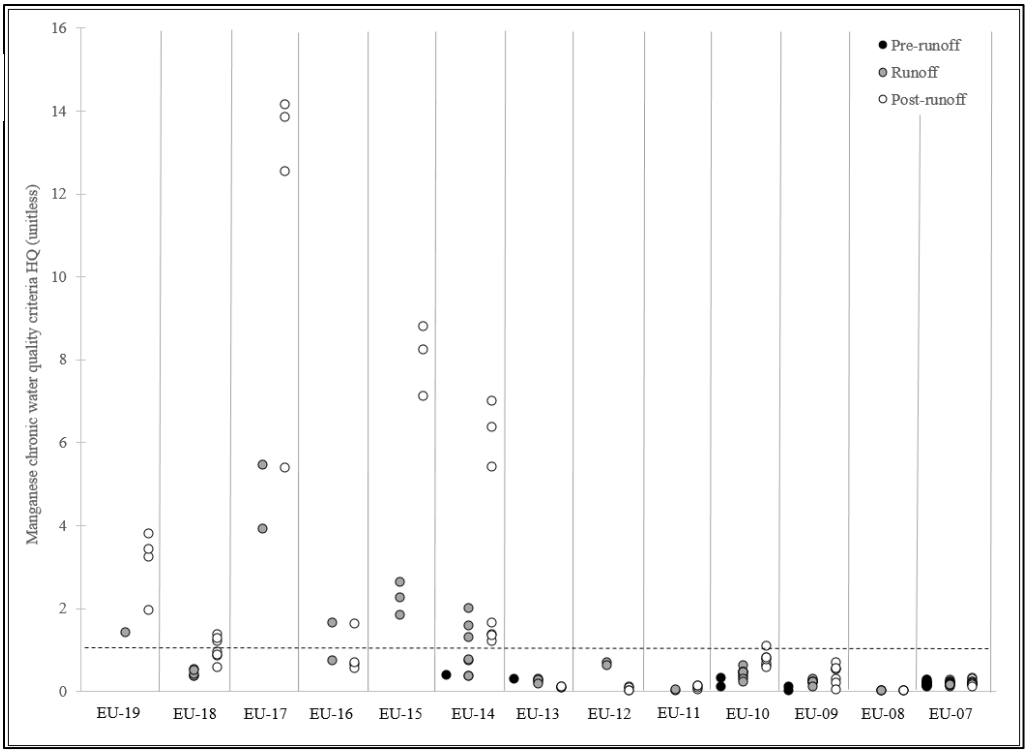


Figure A18-6 Chronic Manganese (Mn) Water Quality Criteria Hazard Quotients (HQs) for Mineral Creek (a) and Animas River (b) Exposure Units (EUs). Hardness-dependent HQs were derived for each surface water sample collected among the three hydroperiods using CDPHE (2017c) chronic water quality criteria. Sampling points that are above the dashed line indicate that Mn concentrations were greater than respective chronic criteria; sampling point beneath the dashed line indicate that Mn concentrations were less than respective thresholds.

a)



b)



Appendix 19

American Dipper Estimated Daily Dose Hazard Quotient Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

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Table A19.2 EU-02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

Table A19.3 EU-03 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

Table A19.4 EU-04 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Mineral Creek Upstream of Mill Creek

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Table A19.24 Reference Exposure Unit Maggie Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Maggie Gulch

Table A19.25 Reference Exposure Unit Mill Creek Estimated Daily Dose (EDDs) Hazard Quotients (HQs) for American Dipper Foraging in Mill Creek

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Table A19.27 Reference Exposure Unit North Fork Animas River Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in North Fork Animas River above Burrows Gulch

Table A19.1 EU-01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Mineral Creek from Animas River to South Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.24E+00	2.24	22.4	0.55	0.06	8.26E-01	2.24	22.4	0.37	0.04
Cadmium	2.21E-01	1.47	14.7	0.15	0.02	1.30E-01	1.47	14.7	0.09	0.01
Chromium	1.04E+00	2.66	26.6	0.39	0.04	5.70E-01	2.66	26.6	0.21	0.02
Copper	1.67E+01	4.05	12.1	4.11	1.38	1.02E+01	4.05	12.1	2.51	0.84
Lead	1.81E+01	1.63	3.26	11.1	5.54	1.08E+01	1.63	3.26	6.61	3.31
Mercury	1.20E-02	0.45	0.90	0.03	0.01	8.14E-03	0.45	0.90	0.02	0.01
Nickel	1.40E-01	6.71	67.1	0.02	0.00	1.17E-01	6.71	67.1	0.02	0.002
Selenium	4.85E-01	0.29	0.58	1.67	0.84	2.54E-01	0.29	0.58	0.88	0.44
Silver	3.68E-02	2.02	20.2	0.02	0.002	2.36E-02	2.02	20.2	0.01	0.001
Zinc	4.58E+01	66.1	661	0.69	0.07	2.96E+01	66.1	661	0.45	0.04

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.2 EU-02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.16E+00	2.24	22.4	0.52	0.05	8.89E-01	2.24	22.4	0.40	0.04
Cadmium	4.29E-02	1.47	14.7	0.03	0.00	3.34E-02	1.47	14.7	0.02	0.00
Chromium	1.53E-01	2.66	26.6	0.06	0.01	1.42E-01	2.66	26.6	0.05	0.01
Copper	2.44E+00	4.05	12.1	0.60	0.20	2.30E+00	4.05	12.1	0.57	0.19
Lead	8.24E+00	1.63	3.26	5.1	2.53	7.31E+00	1.63	3.26	4.49	2.24
Mercury	8.94E-02	0.45	0.90	0.20	0.10	8.88E-02	0.45	0.90	0.20	0.10
Nickel	1.16E-01	6.71	67.1	0.02	0.00	1.06E-01	6.71	67.1	0.02	0.002
Selenium	1.45E-01	0.29	0.58	0.50	0.25	1.38E-01	0.29	0.58	0.48	0.24
Silver	6.66E-02	2.02	20.2	0.03	0.003	6.13E-02	2.02	20.2	0.03	0.003
Zinc	2.76E+01	66.1	661	0.42	0.04	1.69E+01	66.1	661	0.26	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.3 EU-03 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.11E+00	2.24	22.4	0.50	0.05	9.55E-01	2.24	22.4	0.43	0.04
Cadmium	2.33E-01	1.47	14.7	0.16	0.02	1.31E-01	1.47	14.7	0.09	0.01
Chromium	1.68E-01	2.66	26.6	0.06	0.01	1.42E-01	2.66	26.6	0.05	0.01
Copper	6.58E+00	4.05	12.1	1.62	0.54	4.97E+00	4.05	12.1	1.23	0.41
Lead	1.87E+01	1.63	3.26	11.5	5.74	1.12E+01	1.63	3.26	6.90	3.45
Mercury	1.33E-02	0.45	0.90	0.03	0.01	1.04E-02	0.45	0.90	0.02	0.01
Nickel	1.23E-01	6.71	67.1	0.02	0.00	9.38E-02	6.71	67.1	0.01	0.001
Selenium	7.94E-02	0.29	0.58	0.27	0.14	7.10E-02	0.29	0.58	0.24	0.12
Silver	2.91E-02	2.02	20.2	0.01	0.001	2.22E-02	2.02	20.2	0.01	0.001
Zinc	6.88E+01	66.1	661	1.04	0.10	4.40E+01	66.1	661	0.67	0.07

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.4 EU-04 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Mineral Creek Upstream of Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	3.26E+00	2.24	22.4	1.46	0.15	2.67E+00	2.24	22.4	1.19	0.12
Cadmium	2.88E-01	1.47	14.7	0.20	0.02	2.05E-01	1.47	14.7	0.14	0.01
Chromium	1.20E-01	2.66	26.6	0.05	0.005	1.10E-01	2.66	26.6	0.04	0.004
Copper	1.81E+01	4.05	12.1	4.46	1.49	1.57E+01	4.05	12.1	3.87	1.30
Lead	6.25E+01	1.63	3.26	38.3	19.2	5.26E+01	1.63	3.26	32.2	16.1
Mercury	1.48E-02	0.45	0.90	0.03	0.02	1.23E-02	0.45	0.90	0.03	0.01
Nickel	1.93E-01	6.71	67.1	0.03	0.00	1.34E-01	6.71	67.1	0.02	0.00
Selenium	4.39E-02	0.29	0.58	0.15	0.08	4.39E-02	0.29	0.58	0.15	0.08
Silver	7.46E-02	2.02	20.2	0.04	0.004	7.46E-02	2.02	20.2	0.04	0.004
Zinc	1.23E+02	66.1	661	1.87	0.19	1.21E+02	66.1	661	1.83	0.18

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.5 EU-05 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in South Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.18E-01	2.24	22.4	0.14	0.01	2.81E-01	2.24	22.4	0.13	0.01
Cadmium	7.33E-02	1.47	14.7	0.05	0.00	4.82E-02	1.47	14.7	0.03	0.00
Chromium	1.95E-01	2.66	26.6	0.07	0.01	1.70E-01	2.66	26.6	0.06	0.01
Copper	1.73E+00	4.05	12.1	0.43	0.14	1.37E+00	4.05	12.1	0.34	0.11
Lead	2.15E+00	1.63	3.26	1.32	0.66	1.74E+00	1.63	3.26	1.07	0.53
Mercury	1.72E-02	0.45	0.90	0.04	0.02	1.27E-02	0.45	0.90	0.03	0.01
Nickel	3.59E-01	6.71	67.1	0.05	0.01	2.50E-01	6.71	67.1	0.04	0.004
Selenium	1.29E-01	0.29	0.58	0.44	0.22	1.14E-01	0.29	0.58	0.39	0.20
Silver	2.27E-02	2.02	20.2	0.01	0.001	1.42E-02	2.02	20.2	0.01	0.001
Zinc	2.28E+01	66.1	661	0.34	0.03	1.62E+01	66.1	661	0.24	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.6 EU-06 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Middle Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.06E+00	2.24	22.4	0.47	0.05	8.97E-01	2.24	22.4	0.40	0.04
Cadmium	7.66E-02	1.47	14.7	0.05	0.01	6.08E-02	1.47	14.7	0.04	0.00
Chromium	3.67E-01	2.66	26.6	0.14	0.01	3.44E-01	2.66	26.6	0.13	0.01
Copper	3.95E+00	4.05	12.1	0.98	0.33	3.23E+00	4.05	12.1	0.80	0.27
Lead	2.85E+00	1.63	3.26	1.75	0.87	2.44E+00	1.63	3.26	1.50	0.75
Mercury	2.57E-02	0.45	0.90	0.06	0.03	2.49E-02	0.45	0.90	0.06	0.03
Nickel	1.27E-01	6.71	67.1	0.02	0.00	9.18E-02	6.71	67.1	0.01	0.001
Selenium	2.91E-01	0.29	0.58	1.00	0.50	2.59E-01	0.29	0.58	0.89	0.45
Silver	3.10E-02	2.02	20.2	0.02	0.002	2.10E-02	2.02	20.2	0.01	0.001
Zinc	1.18E+01	66.1	661	0.18	0.02	1.10E+01	66.1	661	0.17	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.7 EU-07 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	3.71E+00	2.24	22.4	1.66	0.17	1.09E+00	2.24	22.4	0.49	0.05
Cadmium	1.68E+00	1.47	14.7	1.15	0.11	6.26E-01	1.47	14.7	0.43	0.04
Chromium	7.80E-01	2.66	26.6	0.29	0.03	4.69E-01	2.66	26.6	0.18	0.02
Copper	3.07E+01	4.05	12.1	7.58	2.54	1.29E+01	4.05	12.1	3.18	1.07
Lead	9.58E+01	1.63	3.26	58.8	29.4	3.75E+01	1.63	3.26	23.0	11.5
Mercury	1.09E-02	0.45	0.90	0.02	0.01	8.88E-03	0.45	0.90	0.02	0.01
Nickel	2.29E-01	6.71	67.1	0.03	0.00	1.79E-01	6.71	67.1	0.03	0.003
Selenium	3.24E-01	0.29	0.58	1.12	0.56	2.19E-01	0.29	0.58	0.75	0.38
Silver	1.26E-01	2.02	20.2	0.06	0.01	9.87E-02	2.02	20.2	0.05	0.005
Zinc	4.38E+02	66.1	661	6.63	0.66	1.72E+02	66.1	661	2.60	0.26

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.8 EU-08 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Cunningham Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	2.85E-01	2.24	22.4	0.13	0.01	2.33E-01	2.24	22.4	0.10	0.01
Cadmium	2.86E-01	1.47	14.7	0.19	0.02	2.74E-01	1.47	14.7	0.19	0.02
Chromium	1.66E-01	2.66	26.6	0.06	0.01	1.53E-01	2.66	26.6	0.06	0.01
Copper	7.01E+00	4.05	12.1	1.73	0.58	6.35E+00	4.05	12.1	1.57	0.52
Lead	1.27E+01	1.63	3.26	7.79	3.89	9.25E+00	1.63	3.26	5.68	2.84
Mercury	9.39E-03	0.45	0.90	0.02	0.01	9.04E-03	0.45	0.90	0.02	0.01
Nickel	9.42E-02	6.71	67.1	0.01	0.00	8.07E-02	6.71	67.1	0.01	0.001
Selenium	1.88E-01	0.29	0.58	0.65	0.33	1.48E-01	0.29	0.58	0.51	0.26
Silver	7.89E-02	2.02	20.2	0.04	0.004	7.08E-02	2.02	20.2	0.04	0.004
Zinc	3.25E+01	66.1	661	0.49	0.05	3.11E+01	66.1	661	0.47	0.05

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.9 EU-09 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in the Animas River from Howardsville to Minnie Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	7.66E-01	2.24	22.4	0.34	0.03	6.20E-01	2.24	22.4	0.28	0.03
Cadmium	8.50E-01	1.47	14.7	0.58	0.06	5.76E-01	1.47	14.7	0.39	0.04
Chromium	3.76E-01	2.66	26.6	0.14	0.01	2.71E-01	2.66	26.6	0.10	0.01
Copper	1.86E+01	4.05	12.1	4.59	1.54	1.31E+01	4.05	12.1	3.24	1.09
Lead	3.80E+01	1.63	3.26	23.3	11.7	2.99E+01	1.63	3.26	18.3	9.16
Mercury	1.63E-02	0.45	0.90	0.04	0.02	1.22E-02	0.45	0.90	0.03	0.01
Nickel	2.63E-01	6.71	67.1	0.04	0.00	2.06E-01	6.71	67.1	0.03	0.003
Selenium	9.17E-02	0.29	0.58	0.32	0.16	8.15E-02	0.29	0.58	0.28	0.14
Silver	1.39E-01	2.02	20.2	0.07	0.01	1.09E-01	2.02	20.2	0.05	0.01
Zinc	1.63E+02	66.1	661	2.47	0.25	1.13E+02	66.1	661	1.71	0.17

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.10 EU-10 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in the Animas River from Minnie Gulch to Eureka

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.03E+00	2.24	22.4	0.46	0.05	9.34E-01	2.24	22.4	0.42	0.04
Cadmium	7.79E-01	1.47	14.7	0.53	0.05	4.87E-01	1.47	14.7	0.33	0.03
Chromium	1.88E-01	2.66	26.6	0.07	0.01	1.82E-01	2.66	26.6	0.07	0.01
Copper	1.89E+01	4.05	12.1	4.65	1.56	1.42E+01	4.05	12.1	3.51	1.17
Lead	3.54E+01	1.63	3.26	21.7	10.9	2.71E+01	1.63	3.26	16.6	8.30
Mercury	1.15E-02	0.45	0.90	0.03	0.01	1.03E-02	0.45	0.90	0.02	0.01
Nickel	2.98E-01	6.71	67.1	0.04	0.00	2.29E-01	6.71	67.1	0.03	0.003
Selenium	1.25E-01	0.29	0.58	0.43	0.22	7.82E-02	0.29	0.58	0.27	0.14
Silver	4.50E-01	2.02	20.2	0.22	0.02	1.75E-01	2.02	20.2	0.09	0.01
Zinc	1.42E+02	66.1	661	2.15	0.22	9.95E+01	66.1	661	1.51	0.15

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.11 EU-11 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	7.34E-01	2.24	22.4	0.33	0.03	5.17E-01	2.24	22.4	0.23	0.02
Cadmium	4.83E-02	1.47	14.7	0.03	0.00	4.13E-02	1.47	14.7	0.03	0.00
Chromium	1.63E-01	2.66	26.6	0.06	0.01	1.50E-01	2.66	26.6	0.06	0.01
Copper	2.28E+00	4.05	12.1	0.56	0.19	1.94E+00	4.05	12.1	0.48	0.16
Lead	5.64E+00	1.63	3.26	3.46	1.73	3.70E+00	1.63	3.26	2.27	1.14
Mercury	8.52E-03	0.45	0.90	0.02	0.01	8.49E-03	0.45	0.90	0.02	0.01
Nickel	2.08E-01	6.71	67.1	0.03	0.003	1.61E-01	6.71	67.1	0.02	0.002
Selenium	1.31E-01	0.29	0.58	0.45	0.23	1.13E-01	0.29	0.58	0.39	0.20
Silver	3.26E-02	2.02	20.2	0.02	0.002	2.59E-02	2.02	20.2	0.01	0.001
Zinc	1.63E+01	66.1	661	0.25	0.02	1.39E+01	66.1	661	0.21	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.12 EU-12 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Eureka Gulch Up to Confluence with Upper South Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.16E-01	2.24	22.4	0.23	0.02	3.83E-01	2.24	22.4	0.17	0.02
Cadmium	4.51E-01	1.47	14.7	0.31	0.03	3.84E-01	1.47	14.7	0.26	0.03
Chromium	1.70E-01	2.66	26.6	0.06	0.01	1.57E-01	2.66	26.6	0.06	0.01
Copper	1.57E+01	4.05	12.1	3.87	1.29	1.43E+01	4.05	12.1	3.52	1.18
Lead	1.82E+01	1.63	3.26	11.2	5.60	1.56E+01	1.63	3.26	9.56	4.78
Mercury	8.99E-03	0.45	0.90	0.02	0.01	8.76E-03	0.45	0.90	0.02	0.01
Nickel	2.59E-01	6.71	67.1	0.04	0.004	2.34E-01	6.71	67.1	0.03	0.003
Selenium	1.07E-01	0.29	0.58	0.37	0.18	7.09E-02	0.29	0.58	0.24	0.12
Silver	9.73E-02	2.02	20.2	0.05	0.005	6.88E-02	2.02	20.2	0.03	0.003
Zinc	1.12E+02	66.1	661	1.69	0.17	8.71E+01	66.1	661	1.32	0.13

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.13 EU-13 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Mainstem South Fork Animas River Up to Confluence

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	7.70E-01	2.24	22.4	0.34	0.03	5.72E-01	2.24	22.4	0.26	0.03
Cadmium	4.16E-01	1.47	14.7	0.28	0.03	4.08E-01	1.47	14.7	0.28	0.03
Chromium	2.40E-01	2.66	26.6	0.09	0.01	2.27E-01	2.66	26.6	0.09	0.01
Copper	9.71E+00	4.05	12.1	2.40	0.80	9.44E+00	4.05	12.1	2.33	0.78
Lead	1.48E+01	1.63	3.26	9.11	4.55	1.27E+01	1.63	3.26	7.77	3.89
Mercury	2.63E-02	0.45	0.90	0.06	0.03	2.17E-02	0.45	0.90	0.05	0.02
Nickel	3.30E-01	6.71	67.1	0.05	0.005	2.93E-01	6.71	67.1	0.04	0.004
Selenium	1.29E-01	0.29	0.58	0.44	0.22	9.37E-02	0.29	0.58	0.32	0.16
Silver	6.04E-02	2.02	20.2	0.03	0.003	5.03E-02	2.02	20.2	0.02	0.002
Zinc	1.03E+02	66.1	661	1.56	0.16	9.49E+01	66.1	661	1.44	0.14

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.14 EU-14 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in the Animas River from Eureka to Animas Forks

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.07E+00	2.24	22.4	0.48	0.05	8.50E-01	2.24	22.4	0.38	0.04
Cadmium	3.48E-01	1.47	14.7	0.24	0.02	2.97E-01	1.47	14.7	0.20	0.02
Chromium	1.49E-01	2.66	26.6	0.06	0.01	1.41E-01	2.66	26.6	0.05	0.01
Copper	1.27E+01	4.05	12.1	3.13	1.05	1.04E+01	4.05	12.1	2.56	0.86
Lead	2.35E+01	1.63	3.26	14.4	7.22	1.81E+01	1.63	3.26	11.1	5.54
Mercury	2.01E-02	0.45	0.90	0.04	0.02	1.95E-02	0.45	0.90	0.04	0.02
Nickel	1.63E-01	6.71	67.1	0.02	0.002	1.32E-01	6.71	67.1	0.02	0.002
Selenium	4.52E-02	0.29	0.58	0.16	0.08	3.95E-02	0.29	0.58	0.14	0.07
Silver	1.00E-01	2.02	20.2	0.05	0.005	7.63E-02	2.02	20.2	0.04	0.004
Zinc	7.56E+01	66.1	661	1.14	0.11	5.67E+01	66.1	661	0.86	0.09

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.15 EU-15 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.23E+00	2.24	22.4	1.00	0.10	1.79E+00	2.24	22.4	0.80	0.08
Cadmium	4.68E-01	1.47	14.7	0.32	0.03	3.39E-01	1.47	14.7	0.23	0.02
Chromium	5.91E-01	2.66	26.6	0.22	0.02	5.27E-01	2.66	26.6	0.20	0.02
Copper	7.76E+01	4.05	12.1	19.2	6.41	4.95E+01	4.05	12.1	12.2	4.09
Lead	4.93E+01	1.63	3.26	30.3	15.1	3.37E+01	1.63	3.26	20.7	10.3
Mercury	7.75E-02	0.45	0.90	0.17	0.09	6.06E-02	0.45	0.90	0.13	0.07
Nickel	3.84E-01	6.71	67.1	0.06	0.01	2.90E-01	6.71	67.1	0.04	0.004
Selenium	1.62E-01	0.29	0.58	0.56	0.28	1.06E-01	0.29	0.58	0.37	0.18
Silver	3.05E-01	2.02	20.2	0.15	0.02	1.73E-01	2.02	20.2	0.09	0.01
Zinc	9.19E+01	66.1	661	1.39	0.14	5.96E+01	66.1	661	0.90	0.09

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.16 EU-16 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Placer Gulch to Confluence with Upper West Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.25E+00	2.24	22.4	0.56	0.06	1.03E+00	2.24	22.4	0.46	0.05
Cadmium	1.19E+00	1.47	14.7	0.81	0.08	7.08E-01	1.47	14.7	0.48	0.05
Chromium	2.46E-01	2.66	26.6	0.09	0.01	2.32E-01	2.66	26.6	0.09	0.01
Copper	3.34E+01	4.05	12.1	8.25	2.76	2.23E+01	4.05	12.1	5.51	1.84
Lead	1.61E+02	1.63	3.26	98.9	49.5	1.17E+02	1.63	3.26	71.7	35.8
Mercury	1.51E-01	0.45	0.90	0.34	0.17	1.46E-01	0.45	0.90	0.32	0.16
Nickel	3.84E-01	6.71	67.1	0.06	0.01	2.53E-01	6.71	67.1	0.04	0.004
Selenium	2.43E-01	0.29	0.58	0.84	0.42	2.02E-01	0.29	0.58	0.70	0.35
Silver	4.76E-01	2.02	20.2	0.24	0.02	3.03E-01	2.02	20.2	0.15	0.02
Zinc	3.88E+02	66.1	661	5.87	0.59	1.58E+02	66.1	661	2.40	0.24

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.17 EU-17 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Upper West Fork Animas River from Placer Gulch Up to its Source

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.11E+00	2.24	22.4	0.94	0.09	1.63E+00	2.24	22.4	0.73	0.07
Cadmium	1.92E-01	1.47	14.7	0.13	0.01	1.50E-01	1.47	14.7	0.10	0.01
Chromium	7.73E-01	2.66	26.6	0.29	0.03	6.32E-01	2.66	26.6	0.24	0.02
Copper	4.51E+01	4.05	12.1	11.1	3.72	3.14E+01	4.05	12.1	7.75	2.59
Lead	8.38E+00	1.63	3.26	5.14	2.57	6.19E+00	1.63	3.26	3.80	1.90
Mercury	3.18E-02	0.45	0.90	0.07	0.04	3.00E-02	0.45	0.90	0.07	0.03
Nickel	5.83E-01	6.71	67.1	0.09	0.01	3.87E-01	6.71	67.1	0.06	0.006
Selenium	3.31E-01	0.29	0.58	1.14	0.57	1.75E-01	0.29	0.58	0.60	0.30
Silver	1.07E-01	2.02	20.2	0.05	0.01	6.25E-02	2.02	20.2	0.03	0.00
Zinc	3.89E+01	66.1	661	0.59	0.06	3.39E+01	66.1	661	0.51	0.05

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.18 EU-18 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.90E+00	2.24	22.4	1.30	0.13	2.20E+00	2.24	22.4	0.98	0.10
Cadmium	3.77E-01	1.47	14.7	0.26	0.03	3.22E-01	1.47	14.7	0.22	0.02
Chromium	4.97E-01	2.66	26.6	0.19	0.02	4.55E-01	2.66	26.6	0.17	0.02
Copper	1.64E+01	4.05	12.1	4.04	1.35	1.38E+01	4.05	12.1	3.41	1.14
Lead	1.20E+01	1.63	3.26	7.34	3.67	9.10E+00	1.63	3.26	5.59	2.79
Mercury	3.98E-02	0.45	0.90	0.09	0.04	2.88E-02	0.45	0.90	0.06	0.03
Nickel	2.97E-01	6.71	67.1	0.04	0.00	2.54E-01	6.71	67.1	0.04	0.004
Selenium	7.14E-01	0.29	0.58	2.46	1.23	1.74E-01	0.29	0.58	0.60	0.30
Silver	1.03E-01	2.02	20.2	0.05	0.01	7.20E-02	2.02	20.2	0.04	0.004
Zinc	5.59E+01	66.1	661	0.85	0.08	4.17E+01	66.1	661	0.63	0.06

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.19 EU-19 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Burrows Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.15E+00	2.24	22.4	0.52	0.05	1.04E+00	2.24	22.4	0.46	0.05
Cadmium	1.92E-01	1.47	14.7	0.13	0.01	1.80E-01	1.47	14.7	0.12	0.01
Chromium	1.27E-01	2.66	26.6	0.05	0.005	1.09E-01	2.66	26.6	0.04	0.004
Copper	6.75E+00	4.05	12.1	1.67	0.56	6.40E+00	4.05	12.1	1.58	0.53
Lead	1.24E+01	1.63	3.26	7.60	3.80	1.02E+01	1.63	3.26	6.27	3.13
Mercury	4.22E-02	0.45	0.90	0.09	0.05	4.19E-02	0.45	0.90	0.09	0.05
Nickel	1.50E-01	6.71	67.1	0.02	0.002	1.29E-01	6.71	67.1	0.02	0.002
Selenium	7.54E-02	0.29	0.58	0.26	0.13	6.37E-02	0.29	0.58	0.22	0.11
Silver	9.03E-02	2.02	20.2	0.04	0.004	7.93E-02	2.02	20.2	0.04	0.004
Zinc	2.22E+01	66.1	661	0.34	0.03	1.96E+01	66.1	661	0.30	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.20 EU-DR01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	9.23E-01	2.24	22.4	0.41	0.04	6.03E-01	2.24	22.4	0.27	0.03
Cadmium	4.02E-01	1.47	14.7	0.27	0.03	3.08E-01	1.47	14.7	0.21	0.02
Chromium	1.49E+01	2.66	26.6	5.59	0.56	5.63E+00	2.66	26.6	2.12	0.21
Copper	1.34E+01	4.05	12.1	3.30	1.11	9.33E+00	4.05	12.1	2.30	0.77
Lead	1.07E+01	1.63	3.26	6.58	3.29	6.64E+00	1.63	3.26	4.07	2.04
Mercury	1.38E-01	0.45	0.90	0.31	0.15	5.32E-02	0.45	0.90	0.12	0.06
Nickel	7.57E+00	6.71	67.1	1.13	0.11	2.92E+00	6.71	67.1	0.44	0.04
Selenium	1.47E+00	0.29	0.58	5.06	2.53	6.11E-01	0.29	0.58	2.11	1.05
Silver	7.19E-01	2.02	20.2	0.36	0.04	2.85E-01	2.02	20.2	0.14	0.01
Zinc	1.06E+02	66.1	661	1.61	0.16	8.82E+01	66.1	661	1.33	0.13

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.21 EU-DR02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	4.89E-01	2.24	22.4	0.22	0.02	4.74E-01	2.24	22.4	0.21	0.02
Cadmium	1.44E-01	1.47	14.7	0.10	0.01	1.36E-01	1.47	14.7	0.09	0.01
Chromium	5.95E-01	2.66	26.6	0.22	0.02	5.75E-01	2.66	26.6	0.22	0.02
Copper	6.38E+00	4.05	12.1	1.57	0.53	6.20E+00	4.05	12.1	1.53	0.51
Lead	4.55E+00	1.63	3.26	2.79	1.40	4.15E+00	1.63	3.26	2.54	1.27
Mercury	5.99E-03	0.45	0.90	0.01	0.01	5.77E-03	0.45	0.90	0.01	0.01
Nickel	6.20E-01	6.71	67.1	0.09	0.01	5.95E-01	6.71	67.1	0.09	0.01
Selenium	2.10E-01	0.29	0.58	0.73	0.36	1.82E-01	0.29	0.58	0.63	0.31
Silver	4.66E-02	2.02	20.2	0.02	0.002	4.36E-02	2.02	20.2	0.02	0.002
Zinc	8.78E+01	66.1	661	1.33	0.13	8.58E+01	66.1	661	1.30	0.13

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.22 Reference Exposure Unit Bear Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Bear Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.09E-01	2.24	22.4	0.14	0.01	2.72E-01	2.24	22.4	0.12	0.01
Cadmium	6.83E-02	1.47	14.7	0.05	0.005	6.60E-02	1.47	14.7	0.04	0.004
Chromium	1.49E-01	2.66	26.6	0.06	0.01	1.48E-01	2.66	26.6	0.06	0.01
Copper	1.36E+00	4.05	12.1	0.34	0.11	1.32E+00	4.05	12.1	0.33	0.11
Lead	1.18E+00	1.63	3.26	0.73	0.36	9.77E-01	1.63	3.26	0.60	0.30
Mercury	8.83E-03	0.45	0.90	0.02	0.01	8.82E-03	0.45	0.90	0.02	0.01
Nickel	1.71E-01	6.71	67.1	0.03	0.003	1.66E-01	6.71	67.1	0.02	0.002
Selenium	2.20E-01	0.29	0.58	0.76	0.38	2.17E-01	0.29	0.58	0.75	0.38
Silver	7.81E-03	2.02	20.2	0.004	0.0004	6.88E-03	2.02	20.2	0.003	0.0003
Zinc	1.56E+01	66.1	661	0.24	0.02	1.55E+01	66.1	661	0.23	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.23 Reference Exposure Unit Hermosa Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Hermosa Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	4.40E-02	2.24	22.4	0.02	0.002	4.40E-02	2.24	22.4	0.02	0.002
Cadmium	5.98E-03	1.47	14.7	0.004	0.0004	5.98E-03	1.47	14.7	0.004	0.0004
Chromium	5.03E-01	2.66	26.6	0.19	0.02	5.03E-01	2.66	26.6	0.19	0.02
Copper	8.68E-01	4.05	12.1	0.21	0.07	8.68E-01	4.05	12.1	0.21	0.07
Lead	2.21E-01	1.63	3.26	0.14	0.07	2.21E-01	1.63	3.26	0.14	0.07
Mercury	1.89E-02	0.45	0.90	0.04	0.02	1.89E-02	0.45	0.90	0.04	0.02
Nickel	2.84E-01	6.71	67.1	0.04	0.004	2.84E-01	6.71	67.1	0.04	0.004
Selenium	1.93E-01	0.29	0.58	0.67	0.33	1.93E-01	0.29	0.58	0.67	0.33
Silver	5.99E-03	2.02	20.2	0.003	0.0003	5.99E-03	2.02	20.2	0.003	0.0003
Zinc	9.57E+00	66.1	661	0.14	0.01	9.57E+00	66.1	661	0.14	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.24 Reference Exposure Unit Maggie Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Maggie Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.60E-01	2.24	22.4	0.12	0.01	2.06E-01	2.24	22.4	0.09	0.01
Cadmium	5.32E-02	1.47	14.7	0.04	0.004	4.72E-02	1.47	14.7	0.03	0.003
Chromium	1.45E-01	2.66	26.6	0.05	0.01	1.38E-01	2.66	26.6	0.05	0.01
Copper	1.33E+00	4.05	12.1	0.33	0.11	1.23E+00	4.05	12.1	0.30	0.10
Lead	7.35E-01	1.63	3.26	0.45	0.23	6.77E-01	1.63	3.26	0.42	0.21
Mercury	1.22E-02	0.45	0.90	0.03	0.01	9.90E-03	0.45	0.90	0.02	0.01
Nickel	1.37E-01	6.71	67.1	0.02	0.002	1.29E-01	6.71	67.1	0.02	0.002
Selenium	1.99E-01	0.29	0.58	0.68	0.34	1.76E-01	0.29	0.58	0.61	0.30
Silver	1.79E-02	2.02	20.2	0.01	0.001	1.11E-02	2.02	20.2	0.01	0.001
Zinc	1.55E+01	66.1	661	0.23	0.02	1.50E+01	66.1	661	0.23	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.25 Reference Exposure Unit Mill Creek Estimated Daily Dose (EDDs) Hazard Quotients (HQs) for American Dipper Foraging in Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	2.31E-01	2.24	22.4	0.10	0.01	2.31E-01	2.24	22.4	0.10	0.01
Cadmium	8.59E-02	1.47	14.7	0.06	0.01	8.59E-02	1.47	14.7	0.06	0.01
Chromium	1.01E-01	2.66	26.6	0.04	0.004	1.01E-01	2.66	26.6	0.04	0.004
Copper	1.19E+00	4.05	12.1	0.29	0.10	1.19E+00	4.05	12.1	0.29	0.10
Lead	6.57E+00	1.63	3.26	4.03	2.01	6.57E+00	1.63	3.26	4.03	2.01
Mercury	8.76E-03	0.45	0.90	0.02	0.01	8.76E-03	0.45	0.90	0.02	0.01
Nickel	7.46E-02	6.71	67.1	0.01	0.001	7.46E-02	6.71	67.1	0.01	0.001
Selenium	8.06E-02	0.29	0.58	0.28	0.14	8.06E-02	0.29	0.58	0.28	0.14
Silver	5.97E-03	2.02	20.2	0.003	0.0003	5.97E-03	2.02	20.2	0.003	0.0003
Zinc	1.75E+01	66.1	661	0.26	0.03	1.75E+01	66.1	661	0.26	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.26 Reference Exposure Unit Picayne Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in Picayne Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.38E+00	2.24	22.4	0.62	0.06	1.09E+00	2.24	22.4	0.49	0.05
Cadmium	6.13E-02	1.47	14.7	0.04	0.004	5.93E-02	1.47	14.7	0.04	0.004
Chromium	1.88E-01	2.66	26.6	0.07	0.01	1.81E-01	2.66	26.6	0.07	0.01
Copper	1.31E+00	4.05	12.1	0.32	0.11	1.24E+00	4.05	12.1	0.31	0.10
Lead	2.54E+00	1.63	3.26	1.56	0.78	1.68E+00	1.63	3.26	1.03	0.51
Mercury	6.84E-03	0.45	0.90	0.02	0.01	6.75E-03	0.45	0.90	0.02	0.01
Nickel	2.18E-01	6.71	67.1	0.03	0.003	1.99E-01	6.71	67.1	0.03	0.003
Selenium	1.26E-01	0.29	0.58	0.43	0.22	1.11E-01	0.29	0.58	0.38	0.19
Silver	3.43E-02	2.02	20.2	0.02	0.002	2.95E-02	2.02	20.2	0.01	0.001
Zinc	2.01E+01	66.1	661	0.30	0.03	1.94E+01	66.1	661	0.29	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A19.27 Reference Exposure Unit North Fork Animas River Estimated Daily Dose (EDD) Hazard Quotients (HQs) for American Dipper Foraging in North Fork Animas River Above Burrows Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.65E+00	2.24	22.4	0.74	0.07	1.38E+00	2.24	22.4	0.62	0.06
Cadmium	4.58E-01	1.47	14.7	0.31	0.03	4.25E-01	1.47	14.7	0.29	0.03
Chromium	1.76E-01	2.66	26.6	0.07	0.01	1.65E-01	2.66	26.6	0.06	0.01
Copper	1.73E+00	4.05	12.1	0.43	0.14	1.59E+00	4.05	12.1	0.39	0.13
Lead	6.16E+00	1.63	3.26	3.78	1.89	4.70E+00	1.63	3.26	2.89	1.44
Mercury	9.48E-03	0.45	0.90	0.02	0.01	9.23E-03	0.45	0.90	0.02	0.01
Nickel	1.35E-01	6.71	67.1	0.02	0.002	1.30E-01	6.71	67.1	0.02	0.002
Selenium	1.01E-01	0.29	0.58	0.35	0.17	8.56E-02	0.29	0.58	0.30	0.15
Silver	5.24E-02	2.02	20.2	0.03	0.003	4.20E-02	2.02	20.2	0.02	0.002
Zinc	5.34E+01	66.1	661	0.81	0.08	4.84E+01	66.1	661	0.73	0.07

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Appendix 20

Mallard Estimated Daily Dose Hazard Quotient Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

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Table A20.1 EU-01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Mineral Creek from Animas River to South Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.41E-01	2.24	22.4	0.06	0.01	9.45E-02	2.24	22.4	0.04	0.004
Cadmium	5.32E-02	1.47	14.7	0.04	0.004	3.75E-02	1.47	14.7	0.03	0.003
Chromium	1.50E-01	2.66	26.6	0.06	0.01	8.23E-02	2.66	26.6	0.03	0.003
Copper	2.59E+00	4.05	12.1	0.64	0.21	1.65E+00	4.05	12.1	0.41	0.14
Lead	2.39E+00	1.63	3.26	1.47	0.73	1.38E+00	1.63	3.26	0.85	0.42
Mercury	5.31E-03	0.45	0.90	0.01	0.01	3.64E-03	0.45	0.90	0.01	0.004
Nickel	2.18E-02	6.71	67.1	0.003	0.0003	1.87E-02	6.71	67.1	0.003	0.0003
Selenium	2.31E-01	0.29	0.58	0.80	0.40	8.99E-02	0.29	0.58	0.31	0.16
Silver	3.36E-03	2.02	20.2	0.002	0.0002	2.30E-03	2.02	20.2	0.001	0.0001
Zinc	1.04E+01	66.1	661	0.16	0.02	7.58E+00	66.1	661	0.11	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.2 EU-02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.10E-01	2.24	22.4	0.05	0.005	8.87E-02	2.24	22.4	0.04	0.004
Cadmium	2.58E-02	1.47	14.7	0.02	0.002	2.13E-02	1.47	14.7	0.01	0.001
Chromium	2.15E-02	2.66	26.6	0.01	0.001	2.01E-02	2.66	26.6	0.01	0.001
Copper	5.20E-01	4.05	12.1	0.13	0.04	5.01E-01	4.05	12.1	0.12	0.04
Lead	8.10E-01	1.63	3.26	0.50	0.25	7.39E-01	1.63	3.26	0.45	0.23
Mercury	1.55E-02	0.45	0.90	0.03	0.02	1.49E-02	0.45	0.90	0.03	0.02
Nickel	1.89E-02	6.71	67.1	0.003	0.0003	1.74E-02	6.71	67.1	0.003	0.0003
Selenium	4.52E-02	0.29	0.58	0.16	0.08	3.90E-02	0.29	0.58	0.13	0.07
Silver	9.12E-03	2.02	20.2	0.005	0.0005	8.70E-03	2.02	20.2	0.004	0.0004
Zinc	8.79E+00	66.1	661	0.13	0.01	6.21E+00	66.1	661	0.09	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.3 EU-03 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.12E-01	2.24	22.4	0.05	0.005	9.75E-02	2.24	22.4	0.04	0.004
Cadmium	7.67E-02	1.47	14.7	0.05	0.01	5.19E-02	1.47	14.7	0.04	0.004
Chromium	2.30E-02	2.66	26.6	0.01	0.001	1.98E-02	2.66	26.6	0.01	0.001
Copper	1.08E+00	4.05	12.1	0.27	0.09	8.82E-01	4.05	12.1	0.22	0.07
Lead	1.84E+00	1.63	3.26	1.13	0.56	1.16E+00	1.63	3.26	0.71	0.36
Mercury	6.34E-03	0.45	0.90	0.01	0.01	4.46E-03	0.45	0.90	0.01	0.005
Nickel	1.96E-02	6.71	67.1	0.003	0.0003	1.56E-02	6.71	67.1	0.002	0.0002
Selenium	2.87E-02	0.29	0.58	0.10	0.05	2.16E-02	0.29	0.58	0.07	0.04
Silver	2.74E-03	2.02	20.2	0.001	0.0001	2.18E-03	2.02	20.2	0.001	0.0001
Zinc	1.61E+01	66.1	661	0.24	0.02	1.17E+01	66.1	661	0.18	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.4 EU-04 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Mineral Creek Upstream of Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	2.95E-01	2.24	22.4	0.13	0.01	2.52E-01	2.24	22.4	0.11	0.01
Cadmium	8.74E-02	1.47	14.7	0.06	0.01	6.81E-02	1.47	14.7	0.05	0.005
Chromium	1.66E-02	2.66	26.6	0.01	0.001	1.54E-02	2.66	26.6	0.01	0.001
Copper	2.54E+00	4.05	12.1	0.63	0.21	2.32E+00	4.05	12.1	0.57	0.19
Lead	6.75E+00	1.63	3.26	4.14	2.07	6.08E+00	1.63	3.26	3.73	1.86
Mercury	6.73E-03	0.45	0.90	0.01	0.01	5.16E-03	0.45	0.90	0.01	0.01
Nickel	2.90E-02	6.71	67.1	0.004	0.0004	2.13E-02	6.71	67.1	0.003	0.0003
Selenium	1.43E-02	0.29	0.58	0.05	0.02	1.43E-02	0.29	0.58	0.05	0.02
Silver	6.81E-03	2.02	20.2	0.003	0.0003	6.81E-03	2.02	20.2	0.003	0.0003
Zinc	2.46E+01	66.1	661	0.37	0.04	2.42E+01	66.1	661	0.37	0.04

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.5 EU-05 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in South Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	4.03E-02	2.24	22.4	0.02	0.002	3.68E-02	2.24	22.4	0.02	0.002
Cadmium	2.54E-02	1.47	14.7	0.02	0.002	1.84E-02	1.47	14.7	0.01	0.001
Chromium	2.73E-02	2.66	26.6	0.01	0.001	2.36E-02	2.66	26.6	0.01	0.001
Copper	3.87E-01	4.05	12.1	0.10	0.03	3.34E-01	4.05	12.1	0.08	0.03
Lead	2.46E-01	1.63	3.26	0.15	0.08	2.05E-01	1.63	3.26	0.13	0.06
Mercury	4.91E-03	0.45	0.90	0.01	0.01	3.57E-03	0.45	0.90	0.01	0.004
Nickel	5.25E-02	6.71	67.1	0.01	0.001	3.76E-02	6.71	67.1	0.01	0.001
Selenium	4.29E-02	0.29	0.58	0.15	0.07	3.27E-02	0.29	0.58	0.11	0.06
Silver	2.53E-03	2.02	20.2	0.001	0.0001	1.69E-03	2.02	20.2	0.001	0.0001
Zinc	6.18E+00	66.1	661	0.09	0.01	4.70E+00	66.1	661	0.07	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.6 EU-06 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Middle Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.47E-01	2.24	22.4	0.07	0.01	1.26E-01	2.24	22.4	0.06	0.01
Cadmium	2.26E-02	1.47	14.7	0.02	0.002	1.82E-02	1.47	14.7	0.01	0.001
Chromium	5.34E-02	2.66	26.6	0.02	0.002	5.01E-02	2.66	26.6	0.02	0.002
Copper	7.23E-01	4.05	12.1	0.18	0.06	6.10E-01	4.05	12.1	0.15	0.05
Lead	3.56E-01	1.63	3.26	0.22	0.11	3.12E-01	1.63	3.26	0.19	0.10
Mercury	4.63E-03	0.45	0.90	0.01	0.01	4.37E-03	0.45	0.90	0.01	0.005
Nickel	2.03E-02	6.71	67.1	0.003	0.0003	1.49E-02	6.71	67.1	0.002	0.0002
Selenium	6.12E-02	0.29	0.58	0.21	0.11	5.42E-02	0.29	0.58	0.19	0.09
Silver	3.87E-03	2.02	20.2	0.002	0.0002	2.64E-03	2.02	20.2	0.001	0.0001
Zinc	3.41E+00	66.1	661	0.05	0.01	3.21E+00	66.1	661	0.05	0.005

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.7 EU-07 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.30E-01	2.24	22.4	0.24	0.02	1.49E-01	2.24	22.4	0.07	0.01
Cadmium	2.92E-01	1.47	14.7	0.20	0.02	1.33E-01	1.47	14.7	0.09	0.01
Chromium	1.13E-01	2.66	26.6	0.04	0.004	6.72E-02	2.66	26.6	0.03	0.003
Copper	4.53E+00	4.05	12.1	1.12	0.37	1.94E+00	4.05	12.1	0.48	0.16
Lead	1.23E+01	1.63	3.26	7.54	3.77	3.98E+00	1.63	3.26	2.44	1.22
Mercury	4.26E-03	0.45	0.90	0.01	0.005	3.48E-03	0.45	0.90	0.01	0.004
Nickel	3.46E-02	6.71	67.1	0.01	0.001	2.76E-02	6.71	67.1	0.004	0.0004
Selenium	6.12E-02	0.29	0.58	0.21	0.11	4.27E-02	0.29	0.58	0.15	0.07
Silver	1.17E-02	2.02	20.2	0.01	0.001	9.18E-03	2.02	20.2	0.005	0.0005
Zinc	7.08E+01	66.1	661	1.07	0.11	3.12E+01	66.1	661	0.47	0.05

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.8 EU-08 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Cunningham Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	3.79E-02	2.24	22.4	0.02	0.002	3.26E-02	2.24	22.4	0.01	0.001
Cadmium	6.64E-02	1.47	14.7	0.05	0.005	6.16E-02	1.47	14.7	0.04	0.004
Chromium	2.25E-02	2.66	26.6	0.01	0.001	2.10E-02	2.66	26.6	0.01	0.001
Copper	1.19E+00	4.05	12.1	0.29	0.10	1.10E+00	4.05	12.1	0.27	0.09
Lead	1.14E+00	1.63	3.26	0.70	0.35	8.89E-01	1.63	3.26	0.55	0.27
Mercury	2.94E-03	0.45	0.90	0.01	0.003	2.39E-03	0.45	0.90	0.01	0.003
Nickel	1.56E-02	6.71	67.1	0.002	0.0002	1.37E-02	6.71	67.1	0.002	0.0002
Selenium	8.26E-02	0.29	0.58	0.28	0.14	4.29E-02	0.29	0.58	0.15	0.07
Silver	9.72E-03	2.02	20.2	0.005	0.0005	9.07E-03	2.02	20.2	0.004	0.0004
Zinc	7.98E+00	66.1	661	0.12	0.01	7.55E+00	66.1	661	0.11	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.9 EU-09 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in the Animas River from Howardsville to Minnie Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	8.52E-02	2.24	22.4	0.04	0.004	7.05E-02	2.24	22.4	0.03	0.003
Cadmium	1.72E-01	1.47	14.7	0.12	0.01	1.27E-01	1.47	14.7	0.09	0.01
Chromium	5.33E-02	2.66	26.6	0.02	0.002	3.81E-02	2.66	26.6	0.01	0.001
Copper	2.60E+00	4.05	12.1	0.64	0.21	1.90E+00	4.05	12.1	0.47	0.16
Lead	3.07E+00	1.63	3.26	1.88	0.94	2.44E+00	1.63	3.26	1.50	0.75
Mercury	5.60E-03	0.45	0.90	0.01	0.01	3.73E-03	0.45	0.90	0.01	0.004
Nickel	3.91E-02	6.71	67.1	0.01	0.001	3.14E-02	6.71	67.1	0.005	0.0005
Selenium	2.89E-02	0.29	0.58	0.10	0.05	2.24E-02	0.29	0.58	0.08	0.04
Silver	1.35E-02	2.02	20.2	0.01	0.001	1.05E-02	2.02	20.2	0.01	0.001
Zinc	3.03E+01	66.1	661	0.46	0.05	2.24E+01	66.1	661	0.34	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.10 EU-10 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in the Animas River from Minnie Gulch to Eureka

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.07E-01	2.24	22.4	0.05	0.005	9.91E-02	2.24	22.4	0.04	0.004
Cadmium	1.72E-01	1.47	14.7	0.12	0.01	1.21E-01	1.47	14.7	0.08	0.01
Chromium	2.54E-02	2.66	26.6	0.01	0.001	2.47E-02	2.66	26.6	0.01	0.001
Copper	2.29E+00	4.05	12.1	0.56	0.19	1.90E+00	4.05	12.1	0.47	0.16
Lead	2.73E+00	1.63	3.26	1.68	0.84	2.17E+00	1.63	3.26	1.33	0.67
Mercury	4.49E-03	0.45	0.90	0.01	0.005	3.28E-03	0.45	0.90	0.01	0.004
Nickel	4.24E-02	6.71	67.1	0.01	0.001	3.39E-02	6.71	67.1	0.01	0.001
Selenium	8.56E-02	0.29	0.58	0.30	0.15	3.91E-02	0.29	0.58	0.13	0.07
Silver	3.72E-02	2.02	20.2	0.02	0.002	1.53E-02	2.02	20.2	0.01	0.001
Zinc	2.74E+01	66.1	661	0.41	0.04	2.09E+01	66.1	661	0.32	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.11 EU-11 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	7.34E-02	2.24	22.4	0.03	0.003	5.53E-02	2.24	22.4	0.02	0.002
Cadmium	2.53E-02	1.47	14.7	0.02	0.002	2.18E-02	1.47	14.7	0.01	0.001
Chromium	2.11E-02	2.66	26.6	0.01	0.001	1.95E-02	2.66	26.6	0.01	0.001
Copper	4.88E-01	4.05	12.1	0.12	0.04	4.44E-01	4.05	12.1	0.11	0.04
Lead	5.12E-01	1.63	3.26	0.31	0.16	3.61E-01	1.63	3.26	0.22	0.11
Mercury	1.94E-03	0.45	0.90	0.004	0.002	1.85E-03	0.45	0.90	0.004	0.002
Nickel	3.09E-02	6.71	67.1	0.005	0.0005	2.48E-02	6.71	67.1	0.004	0.0004
Selenium	5.31E-02	0.29	0.58	0.18	0.09	3.68E-02	0.29	0.58	0.13	0.06
Silver	3.01E-03	2.02	20.2	0.001	0.0001	2.47E-03	2.02	20.2	0.001	0.0001
Zinc	5.46E+00	66.1	661	0.08	0.01	4.65E+00	66.1	661	0.07	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.12 EU-12 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Eureka Gulch Up to Confluence with Upper South Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.79E-02	2.24	22.4	0.03	0.003	4.61E-02	2.24	22.4	0.02	0.002
Cadmium	1.14E-01	1.47	14.7	0.08	0.01	9.92E-02	1.47	14.7	0.07	0.01
Chromium	2.28E-02	2.66	26.6	0.01	0.001	2.13E-02	2.66	26.6	0.01	0.001
Copper	2.31E+00	4.05	12.1	0.57	0.19	2.17E+00	4.05	12.1	0.54	0.18
Lead	1.88E+00	1.63	3.26	1.16	0.58	1.69E+00	1.63	3.26	1.04	0.52
Mercury	2.82E-03	0.45	0.90	0.01	0.003	2.46E-03	0.45	0.90	0.01	0.003
Nickel	3.78E-02	6.71	67.1	0.01	0.001	3.47E-02	6.71	67.1	0.01	0.001
Selenium	6.64E-02	0.29	0.58	0.23	0.11	3.12E-02	0.29	0.58	0.11	0.05
Silver	1.00E-02	2.02	20.2	0.005	0.0005	7.77E-03	2.02	20.2	0.004	0.0004
Zinc	2.29E+01	66.1	661	0.35	0.03	1.88E+01	66.1	661	0.28	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.13 EU-13 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Mainstem South Fork Animas River Up to Confluence

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	8.41E-02	2.24	22.4	0.04	0.004	6.73E-02	2.24	22.4	0.03	0.003
Cadmium	9.80E-02	1.47	14.7	0.07	0.01	9.59E-02	1.47	14.7	0.07	0.01
Chromium	3.23E-02	2.66	26.6	0.01	0.001	3.08E-02	2.66	26.6	0.01	0.001
Copper	1.50E+00	4.05	12.1	0.37	0.12	1.47E+00	4.05	12.1	0.36	0.12
Lead	1.28E+00	1.63	3.26	0.79	0.39	1.13E+00	1.63	3.26	0.69	0.35
Mercury	9.68E-03	0.45	0.90	0.02	0.01	7.26E-03	0.45	0.90	0.02	0.01
Nickel	4.78E-02	6.71	67.1	0.01	0.001	4.32E-02	6.71	67.1	0.01	0.001
Selenium	7.58E-02	0.29	0.58	0.26	0.13	4.11E-02	0.29	0.58	0.14	0.07
Silver	5.61E-03	2.02	20.2	0.003	0.0003	4.80E-03	2.02	20.2	0.002	0.0002
Zinc	2.10E+01	66.1	661	0.32	0.03	1.94E+01	66.1	661	0.29	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.14 EU-14 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in the Animas River from Eureka to Animas Forks

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.02E-01	2.24	22.4	0.05	0.005	8.43E-02	2.24	22.4	0.04	0.004
Cadmium	9.55E-02	1.47	14.7	0.06	0.01	8.36E-02	1.47	14.7	0.06	0.01
Chromium	2.00E-02	2.66	26.6	0.01	0.001	1.90E-02	2.66	26.6	0.01	0.001
Copper	1.73E+00	4.05	12.1	0.43	0.14	1.52E+00	4.05	12.1	0.37	0.13
Lead	1.82E+00	1.63	3.26	1.12	0.56	1.45E+00	1.63	3.26	0.89	0.44
Mercury	5.43E-03	0.45	0.90	0.01	0.01	4.80E-03	0.45	0.90	0.01	0.01
Nickel	2.49E-02	6.71	67.1	0.004	0.0004	2.07E-02	6.71	67.1	0.003	0.0003
Selenium	2.13E-02	0.29	0.58	0.07	0.04	1.62E-02	0.29	0.58	0.06	0.03
Silver	8.83E-03	2.02	20.2	0.004	0.0004	6.92E-03	2.02	20.2	0.003	0.0003
Zinc	1.74E+01	66.1	661	0.26	0.03	1.41E+01	66.1	661	0.21	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.15 EU-15 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.93E-01	2.24	22.4	0.13	0.01	2.40E-01	2.24	22.4	0.11	0.01
Cadmium	1.11E-01	1.47	14.7	0.08	0.01	8.49E-02	1.47	14.7	0.06	0.01
Chromium	8.48E-02	2.66	26.6	0.03	0.003	7.59E-02	2.66	26.6	0.03	0.003
Copper	1.13E+01	4.05	12.1	2.78	0.93	7.30E+00	4.05	12.1	1.80	0.60
Lead	4.20E+00	1.63	3.26	2.57	1.29	2.99E+00	1.63	3.26	1.83	0.92
Mercury	1.54E-02	0.45	0.90	0.03	0.02	1.22E-02	0.45	0.90	0.03	0.01
Nickel	5.79E-02	6.71	67.1	0.01	0.001	4.45E-02	6.71	67.1	0.01	0.001
Selenium	3.36E-02	0.29	0.58	0.12	0.06	2.17E-02	0.29	0.58	0.07	0.04
Silver	3.77E-02	2.02	20.2	0.02	0.002	2.14E-02	2.02	20.2	0.01	0.001
Zinc	1.96E+01	66.1	661	0.30	0.03	1.38E+01	66.1	661	0.21	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.16 EU-16 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Placer Gulch to Confluence with Upper West Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.19E-01	2.24	22.4	0.05	0.01	1.02E-01	2.24	22.4	0.05	0.005
Cadmium	2.32E-01	1.47	14.7	0.16	0.02	1.63E-01	1.47	14.7	0.11	0.01
Chromium	3.42E-02	2.66	26.6	0.01	0.001	3.26E-02	2.66	26.6	0.01	0.001
Copper	3.23E+00	4.05	12.1	0.80	0.27	2.42E+00	4.05	12.1	0.60	0.20
Lead	1.09E+01	1.63	3.26	6.69	3.34	8.09E+00	1.63	3.26	4.96	2.48
Mercury	3.02E-02	0.45	0.90	0.07	0.03	2.82E-02	0.45	0.90	0.06	0.03
Nickel	5.36E-02	6.71	67.1	0.01	0.001	3.76E-02	6.71	67.1	0.01	0.001
Selenium	9.37E-02	0.29	0.58	0.32	0.16	5.34E-02	0.29	0.58	0.18	0.09
Silver	4.37E-02	2.02	20.2	0.02	0.002	2.99E-02	2.02	20.2	0.01	0.001
Zinc	5.56E+01	66.1	661	0.84	0.08	2.92E+01	66.1	661	0.44	0.04

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.17 EU-17 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Upper West Fork Animas River from Placer Gulch Up to its Source

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.78E-01	2.24	22.4	0.12	0.01	2.19E-01	2.24	22.4	0.10	0.01
Cadmium	5.22E-02	1.47	14.7	0.04	0.004	4.20E-02	1.47	14.7	0.03	0.003
Chromium	1.10E-01	2.66	26.6	0.04	0.004	9.05E-02	2.66	26.6	0.03	0.003
Copper	6.68E+00	4.05	12.1	1.65	0.55	4.73E+00	4.05	12.1	1.17	0.39
Lead	8.89E-01	1.63	3.26	0.55	0.27	6.87E-01	1.63	3.26	0.42	0.21
Mercury	6.24E-03	0.45	0.90	0.01	0.01	5.80E-03	0.45	0.90	0.01	0.01
Nickel	8.57E-02	6.71	67.1	0.01	0.001	5.83E-02	6.71	67.1	0.01	0.001
Selenium	7.01E-02	0.29	0.58	0.24	0.12	3.62E-02	0.29	0.58	0.12	0.06
Silver	1.32E-02	2.02	20.2	0.01	0.001	7.75E-03	2.02	20.2	0.004	0.0004
Zinc	9.81E+00	66.1	661	0.15	0.01	8.73E+00	66.1	661	0.13	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.18 EU-18 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.74E-01	2.24	22.4	0.17	0.02	2.90E-01	2.24	22.4	0.13	0.01
Cadmium	9.28E-02	1.47	14.7	0.06	0.01	8.14E-02	1.47	14.7	0.06	0.01
Chromium	7.17E-02	2.66	26.6	0.03	0.003	6.58E-02	2.66	26.6	0.02	0.002
Copper	2.57E+00	4.05	12.1	0.63	0.21	2.20E+00	4.05	12.1	0.54	0.18
Lead	1.21E+00	1.63	3.26	0.74	0.37	9.55E-01	1.63	3.26	0.59	0.29
Mercury	8.06E-03	0.45	0.90	0.02	0.01	5.50E-03	0.45	0.90	0.01	0.01
Nickel	4.55E-02	6.71	67.1	0.01	0.001	3.92E-02	6.71	67.1	0.01	0.001
Selenium	1.55E-01	0.29	0.58	0.53	0.27	3.61E-02	0.29	0.58	0.12	0.06
Silver	1.27E-02	2.02	20.2	0.01	0.001	8.93E-03	2.02	20.2	0.004	0.0004
Zinc	1.31E+01	66.1	661	0.20	0.02	1.03E+01	66.1	661	0.16	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.19 EU-19 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Burrows Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.19E-01	2.24	22.4	0.05	0.01	1.10E-01	2.24	22.4	0.05	0.005
Cadmium	6.62E-02	1.47	14.7	0.05	0.005	6.27E-02	1.47	14.7	0.04	0.004
Chromium	1.67E-02	2.66	26.6	0.01	0.001	1.46E-02	2.66	26.6	0.01	0.001
Copper	1.08E+00	4.05	12.1	0.27	0.09	1.04E+00	4.05	12.1	0.26	0.09
Lead	1.18E+00	1.63	3.26	0.73	0.36	1.02E+00	1.63	3.26	0.63	0.31
Mercury	7.72E-03	0.45	0.90	0.02	0.01	7.30E-03	0.45	0.90	0.02	0.01
Nickel	2.37E-02	6.71	67.1	0.004	0.0004	2.07E-02	6.71	67.1	0.003	0.0003
Selenium	2.65E-02	0.29	0.58	0.09	0.05	1.62E-02	0.29	0.58	0.06	0.03
Silver	1.10E-02	2.02	20.2	0.01	0.001	1.01E-02	2.02	20.2	0.01	0.001
Zinc	7.34E+00	66.1	661	0.11	0.01	6.66E+00	66.1	661	0.10	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.20 EU-DR01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.31E-01	2.24	22.4	0.06	0.01	8.52E-02	2.24	22.4	0.04	0.004
Cadmium	8.32E-02	1.47	14.7	0.06	0.01	6.69E-02	1.47	14.7	0.05	0.005
Chromium	2.19E+00	2.66	26.6	0.82	0.08	8.26E-01	2.66	26.6	0.31	0.03
Copper	2.13E+00	4.05	12.1	0.53	0.18	1.54E+00	4.05	12.1	0.38	0.13
Lead	1.36E+00	1.63	3.26	0.83	0.42	8.00E-01	1.63	3.26	0.49	0.25
Mercury	2.15E-02	0.45	0.90	0.05	0.02	8.74E-03	0.45	0.90	0.02	0.01
Nickel	1.12E+00	6.71	67.1	0.17	0.02	4.32E-01	6.71	67.1	0.06	0.01
Selenium	2.83E-01	0.29	0.58	0.98	0.49	1.15E-01	0.29	0.58	0.40	0.20
Silver	1.04E-01	2.02	20.2	0.05	0.01	4.07E-02	2.02	20.2	0.02	0.002
Zinc	1.97E+01	66.1	661	0.30	0.03	1.67E+01	66.1	661	0.25	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.21 EU-DR02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	6.94E-02	2.24	22.4	0.03	0.003	6.78E-02	2.24	22.4	0.03	0.003
Cadmium	4.51E-02	1.47	14.7	0.03	0.003	4.19E-02	1.47	14.7	0.03	0.003
Chromium	8.34E-02	2.66	26.6	0.03	0.003	8.10E-02	2.66	26.6	0.03	0.003
Copper	1.10E+00	4.05	12.1	0.27	0.09	1.08E+00	4.05	12.1	0.27	0.09
Lead	5.06E-01	1.63	3.26	0.31	0.16	4.73E-01	1.63	3.26	0.29	0.14
Mercury	2.54E-03	0.45	0.90	0.01	0.003	2.24E-03	0.45	0.90	0.005	0.002
Nickel	9.10E-02	6.71	67.1	0.01	0.001	8.79E-02	6.71	67.1	0.01	0.001
Selenium	6.69E-02	0.29	0.58	0.23	0.12	4.02E-02	0.29	0.58	0.14	0.07
Silver	5.56E-03	2.02	20.2	0.003	0.0003	5.31E-03	2.02	20.2	0.003	0.0003
Zinc	1.70E+01	66.1	661	0.26	0.03	1.64E+01	66.1	661	0.25	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.22 Reference Exposure Unit Bear Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Bear Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	3.89E-02	2.24	22.4	0.02	0.002	3.54E-02	2.24	22.4	0.02	0.002
Cadmium	2.43E-02	1.47	14.7	0.02	0.002	2.29E-02	1.47	14.7	0.02	0.002
Chromium	2.01E-02	2.66	26.6	0.01	0.001	2.01E-02	2.66	26.6	0.01	0.001
Copper	3.44E-01	4.05	12.1	0.08	0.03	3.34E-01	4.05	12.1	0.08	0.03
Lead	1.45E-01	1.63	3.26	0.09	0.04	1.25E-01	1.63	3.26	0.08	0.04
Mercury	1.89E-03	0.45	0.90	0.004	0.002	1.86E-03	0.45	0.90	0.004	0.002
Nickel	2.63E-02	6.71	67.1	0.004	0.0004	2.57E-02	6.71	67.1	0.004	0.0004
Selenium	5.09E-02	0.29	0.58	0.18	0.09	4.79E-02	0.29	0.58	0.17	0.08
Silver	1.05E-03	2.02	20.2	0.001	0.0001	9.71E-04	2.02	20.2	0.0005	0.00005
Zinc	4.66E+00	66.1	661	0.07	0.01	4.61E+00	66.1	661	0.07	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.23 Reference Exposure Unit Hermosa Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Hermosa Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	8.56E-03	2.24	22.4	0.004	0.0004	8.56E-03	2.24	22.4	0.004	0.0004
Cadmium	3.40E-03	1.47	14.7	0.002	0.0002	3.40E-03	1.47	14.7	0.002	0.0002
Chromium	6.30E-02	2.66	26.6	0.02	0.002	6.30E-02	2.66	26.6	0.02	0.002
Copper	2.43E-01	4.05	12.1	0.06	0.02	2.43E-01	4.05	12.1	0.06	0.02
Lead	4.17E-02	1.63	3.26	0.03	0.01	4.17E-02	1.63	3.26	0.03	0.01
Mercury	3.16E-03	0.45	0.90	0.01	0.004	3.16E-03	0.45	0.90	0.01	0.004
Nickel	3.99E-02	6.71	67.1	0.01	0.001	3.99E-02	6.71	67.1	0.01	0.001
Selenium	5.95E-02	0.29	0.58	0.21	0.10	5.95E-02	0.29	0.58	0.21	0.10
Silver	8.98E-04	2.02	20.2	0.0004	0.00004	8.98E-04	2.02	20.2	0.0004	0.00004
Zinc	2.59E+00	66.1	661	0.04	0.004	2.59E+00	66.1	661	0.04	0.004

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.24 Reference Exposure Unit Maggie Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Maggie Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	3.37E-02	2.24	22.4	0.02	0.002	2.83E-02	2.24	22.4	0.01	0.001
Cadmium	2.08E-02	1.47	14.7	0.01	0.001	1.67E-02	1.47	14.7	0.01	0.001
Chromium	1.99E-02	2.66	26.6	0.01	0.001	1.90E-02	2.66	26.6	0.01	0.001
Copper	3.46E-01	4.05	12.1	0.09	0.03	3.26E-01	4.05	12.1	0.08	0.03
Lead	1.03E-01	1.63	3.26	0.06	0.03	9.74E-02	1.63	3.26	0.06	0.03
Mercury	5.62E-03	0.45	0.90	0.01	0.01	3.86E-03	0.45	0.90	0.01	0.004
Nickel	2.14E-02	6.71	67.1	0.003	0.0003	2.04E-02	6.71	67.1	0.003	0.0003
Selenium	5.90E-02	0.29	0.58	0.20	0.10	3.79E-02	0.29	0.58	0.13	0.07
Silver	1.84E-03	2.02	20.2	0.001	0.0001	1.31E-03	2.02	20.2	0.001	0.0001
Zinc	4.18E+00	66.1	661	0.06	0.01	3.92E+00	66.1	661	0.06	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.25 Reference Exposure Unit Mill Creek Estimated Daily Dose (EDDs) Hazard Quotients (HQs) for Mallard Foraging in Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.15E-02	2.24	22.4	0.01	0.001	3.15E-02	2.24	22.4	0.01	0.001
Cadmium	3.45E-02	1.47	14.7	0.02	0.002	3.45E-02	1.47	14.7	0.02	0.002
Chromium	1.46E-02	2.66	26.6	0.01	0.001	1.46E-02	2.66	26.6	0.01	0.001
Copper	3.01E-01	4.05	12.1	0.07	0.02	3.01E-01	4.05	12.1	0.07	0.02
Lead	6.35E-01	1.63	3.26	0.39	0.19	6.35E-01	1.63	3.26	0.39	0.19
Mercury	1.60E-03	0.45	0.90	0.004	0.002	1.60E-03	0.45	0.90	0.004	0.002
Nickel	1.27E-02	6.71	67.1	0.002	0.0002	1.27E-02	6.71	67.1	0.002	0.0002
Selenium	2.62E-02	0.29	0.58	0.09	0.05	2.62E-02	0.29	0.58	0.09	0.05
Silver	9.03E-04	2.02	20.2	0.0004	0.00004	9.03E-04	2.02	20.2	0.0004	0.00004
Zinc	5.54E+00	66.1	661	0.08	0.01	5.54E+00	66.1	661	0.08	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.26 Reference Exposure Unit Picayne Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in Picayne Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.39E-01	2.24	22.4	0.06	0.01	1.16E-01	2.24	22.4	0.05	0.01
Cadmium	2.78E-02	1.47	14.7	0.02	0.002	2.69E-02	1.47	14.7	0.02	0.002
Chromium	2.53E-02	2.66	26.6	0.01	0.001	2.44E-02	2.66	26.6	0.01	0.001
Copper	3.49E-01	4.05	12.1	0.09	0.03	3.35E-01	4.05	12.1	0.08	0.03
Lead	2.73E-01	1.63	3.26	0.17	0.08	1.98E-01	1.63	3.26	0.12	0.06
Mercury	1.85E-03	0.45	0.90	0.004	0.002	1.63E-03	0.45	0.90	0.004	0.002
Nickel	3.23E-02	6.71	67.1	0.005	0.0005	3.00E-02	6.71	67.1	0.004	0.0004
Selenium	3.97E-02	0.29	0.58	0.14	0.07	2.61E-02	0.29	0.58	0.09	0.05
Silver	3.48E-03	2.02	20.2	0.002	0.0002	3.09E-03	2.02	20.2	0.002	0.0002
Zinc	5.89E+00	66.1	661	0.09	0.01	5.67E+00	66.1	661	0.09	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A20.27 Reference Exposure Unit North Fork Animas River Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Mallard Foraging in North Fork Animas River Above Burrows Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.70E-01	2.24	22.4	0.08	0.01	1.49E-01	2.24	22.4	0.07	0.01
Cadmium	1.10E-01	1.47	14.7	0.07	0.01	1.02E-01	1.47	14.7	0.07	0.01
Chromium	2.44E-02	2.66	26.6	0.01	0.001	2.31E-02	2.66	26.6	0.01	0.001
Copper	4.11E-01	4.05	12.1	0.10	0.03	3.86E-01	4.05	12.1	0.10	0.03
Lead	6.22E-01	1.63	3.26	0.38	0.19	5.08E-01	1.63	3.26	0.31	0.16
Mercury	3.06E-03	0.45	0.90	0.01	0.003	2.71E-03	0.45	0.90	0.01	0.00
Nickel	2.15E-02	6.71	67.1	0.003	0.0003	2.09E-02	6.71	67.1	0.003	0.0003
Selenium	3.32E-02	0.29	0.58	0.11	0.06	1.96E-02	0.29	0.58	0.07	0.03
Silver	5.36E-03	2.02	20.2	0.003	0.0003	4.53E-03	2.02	20.2	0.002	0.0002
Zinc	1.24E+01	66.1	661	0.19	0.02	1.12E+01	66.1	661	0.17	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Appendix 21

Belted Kingfish Estimated Daily Dose Hazard Quotient Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

List of Appendix 21 Tables:

Table A21.1 EU-01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mineral Creek from Animas River to South Fork Mineral Creek

Table A21.2 EU-02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

Table A21.3 EU-03 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

Table A21.4 EU-04 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mineral Creek Upstream of Mill Creek

Table A21.5 EU-05 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in South Fork Mineral Creek

Table A21.6 EU-06 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Middle Fork Mineral Creek

Table A21.7 EU-07 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

Table A21.8 EU-08 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Cunningham Creek

Table A21.9 EU-09 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River from Howardsville to Minnie Gulch

Table A21.10 EU-10 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River from Minnie Gulch to Eureka

Table A21.11 EU-11 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

Table A21.12 EU-12 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Eureka Gulch Up to Confluence with Upper South Fork

Table A21.13 EU-13 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mainstem South Fork Animas River Up to Confluence

Table A21.14 EU-14 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River from Eureka to Animas Forks

Table A21.15 EU-15 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

Table A21.16 EU-16 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Placer Gulch to Confluence with Upper West Fork

Table A21.17 EU-17 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in upper West Fork Animas River from Placer Gulch Up to its Source

Table A21.18 EU-18 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

Table A21.19 EU-19 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Burrows Gulch

Table A21.20 EU-DR01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

Table A21.21 EU-DR02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

Table A21.22 Reference Exposure Unit Bear Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Bear Creek

Table A21.23 Reference Exposure Unit Hermosa Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Hermosa Creek

Table A21.24 Reference Exposure Unit Maggie Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Maggie Gulch

Table A21.25 Reference Exposure Unit Mill Creek Estimated Daily Dose (EDDs) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mill Creek

Table A21.26 Reference Exposure Unit Picayne Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Picayne Gulch

Table A21.27 Reference Exposure Unit North Fork Animas River Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in North Fork Animas River Above Burrows Gulch

Table A21.1 EU-01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mineral Creek from Animas River to South Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	9.98E-01	2.24	22.4	0.45	0.04	7.30E-01	2.24	22.4	0.33	0.03
Cadmium	9.26E-02	1.47	14.7	0.06	0.01	8.47E-02	1.47	14.7	0.06	0.01
Chromium	4.80E-02	2.66	26.6	0.02	0.00	2.74E-02	2.66	26.6	0.01	0.00
Copper	1.65E+00	4.05	12.1	0.41	0.14	1.50E+00	4.05	12.1	0.37	0.12
Lead	3.44E+00	1.63	3.26	2.11	1.05	2.85E+00	1.63	3.26	1.75	0.87
Mercury	9.53E-02	0.45	0.90	0.21	0.11	4.61E-02	0.45	0.90	0.10	0.05
Nickel	1.15E+00	6.71	67.1	0.17	0.02	9.37E-01	6.71	67.1	0.14	0.01
Selenium	3.10E+00	0.29	0.58	10.7	5.35	1.22E+00	0.29	0.58	4.20	2.10
Silver	2.82E-01	2.02	20.2	0.14	0.01	1.62E-01	2.02	20.2	0.08	0.01
Zinc	2.12E+01	66.1	661	0.32	0.03	1.80E+01	66.1	661	0.27	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.2 EU-02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.34E+00	2.24	22.4	0.60	0.06	1.01E+00	2.24	22.4	0.45	0.05
Cadmium	8.87E-02	1.47	14.7	0.06	0.01	7.84E-02	1.47	14.7	0.05	0.01
Chromium	1.80E-02	2.66	26.6	0.01	0.001	1.30E-02	2.66	26.6	0.005	0.0005
Copper	1.25E+00	4.05	12.1	0.31	0.10	1.18E+00	4.05	12.1	0.29	0.10
Lead	4.81E+00	1.63	3.26	2.95	1.48	4.15E+00	1.63	3.26	2.55	1.27
Mercury	4.33E-02	0.45	0.90	0.10	0.05	2.64E-02	0.45	0.90	0.06	0.03
Nickel	5.47E-01	6.71	67.1	0.08	0.01	4.54E-01	6.71	67.1	0.07	0.01
Selenium	6.62E-01	0.29	0.58	2.28	1.14	5.55E-01	0.29	0.58	1.91	0.96
Silver	9.98E-02	2.02	20.2	0.05	0.005	5.15E-02	2.02	20.2	0.03	0.003
Zinc	3.17E+01	66.1	661	0.48	0.05	2.20E+01	66.1	661	0.33	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.3 EU-03 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.92E-01	2.24	22.4	0.17	0.02	1.78E-01	2.24	22.4	0.08	0.01
Cadmium	1.67E-01	1.47	14.7	0.11	0.01	1.21E-01	1.47	14.7	0.08	0.01
Chromium	8.58E-01	2.66	26.6	0.32	0.03	5.85E-01	2.66	26.6	0.22	0.02
Copper	2.54E+00	4.05	12.1	0.63	0.21	1.82E+00	4.05	12.1	0.45	0.15
Lead	5.44E+00	1.63	3.26	3.34	1.67	2.26E+00	1.63	3.26	1.39	0.69
Mercury	2.47E-02	0.45	0.90	0.05	0.03	1.66E-02	0.45	0.90	0.04	0.02
Nickel	8.23E-02	6.71	67.1	0.01	0.001	3.80E-02	6.71	67.1	0.01	0.001
Selenium	6.43E-01	0.29	0.58	2.22	1.11	5.12E-01	0.29	0.58	1.77	0.88
Silver	7.60E-02	2.02	20.2	0.04	0.004	3.34E-02	2.02	20.2	0.02	0.002
Zinc	5.25E+01	66.1	661	0.79	0.08	3.76E+01	66.1	661	0.57	0.06

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.4 EU-04 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mineral Creek Upstream of Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.41E+00	2.24	22.4	1.52	0.15	2.69E+00	2.24	22.4	1.20	0.12
Cadmium	1.82E-01	1.47	14.7	0.12	0.01	1.52E-01	1.47	14.7	0.10	0.01
Chromium	1.83E-02	2.66	26.6	0.01	0.001	1.41E-02	2.66	26.6	0.01	0.001
Copper	3.18E+00	4.05	12.1	0.78	0.26	2.56E+00	4.05	12.1	0.63	0.21
Lead	2.36E+01	1.63	3.26	14.5	7.23	1.65E+01	1.63	3.26	10.1	5.07
Mercury	1.57E-01	0.45	0.90	0.35	0.17	8.50E-02	0.45	0.90	0.19	0.09
Nickel	1.42E+00	6.71	67.1	0.21	0.02	8.85E-01	6.71	67.1	0.13	0.01
Selenium	3.21E-01	0.29	0.58	1.11	0.55	3.21E-01	0.29	0.58	1.11	0.55
Silver	5.66E-01	2.02	20.2	0.28	0.03	5.66E-01	2.02	20.2	0.28	0.03
Zinc	7.86E+01	66.1	661	1.19	0.12	7.75E+01	66.1	661	1.17	0.12

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.5 EU-05 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in South Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.15E-01	2.24	22.4	0.10	0.01	1.53E-01	2.24	22.4	0.07	0.01
Cadmium	1.15E-01	1.47	14.7	0.08	0.01	8.79E-02	1.47	14.7	0.06	0.01
Chromium	6.09E-01	2.66	26.6	0.23	0.02	5.73E-01	2.66	26.6	0.22	0.02
Copper	6.29E-01	4.05	12.1	0.16	0.05	5.57E-01	4.05	12.1	0.14	0.05
Lead	6.46E-01	1.63	3.26	0.40	0.20	3.69E-01	1.63	3.26	0.23	0.11
Mercury	2.05E-02	0.45	0.90	0.05	0.02	1.59E-02	0.45	0.90	0.04	0.02
Nickel	3.87E-02	6.71	67.1	0.01	0.001	3.28E-02	6.71	67.1	0.005	0.0005
Selenium	8.26E-01	0.29	0.58	2.85	1.43	7.27E-01	0.29	0.58	2.51	1.26
Silver	2.34E-02	2.02	20.2	0.01	0.001	2.15E-02	2.02	20.2	0.01	0.001
Zinc	2.02E+01	66.1	661	0.31	0.03	1.41E+01	66.1	661	0.21	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.6 EU-06 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Middle Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.60E-01	2.24	22.4	0.16	0.02	2.96E-01	2.24	22.4	0.13	0.01
Cadmium	6.10E-02	1.47	14.7	0.04	0.004	5.32E-02	1.47	14.7	0.04	0.004
Chromium	1.21E-02	2.66	26.6	0.005	0.0005	1.04E-02	2.66	26.6	0.004	0.0004
Copper	6.45E-01	4.05	12.1	0.16	0.05	5.81E-01	4.05	12.1	0.14	0.05
Lead	1.25E+00	1.63	3.26	0.76	0.38	1.04E+00	1.63	3.26	0.64	0.32
Mercury	6.18E-03	0.45	0.90	0.01	0.01	4.36E-03	0.45	0.90	0.01	0.005
Nickel	2.82E-01	6.71	67.1	0.04	0.004	1.86E-01	6.71	67.1	0.028	0.003
Selenium	5.49E-01	0.29	0.58	1.89	0.95	5.01E-01	0.29	0.58	1.73	0.87
Silver	9.98E-02	2.02	20.2	0.05	0.005	6.75E-02	2.02	20.2	0.03	0.003
Zinc	8.02E+00	66.1	661	0.12	0.01	7.51E+00	66.1	661	0.11	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.7 EU-07 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.29E-01	2.24	22.4	0.24	0.02	4.42E-01	2.24	22.4	0.20	0.02
Cadmium	1.78E-01	1.47	14.7	0.12	0.01	1.63E-01	1.47	14.7	0.11	0.01
Chromium	3.58E-02	2.66	26.6	0.01	0.001	3.08E-02	2.66	26.6	0.01	0.001
Copper	2.61E+00	4.05	12.1	0.65	0.22	2.38E+00	4.05	12.1	0.59	0.20
Lead	1.80E+01	1.63	3.26	11.0	5.51	1.54E+01	1.63	3.26	9.42	4.71
Mercury	5.41E-02	0.45	0.90	0.12	0.06	3.68E-02	0.45	0.90	0.08	0.041
Nickel	1.28E+00	6.71	67.1	0.19	0.02	1.11E+00	6.71	67.1	0.17	0.02
Selenium	4.45E-01	0.29	0.58	1.53	0.77	3.79E-01	0.29	0.58	1.31	0.65
Silver	9.22E-01	2.02	20.2	0.46	0.05	7.25E-01	2.02	20.2	0.36	0.04
Zinc	5.70E+01	66.1	661	0.86	0.09	4.86E+01	66.1	661	0.73	0.07

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.8 EU-08 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Cunningham Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.53E-01	2.24	22.4	0.11	0.01	1.90E-01	2.24	22.4	0.08	0.01
Cadmium	1.04E-01	1.47	14.7	0.07	0.01	9.45E-02	1.47	14.7	0.06	0.01
Chromium	3.05E-02	2.66	26.6	0.01	0.001	2.51E-02	2.66	26.6	0.01	0.001
Copper	1.43E+00	4.05	12.1	0.35	0.12	1.14E+00	4.05	12.1	0.28	0.09
Lead	7.92E+00	1.63	3.26	4.86	2.43	5.49E+00	1.63	3.26	3.37	1.68
Mercury	1.95E-02	0.45	0.90	0.04	0.02	9.33E-03	0.45	0.90	0.02	0.01
Nickel	6.87E-01	6.71	67.1	0.10	0.01	5.65E-01	6.71	67.1	0.08	0.01
Selenium	1.26E+00	0.29	0.58	4.35	2.18	6.05E-01	0.29	0.58	2.09	1.04
Silver	2.62E-01	2.02	20.2	0.13	0.01	1.89E-01	2.02	20.2	0.09	0.01
Zinc	1.78E+01	66.1	661	0.27	0.03	1.61E+01	66.1	661	0.24	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.9 EU-09 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River from Howardsville to Minnie Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.09E-01	2.24	22.4	0.05	0.005	9.09E-02	2.24	22.4	0.04	0.004
Cadmium	1.96E-01	1.47	14.7	0.13	0.01	1.77E-01	1.47	14.7	0.12	0.01
Chromium	5.80E-01	2.66	26.6	0.22	0.02	5.62E-01	2.66	26.6	0.21	0.02
Copper	2.72E+00	4.05	12.1	0.67	0.22	2.36E+00	4.05	12.1	0.58	0.19
Lead	3.50E+00	1.63	3.26	2.15	1.07	2.76E+00	1.63	3.26	1.69	0.85
Mercury	6.21E-02	0.45	0.90	0.14	0.07	2.63E-02	0.45	0.90	0.06	0.03
Nickel	3.84E-01	6.71	67.1	0.06	0.01	1.73E-01	6.71	67.1	0.03	0.003
Selenium	4.06E-01	0.29	0.58	1.40	0.70	3.71E-01	0.29	0.58	1.28	0.64
Silver	4.46E-02	2.02	20.2	0.02	0.002	4.08E-02	2.02	20.2	0.02	0.002
Zinc	4.34E+01	66.1	661	0.66	0.07	3.86E+01	66.1	661	0.58	0.06

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.10 EU-10 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River from Minnie Gulch to Eureka

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.06E+00	2.24	22.4	0.47	0.05	9.39E-01	2.24	22.4	0.42	0.04
Cadmium	2.71E-01	1.47	14.7	0.18	0.02	2.02E-01	1.47	14.7	0.14	0.01
Chromium	3.62E-02	2.66	26.6	0.01	0.001	3.37E-02	2.66	26.6	0.01	0.001
Copper	4.44E+00	4.05	12.1	1.10	0.37	3.43E+00	4.05	12.1	0.85	0.28
Lead	2.38E+01	1.63	3.26	14.6	7.29	1.78E+01	1.63	3.26	11.0	5.48
Mercury	6.02E-02	0.45	0.90	0.13	0.07	2.47E-02	0.45	0.90	0.05	0.03
Nickel	2.22E+00	6.71	67.1	0.33	0.03	1.60E+00	6.71	67.1	0.24	0.02
Selenium	1.49E+00	0.29	0.58	5.14	2.57	7.38E-01	0.29	0.58	2.54	1.27
Silver	3.90E+00	2.02	20.2	1.93	0.19	1.41E+00	2.02	20.2	0.70	0.07
Zinc	7.91E+01	66.1	661	1.20	0.12	5.73E+01	66.1	661	0.87	0.09

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.11 EU-11 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	8.72E-01	2.24	22.4	0.39	0.04	6.09E-01	2.24	22.4	0.27	0.03
Cadmium	8.43E-02	1.47	14.7	0.06	0.01	7.63E-02	1.47	14.7	0.05	0.01
Chromium	4.61E-02	2.66	26.6	0.02	0.002	4.06E-02	2.66	26.6	0.02	0.002
Copper	1.45E+00	4.05	12.1	0.36	0.12	1.30E+00	4.05	12.1	0.32	0.11
Lead	3.95E+00	1.63	3.26	2.42	1.21	2.58E+00	1.63	3.26	1.58	0.79
Mercury	4.13E-03	0.45	0.90	0.01	0.005	3.22E-03	0.45	0.90	0.01	0.004
Nickel	1.61E+00	6.71	67.1	0.24	0.02	1.18E+00	6.71	67.1	0.18	0.02
Selenium	8.62E-01	0.29	0.58	2.97	1.49	5.84E-01	0.29	0.58	2.01	1.01
Silver	2.46E-01	2.02	20.2	0.12	0.01	1.85E-01	2.02	20.2	0.09	0.01
Zinc	1.68E+01	66.1	661	0.25	0.03	1.36E+01	66.1	661	0.21	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.12 EU-12 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Eureka Gulch Up to Confluence with Upper South Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	5.55E-01	2.24	22.4	0.25	0.02	3.93E-01	2.24	22.4	0.18	0.02
Cadmium	1.93E-01	1.47	14.7	0.13	0.01	1.71E-01	1.47	14.7	0.12	0.01
Chromium	3.59E-02	2.66	26.6	0.01	0.001	3.04E-02	2.66	26.6	0.01	0.001
Copper	2.63E+00	4.05	12.1	0.65	0.22	2.23E+00	4.05	12.1	0.55	0.18
Lead	8.63E+00	1.63	3.26	5.29	2.65	6.74E+00	1.63	3.26	4.14	2.07
Mercury	1.80E-02	0.45	0.90	0.04	0.02	1.14E-02	0.45	0.90	0.03	0.01
Nickel	1.80E+00	6.71	67.1	0.27	0.03	1.58E+00	6.71	67.1	0.24	0.02
Selenium	1.18E+00	0.29	0.58	4.08	2.04	5.98E-01	0.29	0.58	2.06	1.03
Silver	5.82E-01	2.02	20.2	0.29	0.03	3.23E-01	2.02	20.2	0.16	0.02
Zinc	6.53E+01	66.1	661	0.99	0.10	5.14E+01	66.1	661	0.78	0.08

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.13 EU-13 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mainstem South Fork Animas River Up to Confluence

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	7.71E-01	2.24	22.4	0.34	0.03	5.32E-01	2.24	22.4	0.24	0.02
Cadmium	1.48E-01	1.47	14.7	0.10	0.01	1.44E-01	1.47	14.7	0.10	0.01
Chromium	4.75E-02	2.66	26.6	0.02	0.002	4.21E-02	2.66	26.6	0.02	0.002
Copper	2.22E+00	4.05	12.1	0.55	0.18	2.14E+00	4.05	12.1	0.53	0.18
Lead	9.56E+00	1.63	3.26	5.86	2.93	8.02E+00	1.63	3.26	4.92	2.46
Mercury	2.58E-01	0.45	0.90	0.57	0.29	1.25E-01	0.45	0.90	0.28	0.14
Nickel	1.99E+00	6.71	67.1	0.30	0.03	1.66E+00	6.71	67.1	0.25	0.02
Selenium	1.30E+00	0.29	0.58	4.48	2.24	7.32E-01	0.29	0.58	2.52	1.26
Silver	4.46E-01	2.02	20.2	0.22	0.02	3.56E-01	2.02	20.2	0.18	0.02
Zinc	4.55E+01	66.1	661	0.69	0.07	3.98E+01	66.1	661	0.60	0.06

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.14 EU-14 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River from Eureka to Animas Forks

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.25E+00	2.24	22.4	0.56	0.06	9.84E-01	2.24	22.4	0.44	0.04
Cadmium	1.78E-01	1.47	14.7	0.12	0.01	1.60E-01	1.47	14.7	0.11	0.01
Chromium	3.23E-02	2.66	26.6	0.01	0.001	2.89E-02	2.66	26.6	0.01	0.001
Copper	3.26E+00	4.05	12.1	0.80	0.27	2.67E+00	4.05	12.1	0.66	0.22
Lead	1.63E+01	1.63	3.26	9.99	5.00	1.24E+01	1.63	3.26	7.62	3.81
Mercury	4.72E-02	0.45	0.90	0.10	0.05	2.91E-02	0.45	0.90	0.06	0.03
Nickel	1.36E+00	6.71	67.1	0.20	0.02	1.08E+00	6.71	67.1	0.16	0.02
Selenium	4.69E-01	0.29	0.58	1.62	0.81	3.77E-01	0.29	0.58	1.30	0.65
Silver	8.01E-01	2.02	20.2	0.40	0.04	5.84E-01	2.02	20.2	0.29	0.03
Zinc	5.67E+01	66.1	661	0.86	0.09	4.52E+01	66.1	661	0.68	0.07

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.15 EU-15 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	8.89E-01	2.24	22.4	0.40	0.04	6.84E-01	2.24	22.4	0.31	0.03
Cadmium	1.69E-01	1.47	14.7	0.11	0.01	1.41E-01	1.47	14.7	0.10	0.01
Chromium	3.59E-02	2.66	26.6	0.01	0.001	2.79E-02	2.66	26.6	0.01	0.001
Copper	3.34E+00	4.05	12.1	0.82	0.28	2.56E+00	4.05	12.1	0.63	0.21
Lead	2.89E+01	1.63	3.26	17.7	8.87	1.93E+01	1.63	3.26	11.8	5.91
Mercury	1.20E-01	0.45	0.90	0.27	0.13	8.30E-02	0.45	0.90	0.18	0.09
Nickel	1.16E+00	6.71	67.1	0.17	0.02	8.19E-01	6.71	67.1	0.12	0.01
Selenium	3.60E-01	0.29	0.58	1.24	0.62	2.78E-01	0.29	0.58	0.96	0.48
Silver	9.87E-01	2.02	20.2	0.49	0.05	5.59E-01	2.02	20.2	0.28	0.03
Zinc	4.97E+01	66.1	661	0.75	0.08	3.49E+01	66.1	661	0.53	0.05

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.16 EU-16 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Placer Gulch to Confluence with Upper West Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.41E+00	2.24	22.4	0.63	0.06	1.14E+00	2.24	22.4	0.51	0.05
Cadmium	3.69E-01	1.47	14.7	0.25	0.03	2.84E-01	1.47	14.7	0.19	0.02
Chromium	3.23E-02	2.66	26.6	0.01	0.001	2.67E-02	2.66	26.6	0.01	0.001
Copper	7.39E+00	4.05	12.1	1.82	0.61	5.48E+00	4.05	12.1	1.35	0.45
Lead	1.12E+02	1.63	3.26	68.9	34.4	8.08E+01	1.63	3.26	49.6	24.8
Mercury	5.02E-01	0.45	0.90	1.12	0.56	3.48E-01	0.45	0.90	0.77	0.39
Nickel	2.71E+00	6.71	67.1	0.40	0.04	1.52E+00	6.71	67.1	0.23	0.02
Selenium	1.32E+00	0.29	0.58	4.54	2.28	6.55E-01	0.29	0.58	2.26	1.13
Silver	3.54E+00	2.02	20.2	1.75	0.18	1.98E+00	2.02	20.2	0.98	0.10
Zinc	1.78E+02	66.1	661	2.70	0.27	9.85E+01	66.1	661	1.49	0.15

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.17 EU-17 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Upper West Fork Animas River from Placer Gulch Up to its Source

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	8.31E-01	2.24	22.4	0.37	0.04	6.07E-01	2.24	22.4	0.27	0.03
Cadmium	1.04E-01	1.47	14.7	0.07	0.01	9.00E-02	1.47	14.7	0.06	0.01
Chromium	6.34E-02	2.66	26.6	0.02	0.002	4.15E-02	2.66	26.6	0.02	0.002
Copper	2.43E+00	4.05	12.1	0.60	0.20	1.98E+00	4.05	12.1	0.49	0.16
Lead	4.22E+00	1.63	3.26	2.59	1.30	3.01E+00	1.63	3.26	1.85	0.92
Mercury	1.96E-02	0.45	0.90	0.04	0.02	1.56E-02	0.45	0.90	0.03	0.02
Nickel	1.96E+00	6.71	67.1	0.29	0.03	1.17E+00	6.71	67.1	0.17	0.02
Selenium	6.08E-01	0.29	0.58	2.10	1.05	3.78E-01	0.29	0.58	1.30	0.65
Silver	3.44E-01	2.02	20.2	0.17	0.02	2.02E-01	2.02	20.2	0.10	0.01
Zinc	2.44E+01	66.1	661	0.37	0.04	2.16E+01	66.1	661	0.33	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.18 EU-18 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.22E+00	2.24	22.4	0.54	0.05	8.75E-01	2.24	22.4	0.39	0.04
Cadmium	1.50E-01	1.47	14.7	0.10	0.01	1.37E-01	1.47	14.7	0.09	0.01
Chromium	2.44E-02	2.66	26.6	0.01	0.001	2.00E-02	2.66	26.6	0.01	0.001
Copper	1.38E+00	4.05	12.1	0.34	0.11	1.26E+00	4.05	12.1	0.31	0.10
Lead	6.26E+00	1.63	3.26	3.84	1.92	4.63E+00	1.63	3.26	2.84	1.42
Mercury	3.73E-02	0.45	0.90	0.08	0.04	1.30E-02	0.45	0.90	0.03	0.01
Nickel	8.44E-01	6.71	67.1	0.13	0.01	6.92E-01	6.71	67.1	0.10	0.01
Selenium	1.17E+00	0.29	0.58	4.03	2.02	3.77E-01	0.29	0.58	1.30	0.65
Silver	3.31E-01	2.02	20.2	0.16	0.02	2.33E-01	2.02	20.2	0.12	0.01
Zinc	3.31E+01	66.1	661	0.50	0.05	2.58E+01	66.1	661	0.39	0.04

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.19 EU-19 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Burrows Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.16E+00	2.24	22.4	0.52	0.05	1.02E+00	2.24	22.4	0.45	0.05
Cadmium	1.52E-01	1.47	14.7	0.10	0.01	1.46E-01	1.47	14.7	0.10	0.01
Chromium	3.14E-02	2.66	26.6	0.01	0.001	2.39E-02	2.66	26.6	0.01	0.001
Copper	2.15E+00	4.05	12.1	0.53	0.18	2.04E+00	4.05	12.1	0.50	0.17
Lead	7.12E+00	1.63	3.26	4.37	2.18	5.58E+00	1.63	3.26	3.42	1.71
Mercury	1.84E-02	0.45	0.90	0.04	0.02	1.06E-02	0.45	0.90	0.02	0.01
Nickel	1.11E+00	6.71	67.1	0.17	0.02	9.18E-01	6.71	67.1	0.14	0.01
Selenium	4.85E-01	0.29	0.58	1.67	0.84	2.96E-01	0.29	0.58	1.02	0.51
Silver	3.18E-01	2.02	20.2	0.16	0.02	2.18E-01	2.02	20.2	0.11	0.01
Zinc	2.45E+01	66.1	661	0.37	0.04	2.20E+01	66.1	661	0.33	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.20 EU-DR01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	2.81E-01	2.24	22.4	0.13	0.01	2.42E-01	2.24	22.4	0.11	0.01
Cadmium	1.03E-01	1.47	14.7	0.07	0.01	9.53E-02	1.47	14.7	0.06	0.01
Chromium	6.08E-02	2.66	26.6	0.02	0.002	5.14E-02	2.66	26.6	0.02	0.002
Copper	1.33E+00	4.05	12.1	0.33	0.11	1.21E+00	4.05	12.1	0.30	0.10
Lead	3.02E+00	1.63	3.26	1.85	0.93	2.52E+00	1.63	3.26	1.54	0.77
Mercury	9.58E-03	0.45	0.90	0.02	0.01	6.80E-03	0.45	0.90	0.02	0.01
Nickel	1.53E+00	6.71	67.1	0.23	0.02	1.38E+00	6.71	67.1	0.20	0.02
Selenium	1.49E+00	0.29	0.58	5.13	2.57	6.78E-01	0.29	0.58	2.34	1.17
Silver	2.52E-01	2.02	20.2	0.12	0.01	1.92E-01	2.02	20.2	0.10	0.01
Zinc	2.48E+01	66.1	661	0.38	0.04	2.17E+01	66.1	661	0.33	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.21 EU-DR02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	2.21E-01	2.24	22.4	0.10	0.01	2.02E-01	2.24	22.4	0.09	0.01
Cadmium	1.03E-01	1.47	14.7	0.07	0.01	9.66E-02	1.47	14.7	0.07	0.01
Chromium	6.50E-02	2.66	26.6	0.02	0.002	5.66E-02	2.66	26.6	0.02	0.002
Copper	1.23E+00	4.05	12.1	0.30	0.10	1.15E+00	4.05	12.1	0.28	0.09
Lead	2.38E+00	1.63	3.26	1.46	0.73	2.09E+00	1.63	3.26	1.28	0.64
Mercury	2.20E-02	0.45	0.90	0.05	0.02	1.57E-02	0.45	0.90	0.03	0.02
Nickel	1.83E+00	6.71	67.1	0.27	0.03	1.61E+00	6.71	67.1	0.24	0.02
Selenium	9.02E-01	0.29	0.58	3.11	1.56	4.44E-01	0.29	0.58	1.53	0.77
Silver	1.77E-01	2.02	20.2	0.09	0.01	1.51E-01	2.02	20.2	0.07	0.01
Zinc	2.45E+01	66.1	661	0.37	0.04	2.25E+01	66.1	661	0.34	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.22 Reference Exposure Unit Bear Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Bear Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.11E-01	2.24	22.4	0.14	0.01	2.66E-01	2.24	22.4	0.12	0.01
Cadmium	7.11E-02	1.47	14.7	0.05	0.005	6.76E-02	1.47	14.7	0.05	0.005
Chromium	2.86E-02	2.66	26.6	0.01	0.001	2.85E-02	2.66	26.6	0.01	0.001
Copper	6.66E-01	4.05	12.1	0.16	0.06	6.34E-01	4.05	12.1	0.16	0.05
Lead	8.12E-01	1.63	3.26	0.50	0.25	6.67E-01	1.63	3.26	0.41	0.20
Mercury	3.09E-03	0.45	0.90	0.01	0.003	2.83E-03	0.45	0.90	0.01	0.003
Nickel	1.15E+00	6.71	67.1	0.17	0.02	1.10E+00	6.71	67.1	0.16	0.02
Selenium	5.49E-01	0.29	0.58	1.89	0.95	4.96E-01	0.29	0.58	1.71	0.86
Silver	1.99E-02	2.02	20.2	0.01	0.001	1.15E-02	2.02	20.2	0.01	0.001
Zinc	1.21E+01	66.1	661	0.18	0.02	1.19E+01	66.1	661	0.18	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.23 Reference Exposure Unit Hermosa Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Hermosa Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.36E-02	2.24	22.4	0.01	0.001	2.36E-02	2.24	22.4	0.01	0.001
Cadmium	2.35E-02	1.47	14.7	0.02	0.002	2.35E-02	1.47	14.7	0.02	0.002
Chromium	1.71E-01	2.66	26.6	0.06	0.01	1.71E-01	2.66	26.6	0.06	0.01
Copper	4.38E-01	4.05	12.1	0.11	0.04	4.38E-01	4.05	12.1	0.11	0.04
Lead	1.46E-01	1.63	3.26	0.09	0.04	1.46E-01	1.63	3.26	0.09	0.04
Mercury	1.36E-03	0.45	0.90	0.003	0.002	1.36E-03	0.45	0.90	0.003	0.002
Nickel	2.39E+00	6.71	67.1	0.36	0.04	2.39E+00	6.71	67.1	0.36	0.04
Selenium	8.05E-01	0.29	0.58	2.77	1.39	8.05E-01	0.29	0.58	2.77	1.39
Silver	3.72E-03	2.02	20.2	0.002	0.0002	3.72E-03	2.02	20.2	0.002	0.0002
Zinc	5.38E+00	66.1	661	0.08	0.01	5.38E+00	66.1	661	0.08	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.24 Reference Exposure Unit Maggie Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Maggie Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.66E-01	2.24	22.4	0.12	0.01	2.00E-01	2.24	22.4	0.09	0.01
Cadmium	6.68E-02	1.47	14.7	0.05	0.005	5.50E-02	1.47	14.7	0.04	0.004
Chromium	2.40E-02	2.66	26.6	0.01	0.001	2.10E-02	2.66	26.6	0.01	0.001
Copper	7.58E-01	4.05	12.1	0.19	0.06	6.85E-01	4.05	12.1	0.17	0.06
Lead	4.52E-01	1.63	3.26	0.28	0.14	4.12E-01	1.63	3.26	0.25	0.13
Mercury	1.11E-01	0.45	0.90	0.25	0.12	4.46E-02	0.45	0.90	0.10	0.05
Nickel	1.07E+00	6.71	67.1	0.16	0.02	9.97E-01	6.71	67.1	0.15	0.01
Selenium	7.79E-01	0.29	0.58	2.69	1.35	4.11E-01	0.29	0.58	1.42	0.71
Silver	1.12E-01	2.02	20.2	0.06	0.01	5.08E-02	2.02	20.2	0.03	0.003
Zinc	9.29E+00	66.1	661	0.14	0.01	8.26E+00	66.1	661	0.12	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.25 Reference Exposure Unit Mill Creek Estimated Daily Dose (EDDs) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	8.76E-02	2.24	22.4	0.04	0.004	6.77E-02	2.24	22.4	0.03	0.003
Cadmium	9.22E-02	1.47	14.7	0.06	0.01	7.13E-02	1.47	14.7	0.05	0.005
Chromium	6.00E-01	2.66	26.6	0.23	0.02	5.56E-01	2.66	26.6	0.21	0.02
Copper	7.36E-01	4.05	12.1	0.18	0.06	5.33E-01	4.05	12.1	0.13	0.04
Lead	1.74E+00	1.63	3.26	1.07	0.54	1.24E+00	1.63	3.26	0.76	0.38
Mercury	1.35E-02	0.45	0.90	0.03	0.02	1.00E-02	0.45	0.90	0.02	0.01
Nickel	3.57E-02	6.71	67.1	0.01	0.001	2.82E-02	6.71	67.1	0.004	0.0004
Selenium	6.31E-01	0.29	0.58	2.18	1.09	5.36E-01	0.29	0.58	1.85	0.93
Silver	3.19E-02	2.02	20.2	0.02	0.002	2.45E-02	2.02	20.2	0.01	0.001
Zinc	2.76E+01	66.1	661	0.42	0.04	1.91E+01	66.1	661	0.29	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.26 Reference Exposure Unit Picayne Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in Picayne Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.40E+00	2.24	22.4	0.63	0.06	1.05E+00	2.24	22.4	0.47	0.05
Cadmium	8.63E-02	1.47	14.7	0.06	0.01	8.42E-02	1.47	14.7	0.06	0.01
Chromium	3.85E-02	2.66	26.6	0.01	0.001	3.55E-02	2.66	26.6	0.01	0.001
Copper	8.42E-01	4.05	12.1	0.21	0.07	7.95E-01	4.05	12.1	0.20	0.07
Lead	1.67E+00	1.63	3.26	1.02	0.51	1.06E+00	1.63	3.26	0.65	0.33
Mercury	6.18E-03	0.45	0.90	0.01	0.01	3.60E-03	0.45	0.90	0.01	0.004
Nickel	1.58E+00	6.71	67.1	0.24	0.02	1.41E+00	6.71	67.1	0.21	0.02
Selenium	6.05E-01	0.29	0.58	2.09	1.05	3.63E-01	0.29	0.58	1.25	0.63
Silver	2.17E-01	2.02	20.2	0.11	0.01	1.73E-01	2.02	20.2	0.09	0.01
Zinc	1.60E+01	66.1	661	0.24	0.02	1.51E+01	66.1	661	0.23	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A21.27 Reference Exposure Unit North Fork Animas River Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Belted Kingfisher Foraging in North Fork Animas River Above Burrows Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.56E+00	2.24	22.4	0.69	0.07	1.23E+00	2.24	22.4	0.55	0.06
Cadmium	1.71E-01	1.47	14.7	0.12	0.01	1.58E-01	1.47	14.7	0.11	0.01
Chromium	2.42E-02	2.66	26.6	0.01	0.001	1.95E-02	2.66	26.6	0.01	0.001
Copper	8.77E-01	4.05	12.1	0.22	0.07	7.89E-01	4.05	12.1	0.19	0.07
Lead	3.61E+00	1.63	3.26	2.22	1.11	2.59E+00	1.63	3.26	1.59	0.79
Mercury	2.21E-02	0.45	0.90	0.05	0.02	1.49E-02	0.45	0.90	0.03	0.02
Nickel	7.84E-01	6.71	67.1	0.12	0.01	7.42E-01	6.71	67.1	0.11	0.01
Selenium	5.47E-01	0.29	0.58	1.89	0.94	2.99E-01	0.29	0.58	1.03	0.52
Silver	3.22E-01	2.02	20.2	0.16	0.02	2.28E-01	2.02	20.2	0.11	0.01
Zinc	2.95E+01	66.1	661	0.45	0.04	2.50E+01	66.1	661	0.38	0.04

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Appendix 22

Muskrat Estimated Daily Dose Hazard Quotient Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

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Table A22.20 EU-DR01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

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Table A22.24 Reference Exposure Unit Maggie Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Maggie Gulch

Table A22.25 Reference Exposure Unit Mill Creek Estimated Daily Dose (EDDs) Hazard Quotients (HQs) for Muskrat Foraging in Mill Creek

Table A22.26 Reference Exposure Unit Picayne Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Picayne Gulch

Table A22.27 Reference Exposure Unit North Fork Animas River Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in North Fork Animas River Above Burrows Gulch

Table A22.1 EU-01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Mineral Creek from Animas River to South Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	4.93E-01	1.04	1.66	0.47	0.30	3.71E-01	1.04	1.66	0.36	0.22
Cadmium	9.42E-02	0.77	7.70	0.12	0.01	8.02E-02	0.77	7.70	0.10	0.01
Chromium	7.66E-02	2.40	24.0	0.03	0.00	4.37E-02	2.40	24.0	0.02	0.002
Copper	2.32E+00	5.60	9.34	0.41	0.25	2.07E+00	5.60	9.34	0.37	0.22
Lead	2.83E+00	4.70	8.90	0.60	0.31	2.39E+00	4.70	8.90	0.51	0.27
Mercury	1.39E-02	1.00	14.1	0.01	0.00	9.09E-03	1.00	14.1	0.01	0.001
Nickel	1.00E-01	1.70	3.40	0.06	0.03	8.36E-02	1.70	3.40	0.05	0.02
Selenium	6.57E-01	0.14	0.21	4.69	3.07	2.21E-01	0.14	0.21	1.58	1.03
Silver	1.70E-02	6.02	60.2	0.003	0.0003	9.83E-03	6.02	60.2	0.002	0.0002
Zinc	2.08E+01	75.4	754	0.28	0.03	1.73E+01	75.4	754	0.23	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.2 EU-02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	6.46E-01	1.04	1.66	0.62	0.39	4.98E-01	1.04	1.66	0.48	0.30
Cadmium	8.70E-02	0.77	7.70	0.11	0.01	6.98E-02	0.77	7.70	0.09	0.01
Chromium	2.86E-02	2.40	24.0	0.01	0.001	2.06E-02	2.40	24.0	0.01	0.001
Copper	1.65E+00	5.60	9.34	0.29	0.18	1.54E+00	5.60	9.34	0.28	0.17
Lead	3.87E+00	4.70	8.90	0.82	0.43	3.38E+00	4.70	8.90	0.72	0.38
Mercury	8.76E-03	1.00	14.1	0.01	0.001	6.59E-03	1.00	14.1	0.01	0.00
Nickel	5.17E-02	1.70	3.40	0.03	0.02	4.39E-02	1.70	3.40	0.03	0.01
Selenium	1.03E-01	0.14	0.21	0.73	0.48	8.08E-02	0.14	0.21	0.58	0.38
Silver	6.10E-03	6.02	60.2	0.001	0.0001	3.20E-03	6.02	60.2	0.001	0.0001
Zinc	3.31E+01	75.4	754	0.44	0.04	2.17E+01	75.4	754	0.29	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.3 EU-03 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.80E-01	1.04	1.66	0.56	0.35	5.07E-01	1.04	1.66	0.49	0.31
Cadmium	2.83E-01	0.77	7.70	0.37	0.04	1.80E-01	0.77	7.70	0.23	0.02
Chromium	4.64E-02	2.40	24.0	0.02	0.002	3.02E-02	2.40	24.0	0.01	0.001
Copper	2.83E+00	5.60	9.34	0.51	0.30	2.06E+00	5.60	9.34	0.37	0.22
Lead	7.47E+00	4.70	8.90	1.59	0.83	4.52E+00	4.70	8.90	0.96	0.51
Mercury	1.79E-02	1.00	14.1	0.02	0.00	1.12E-02	1.00	14.1	0.01	0.00
Nickel	8.32E-02	1.70	3.40	0.05	0.02	6.25E-02	1.70	3.40	0.04	0.02
Selenium	7.37E-02	0.14	0.21	0.53	0.34	4.89E-02	0.14	0.21	0.35	0.23
Silver	1.29E-02	6.02	60.2	0.002	0.0002	9.27E-03	6.02	60.2	0.002	0.0002
Zinc	5.85E+01	75.4	754	0.78	0.08	4.03E+01	75.4	754	0.53	0.05

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.4 EU-04 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Mineral Creek Upstream of Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.54E+00	1.04	1.66	1.48	0.93	1.24E+00	1.04	1.66	1.19	0.74
Cadmium	3.16E-01	0.77	7.70	0.41	0.04	2.29E-01	0.77	7.70	0.30	0.03
Chromium	2.90E-02	2.40	24.0	0.01	0.001	2.24E-02	2.40	24.0	0.01	0.001
Copper	5.49E+00	5.60	9.34	0.98	0.59	4.11E+00	5.60	9.34	0.73	0.44
Lead	1.74E+01	4.70	8.90	3.70	1.95	1.24E+01	4.70	8.90	2.63	1.39
Mercury	1.88E-02	1.00	14.1	0.02	0.00	1.30E-02	1.00	14.1	0.01	0.001
Nickel	1.21E-01	1.70	3.40	0.07	0.04	7.94E-02	1.70	3.40	0.05	0.02
Selenium	3.48E-02	0.14	0.21	0.25	0.16	3.48E-02	0.14	0.21	0.25	0.16
Silver	3.41E-02	6.02	60.2	0.01	0.001	3.41E-02	6.02	60.2	0.01	0.001
Zinc	9.98E+01	75.4	754	1.32	0.13	9.80E+01	75.4	754	1.30	0.13

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.5 EU-05 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in South Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.73E-01	1.04	1.66	0.17	0.10	1.53E-01	1.04	1.66	0.15	0.09
Cadmium	6.05E-02	0.77	7.70	0.08	0.01	4.45E-02	0.77	7.70	0.06	0.01
Chromium	3.81E-02	2.40	24.0	0.02	0.002	3.70E-02	2.40	24.0	0.02	0.002
Copper	6.80E-01	5.60	9.34	0.12	0.07	6.78E-01	5.60	9.34	0.12	0.07
Lead	1.19E+00	4.70	8.90	0.25	0.13	1.00E+00	4.70	8.90	0.21	0.11
Mercury	8.82E-03	1.00	14.1	0.01	0.001	6.11E-03	1.00	14.1	0.01	0.0004
Nickel	1.54E-01	1.70	3.40	0.09	0.05	1.16E-01	1.70	3.40	0.07	0.03
Selenium	1.03E-01	0.14	0.21	0.73	0.48	6.90E-02	0.14	0.21	0.49	0.32
Silver	6.99E-03	6.02	60.2	0.001	0.0001	3.64E-03	6.02	60.2	0.001	0.0001
Zinc	1.43E+01	75.4	754	0.19	0.02	1.09E+01	75.4	754	0.14	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.6 EU-06 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Middle Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.98E-01	1.04	1.66	0.19	0.12	1.67E-01	1.04	1.66	0.16	0.10
Cadmium	4.47E-02	0.77	7.70	0.06	0.01	3.52E-02	0.77	7.70	0.05	0.005
Chromium	1.92E-02	2.40	24.0	0.01	0.001	1.64E-02	2.40	24.0	0.01	0.001
Copper	7.80E-01	5.60	9.34	0.14	0.08	6.99E-01	5.60	9.34	0.12	0.07
Lead	1.13E+00	4.70	8.90	0.24	0.13	9.68E-01	4.70	8.90	0.21	0.11
Mercury	2.90E-03	1.00	14.1	0.003	0.0002	2.38E-03	1.00	14.1	0.002	0.0002
Nickel	2.90E-02	1.70	3.40	0.02	0.01	2.01E-02	1.70	3.40	0.01	0.01
Selenium	7.95E-02	0.14	0.21	0.57	0.37	6.99E-02	0.14	0.21	0.50	0.33
Silver	6.10E-03	6.02	60.2	0.001	0.0001	4.16E-03	6.02	60.2	0.001	0.0001
Zinc	7.15E+00	75.4	754	0.09	0.01	6.67E+00	75.4	754	0.09	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.7 EU-07 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.78E-01	1.04	1.66	0.27	0.17	2.37E-01	1.04	1.66	0.23	0.14
Cadmium	3.03E-01	0.77	7.70	0.39	0.04	2.61E-01	0.77	7.70	0.34	0.03
Chromium	5.70E-02	2.40	24.0	0.02	0.002	4.90E-02	2.40	24.0	0.02	0.002
Copper	4.22E+00	5.60	9.34	0.75	0.45	3.72E+00	5.60	9.34	0.66	0.40
Lead	1.34E+01	4.70	8.90	2.85	1.49	1.15E+01	4.70	8.90	2.46	1.30
Mercury	9.97E-03	1.00	14.1	0.01	0.001	7.98E-03	1.00	14.1	0.01	0.001
Nickel	1.11E-01	1.70	3.40	0.07	0.03	9.73E-02	1.70	3.40	0.06	0.03
Selenium	5.87E-02	0.14	0.21	0.42	0.27	4.59E-02	0.14	0.21	0.33	0.21
Silver	5.55E-02	6.02	60.2	0.01	0.001	4.36E-02	6.02	60.2	0.01	0.001
Zinc	6.70E+01	75.4	754	0.89	0.09	5.51E+01	75.4	754	0.73	0.07

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.8 EU-08 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Cunningham Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.46E-01	1.04	1.66	0.14	0.09	1.14E-01	1.04	1.66	0.11	0.07
Cadmium	1.17E-01	0.77	7.70	0.15	0.02	9.77E-02	0.77	7.70	0.13	0.01
Chromium	4.85E-02	2.40	24.0	0.02	0.002	3.99E-02	2.40	24.0	0.02	0.002
Copper	1.94E+00	5.60	9.34	0.35	0.21	1.47E+00	5.60	9.34	0.26	0.16
Lead	6.17E+00	4.70	8.90	1.31	0.69	4.37E+00	4.70	8.90	0.93	0.49
Mercury	5.54E-03	1.00	14.1	0.01	0.0004	3.65E-03	1.00	14.1	0.004	0.0003
Nickel	6.33E-02	1.70	3.40	0.04	0.02	5.32E-02	1.70	3.40	0.03	0.02
Selenium	2.31E-01	0.14	0.21	1.65	1.08	9.09E-02	0.14	0.21	0.65	0.42
Silver	1.58E-02	6.02	60.2	0.003	0.0003	1.14E-02	6.02	60.2	0.002	0.0002
Zinc	1.71E+01	75.4	754	0.23	0.02	1.53E+01	75.4	754	0.20	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.9 EU-09 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in the Animas River from Howardsville to Minnie Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.76E-01	1.04	1.66	0.36	0.23	3.16E-01	1.04	1.66	0.30	0.19
Cadmium	3.38E-01	0.77	7.70	0.44	0.04	2.81E-01	0.77	7.70	0.36	0.04
Chromium	5.34E-02	2.40	24.0	0.02	0.002	4.58E-02	2.40	24.0	0.02	0.002
Copper	5.67E+00	5.60	9.34	1.01	0.61	4.56E+00	5.60	9.34	0.82	0.49
Lead	1.78E+01	4.70	8.90	3.79	1.98	1.42E+01	4.70	8.90	3.03	1.60
Mercury	1.24E-02	1.00	14.1	0.01	0.001	7.03E-03	1.00	14.1	0.01	0.0005
Nickel	1.33E-01	1.70	3.40	0.08	0.04	1.10E-01	1.70	3.40	0.06	0.03
Selenium	6.69E-02	0.14	0.21	0.48	0.31	4.58E-02	0.14	0.21	0.33	0.21
Silver	5.69E-02	6.02	60.2	0.01	0.001	4.50E-02	6.02	60.2	0.01	0.001
Zinc	6.73E+01	75.4	754	0.89	0.09	5.17E+01	75.4	754	0.69	0.07

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.10 EU-10 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in the Animas River from Minnie Gulch to Eureka

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.21E-01	1.04	1.66	0.50	0.31	4.67E-01	1.04	1.66	0.45	0.28
Cadmium	6.30E-01	0.77	7.70	0.82	0.08	3.79E-01	0.77	7.70	0.49	0.05
Chromium	5.76E-02	2.40	24.0	0.02	0.002	5.36E-02	2.40	24.0	0.02	0.002
Copper	8.65E+00	5.60	9.34	1.55	0.93	6.10E+00	5.60	9.34	1.09	0.65
Lead	1.75E+01	4.70	8.90	3.73	1.95	1.33E+01	4.70	8.90	2.84	1.50
Mercury	1.06E-02	1.00	14.1	0.01	0.001	6.34E-03	1.00	14.1	0.01	0.0004
Nickel	1.82E-01	1.70	3.40	0.11	0.05	1.35E-01	1.70	3.40	0.08	0.04
Selenium	2.82E-01	0.14	0.21	2.01	1.32	1.18E-01	0.14	0.21	0.84	0.55
Silver	2.34E-01	6.02	60.2	0.04	0.004	8.46E-02	6.02	60.2	0.01	0.001
Zinc	1.01E+02	75.4	754	1.33	0.13	6.74E+01	75.4	754	0.89	0.09

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.11 EU-11 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	4.36E-01	1.04	1.66	0.42	0.26	3.16E-01	1.04	1.66	0.30	0.19
Cadmium	7.96E-02	0.77	7.70	0.10	0.01	6.65E-02	0.77	7.70	0.09	0.01
Chromium	7.35E-02	2.40	24.0	0.03	0.003	6.46E-02	2.40	24.0	0.03	0.003
Copper	1.97E+00	5.60	9.34	0.35	0.21	1.74E+00	5.60	9.34	0.31	0.19
Lead	3.22E+00	4.70	8.90	0.69	0.36	2.18E+00	4.70	8.90	0.46	0.24
Mercury	2.31E-03	1.00	14.1	0.002	0.0002	2.01E-03	1.00	14.1	0.002	0.0001
Nickel	1.36E-01	1.70	3.40	0.08	0.04	1.03E-01	1.70	3.40	0.06	0.03
Selenium	1.44E-01	0.14	0.21	1.03	0.67	8.67E-02	0.14	0.21	0.62	0.41
Silver	1.49E-02	6.02	60.2	0.002	0.0002	1.12E-02	6.02	60.2	0.002	0.0002
Zinc	1.60E+01	75.4	754	0.21	0.02	1.27E+01	75.4	754	0.17	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.12 EU-12 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Eureka Gulch Up to Confluence with Upper South Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.90E-01	1.04	1.66	0.28	0.17	2.14E-01	1.04	1.66	0.21	0.13
Cadmium	3.49E-01	0.77	7.70	0.45	0.05	2.84E-01	0.77	7.70	0.37	0.04
Chromium	5.72E-02	2.40	24.0	0.02	0.002	4.83E-02	2.40	24.0	0.02	0.002
Copper	4.26E+00	5.60	9.34	0.76	0.46	3.42E+00	5.60	9.34	0.61	0.37
Lead	6.68E+00	4.70	8.90	1.42	0.74	5.30E+00	4.70	8.90	1.13	0.60
Mercury	5.30E-03	1.00	14.1	0.01	0.0004	4.08E-03	1.00	14.1	0.004	0.0003
Nickel	1.51E-01	1.70	3.40	0.09	0.04	1.34E-01	1.70	3.40	0.08	0.04
Selenium	2.14E-01	0.14	0.21	1.53	1.00	8.95E-02	0.14	0.21	0.64	0.42
Silver	3.50E-02	6.02	60.2	0.01	0.001	1.95E-02	6.02	60.2	0.003	0.0003
Zinc	7.92E+01	75.4	754	1.05	0.11	5.90E+01	75.4	754	0.78	0.08

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.13 EU-13 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Mainstem South Fork Animas River Up to Confluence

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.90E-01	1.04	1.66	0.38	0.24	2.80E-01	1.04	1.66	0.27	0.17
Cadmium	2.18E-01	0.77	7.70	0.28	0.03	2.09E-01	0.77	7.70	0.27	0.03
Chromium	7.57E-02	2.40	24.0	0.03	0.003	6.71E-02	2.40	24.0	0.03	0.003
Copper	3.40E+00	5.60	9.34	0.61	0.36	3.23E+00	5.60	9.34	0.58	0.35
Lead	7.36E+00	4.70	8.90	1.57	0.82	6.23E+00	4.70	8.90	1.33	0.70
Mercury	2.55E-02	1.00	14.1	0.03	0.00	1.64E-02	1.00	14.1	0.02	0.00
Nickel	1.65E-01	1.70	3.40	0.10	0.05	1.40E-01	1.70	3.40	0.08	0.04
Selenium	2.39E-01	0.14	0.21	1.71	1.12	1.17E-01	0.14	0.21	0.84	0.55
Silver	2.69E-02	6.02	60.2	0.004	0.0004	2.14E-02	6.02	60.2	0.004	0.0004
Zinc	5.10E+01	75.4	754	0.68	0.07	4.34E+01	75.4	754	0.58	0.06

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.14 EU-14 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in the Animas River from Eureka to Animas Forks

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	6.06E-01	1.04	1.66	0.58	0.36	4.87E-01	1.04	1.66	0.47	0.29
Cadmium	3.04E-01	0.77	7.70	0.39	0.04	2.52E-01	0.77	7.70	0.33	0.03
Chromium	5.14E-02	2.40	24.0	0.02	0.002	4.59E-02	2.40	24.0	0.02	0.002
Copper	5.68E+00	5.60	9.34	1.01	0.61	4.34E+00	5.60	9.34	0.77	0.46
Lead	1.22E+01	4.70	8.90	2.60	1.36	9.44E+00	4.70	8.90	2.01	1.06
Mercury	9.21E-03	1.00	14.1	0.01	0.00	6.97E-03	1.00	14.1	0.01	0.00
Nickel	1.17E-01	1.70	3.40	0.07	0.03	9.54E-02	1.70	3.40	0.06	0.03
Selenium	6.35E-02	0.14	0.21	0.45	0.30	4.55E-02	0.14	0.21	0.33	0.21
Silver	4.82E-02	6.02	60.2	0.01	0.001	3.52E-02	6.02	60.2	0.01	0.001
Zinc	6.65E+01	75.4	754	0.88	0.09	5.05E+01	75.4	754	0.67	0.07

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.15 EU-15 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	4.44E-01	1.04	1.66	0.43	0.27	3.50E-01	1.04	1.66	0.34	0.21
Cadmium	2.75E-01	0.77	7.70	0.36	0.04	2.00E-01	0.77	7.70	0.26	0.03
Chromium	5.71E-02	2.40	24.0	0.02	0.002	4.44E-02	2.40	24.0	0.02	0.002
Copper	5.87E+00	5.60	9.34	1.05	0.63	4.11E+00	5.60	9.34	0.73	0.44
Lead	2.12E+01	4.70	8.90	4.51	2.35	1.43E+01	4.70	8.90	3.05	1.61
Mercury	1.60E-02	1.00	14.1	0.02	0.00	1.28E-02	1.00	14.1	0.01	0.00
Nickel	1.02E-01	1.70	3.40	0.06	0.03	7.44E-02	1.70	3.40	0.04	0.02
Selenium	4.23E-02	0.14	0.21	0.30	0.20	2.68E-02	0.14	0.21	0.19	0.13
Silver	5.93E-02	6.02	60.2	0.01	0.001	3.36E-02	6.02	60.2	0.01	0.001
Zinc	5.65E+01	75.4	754	0.75	0.07	3.71E+01	75.4	754	0.49	0.05

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.16 EU-16 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Placer Gulch to Confluence with Upper West Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	6.79E-01	1.04	1.66	0.65	0.41	5.58E-01	1.04	1.66	0.54	0.34
Cadmium	1.04E+00	0.77	7.70	1.36	0.14	6.83E-01	0.77	7.70	0.89	0.09
Chromium	5.15E-02	2.40	24.0	0.02	0.002	4.25E-02	2.40	24.0	0.02	0.002
Copper	1.73E+01	5.60	9.34	3.10	1.86	1.15E+01	5.60	9.34	2.06	1.24
Lead	7.93E+01	4.70	8.90	16.9	8.81	5.75E+01	4.70	8.90	12.2	6.46
Mercury	3.87E-02	1.00	14.1	0.04	0.003	3.07E-02	1.00	14.1	0.03	0.002
Nickel	2.18E-01	1.70	3.40	0.13	0.06	1.29E-01	1.70	3.40	0.08	0.04
Selenium	2.43E-01	0.14	0.21	1.74	1.14	1.01E-01	0.14	0.21	0.72	0.47
Silver	2.13E-01	6.02	60.2	0.04	0.004	1.19E-01	6.02	60.2	0.02	0.002
Zinc	2.83E+02	75.4	754	3.76	0.38	1.33E+02	75.4	754	1.76	0.18

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.17 EU-17 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Upper West Fork Animas River from Placer Gulch Up to its Source

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	4.18E-01	1.04	1.66	0.40	0.25	3.15E-01	1.04	1.66	0.30	0.19
Cadmium	1.14E-01	0.77	7.70	0.15	0.01	8.86E-02	0.77	7.70	0.12	0.01
Chromium	1.01E-01	2.40	24.0	0.04	0.004	6.61E-02	2.40	24.0	0.03	0.003
Copper	3.83E+00	5.60	9.34	0.68	0.41	2.92E+00	5.60	9.34	0.52	0.31
Lead	3.43E+00	4.70	8.90	0.73	0.38	2.51E+00	4.70	8.90	0.53	0.28
Mercury	5.55E-03	1.00	14.1	0.01	0.0004	4.88E-03	1.00	14.1	0.005	0.0003
Nickel	1.64E-01	1.70	3.40	0.10	0.05	1.03E-01	1.70	3.40	0.06	0.03
Selenium	9.15E-02	0.14	0.21	0.65	0.43	4.58E-02	0.14	0.21	0.33	0.21
Silver	2.08E-02	6.02	60.2	0.003	0.0003	1.22E-02	6.02	60.2	0.002	0.0002
Zinc	2.43E+01	75.4	754	0.32	0.03	2.12E+01	75.4	754	0.28	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.18 EU-18 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.91E-01	1.04	1.66	0.57	0.36	4.38E-01	1.04	1.66	0.42	0.26
Cadmium	2.23E-01	0.77	7.70	0.29	0.03	1.91E-01	0.77	7.70	0.25	0.02
Chromium	3.89E-02	2.40	24.0	0.02	0.002	3.18E-02	2.40	24.0	0.01	0.001
Copper	1.85E+00	5.60	9.34	0.33	0.20	1.66E+00	5.60	9.34	0.30	0.18
Lead	4.94E+00	4.70	8.90	1.05	0.55	3.73E+00	4.70	8.90	0.79	0.42
Mercury	8.04E-03	1.00	14.1	0.01	0.001	4.41E-03	1.00	14.1	0.004	0.0003
Nickel	7.63E-02	1.70	3.40	0.04	0.02	6.39E-02	1.70	3.40	0.04	0.02
Selenium	2.11E-01	0.14	0.21	1.51	0.99	4.56E-02	0.14	0.21	0.33	0.21
Silver	2.00E-02	6.02	60.2	0.003	0.0003	1.41E-02	6.02	60.2	0.002	0.0002
Zinc	3.48E+01	75.4	754	0.46	0.05	2.60E+01	75.4	754	0.35	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.19 EU-19 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Burrows Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.66E-01	1.04	1.66	0.54	0.34	5.03E-01	1.04	1.66	0.48	0.30
Cadmium	2.25E-01	0.77	7.70	0.29	0.03	2.11E-01	0.77	7.70	0.27	0.03
Chromium	5.00E-02	2.40	24.0	0.02	0.002	3.80E-02	2.40	24.0	0.02	0.002
Copper	3.27E+00	5.60	9.34	0.58	0.35	3.05E+00	5.60	9.34	0.54	0.33
Lead	5.58E+00	4.70	8.90	1.19	0.62	4.44E+00	4.70	8.90	0.94	0.50
Mercury	5.36E-03	1.00	14.1	0.01	0.00	3.91E-03	1.00	14.1	0.004	0.0003
Nickel	9.82E-02	1.70	3.40	0.06	0.03	8.27E-02	1.70	3.40	0.05	0.02
Selenium	6.67E-02	0.14	0.21	0.48	0.31	3.01E-02	0.14	0.21	0.22	0.14
Silver	1.92E-02	6.02	60.2	0.003	0.0003	1.32E-02	6.02	60.2	0.002	0.0002
Zinc	2.45E+01	75.4	754	0.33	0.03	2.17E+01	75.4	754	0.29	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.20 EU-DR01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.60E-01	1.04	1.66	0.15	0.10	1.40E-01	1.04	1.66	0.13	0.08
Cadmium	1.14E-01	0.77	7.70	0.15	0.01	9.92E-02	0.77	7.70	0.13	0.01
Chromium	9.70E-02	2.40	24.0	0.04	0.004	8.20E-02	2.40	24.0	0.03	0.00
Copper	1.77E+00	5.60	9.34	0.32	0.19	1.58E+00	5.60	9.34	0.28	0.17
Lead	2.52E+00	4.70	8.90	0.54	0.28	2.13E+00	4.70	8.90	0.45	0.24
Mercury	3.71E-03	1.00	14.1	0.004	0.0003	3.06E-03	1.00	14.1	0.003	0.0002
Nickel	1.30E-01	1.70	3.40	0.08	0.04	1.18E-01	1.70	3.40	0.07	0.03
Selenium	2.81E-01	0.14	0.21	2.01	1.31	1.06E-01	0.14	0.21	0.75	0.49
Silver	1.52E-02	6.02	60.2	0.003	0.0003	1.16E-02	6.02	60.2	0.002	0.0002
Zinc	2.49E+01	75.4	754	0.33	0.03	2.14E+01	75.4	754	0.28	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.21 EU-DR02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.30E-01	1.04	1.66	0.12	0.08	1.20E-01	1.04	1.66	0.12	0.07
Cadmium	1.14E-01	0.77	7.70	0.15	0.01	1.02E-01	0.77	7.70	0.13	0.01
Chromium	1.04E-01	2.40	24.0	0.04	0.004	9.04E-02	2.40	24.0	0.04	0.004
Copper	1.62E+00	5.60	9.34	0.29	0.17	1.49E+00	5.60	9.34	0.27	0.16
Lead	2.02E+00	4.70	8.90	0.43	0.22	1.80E+00	4.70	8.90	0.38	0.20
Mercury	5.94E-03	1.00	14.1	0.01	0.0004	4.89E-03	1.00	14.1	0.005	0.0003
Nickel	1.53E-01	1.70	3.40	0.09	0.04	1.36E-01	1.70	3.40	0.08	0.040
Selenium	1.53E-01	0.14	0.21	1.09	0.71	5.84E-02	0.14	0.21	0.42	0.27
Silver	1.07E-02	6.02	60.2	0.002	0.0002	9.07E-03	6.02	60.2	0.002	0.0002
Zinc	2.45E+01	75.4	754	0.33	0.03	2.23E+01	75.4	754	0.30	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.22 Reference Exposure Unit Bear Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Bear Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.75E-01	1.04	1.66	0.17	0.11	1.53E-01	1.04	1.66	0.15	0.09
Cadmium	5.87E-02	0.77	7.70	0.08	0.01	5.37E-02	0.77	7.70	0.07	0.01
Chromium	4.56E-02	2.40	24.0	0.02	0.002	4.54E-02	2.40	24.0	0.02	0.002
Copper	8.08E-01	5.60	9.34	0.14	0.09	7.66E-01	5.60	9.34	0.14	0.08
Lead	7.79E-01	4.70	8.90	0.17	0.09	6.56E-01	4.70	8.90	0.14	0.07
Mercury	1.97E-03	1.00	14.1	0.002	0.0001	1.87E-03	1.00	14.1	0.002	0.0001
Nickel	1.00E-01	1.70	3.40	0.06	0.03	9.69E-02	1.70	3.40	0.06	0.03
Selenium	7.95E-02	0.14	0.21	0.57	0.37	6.89E-02	0.14	0.21	0.49	0.32
Silver	1.31E-03	6.02	60.2	0.0002	0.00002	8.01E-04	6.02	60.2	0.0001	0.00001
Zinc	1.11E+01	75.4	754	0.15	0.01	1.10E+01	75.4	754	0.15	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.23 Reference Exposure Unit Hermosa Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Hermosa Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.14E-02	1.04	1.66	0.02	0.01	2.14E-02	1.04	1.66	0.02	0.01
Cadmium	8.61E-03	0.77	7.70	0.01	0.001	8.61E-03	0.77	7.70	0.01	0.001
Chromium	2.72E-01	2.40	24.0	0.11	0.01	2.72E-01	2.40	24.0	0.11	0.01
Copper	5.25E-01	5.60	9.34	0.09	0.06	5.25E-01	5.60	9.34	0.09	0.06
Lead	1.87E-01	4.70	8.90	0.04	0.02	1.87E-01	4.70	8.90	0.04	0.02
Mercury	1.25E-03	1.00	14.1	0.001	0.0001	1.25E-03	1.00	14.1	0.001	0.0001
Nickel	1.95E-01	1.70	3.40	0.11	0.06	1.95E-01	1.70	3.40	0.11	0.06
Selenium	1.32E-01	0.14	0.21	0.95	0.62	1.32E-01	0.14	0.21	0.95	0.62
Silver	3.37E-04	6.02	60.2	0.0001	0.00001	3.37E-04	6.02	60.2	0.0001	0.00001
Zinc	4.70E+00	75.4	754	0.06	0.01	4.70E+00	75.4	754	0.06	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.24 Reference Exposure Unit Maggie Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Maggie Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.53E-01	1.04	1.66	0.15	0.09	1.19E-01	1.04	1.66	0.11	0.07
Cadmium	5.25E-02	0.77	7.70	0.07	0.01	3.74E-02	0.77	7.70	0.05	0.005
Chromium	3.81E-02	2.40	24.0	0.02	0.002	3.34E-02	2.40	24.0	0.01	0.001
Copper	9.28E-01	5.60	9.34	0.17	0.10	8.32E-01	5.60	9.34	0.15	0.09
Lead	4.71E-01	4.70	8.90	0.10	0.05	4.35E-01	4.70	8.90	0.09	0.05
Mercury	1.53E-02	1.00	14.1	0.02	0.00	8.92E-03	1.00	14.1	0.01	0.001
Nickel	9.40E-02	1.70	3.40	0.06	0.03	8.83E-02	1.70	3.40	0.05	0.03
Selenium	1.27E-01	0.14	0.21	0.91	0.59	5.22E-02	0.14	0.21	0.37	0.24
Silver	6.82E-03	6.02	60.2	0.001	0.0001	3.16E-03	6.02	60.2	0.001	0.0001
Zinc	8.37E+00	75.4	754	0.11	0.01	7.38E+00	75.4	754	0.10	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.25 Reference Exposure Unit Mill Creek Estimated Daily Dose (EDDs) Hazard Quotients (HQs) for Muskrat Foraging in Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.26E-01	1.04	1.66	0.12	0.08	1.26E-01	1.04	1.66	0.12	0.08
Cadmium	1.01E-01	0.77	7.70	0.13	0.01	1.01E-01	0.77	7.70	0.13	0.01
Chromium	1.05E-02	2.40	24.0	0.004	0.0004	1.05E-02	2.40	24.0	0.004	0.0004
Copper	6.17E-01	5.60	9.34	0.11	0.07	6.17E-01	5.60	9.34	0.11	0.07
Lead	3.33E+00	4.70	8.90	0.71	0.37	3.33E+00	4.70	8.90	0.71	0.37
Mercury	1.01E-03	1.00	14.1	0.001	0.0001	1.01E-03	1.00	14.1	0.001	0.0001
Nickel	4.19E-02	1.70	3.40	0.02	0.01	4.19E-02	1.70	3.40	0.02	0.01
Selenium	6.24E-02	0.14	0.21	0.45	0.29	6.24E-02	0.14	0.21	0.45	0.29
Silver	2.70E-04	6.02	60.2	0.00004	0.000004	2.70E-04	6.02	60.2	0.00004	0.000004
Zinc	1.54E+01	75.4	754	0.20	0.02	1.54E+01	75.4	754	0.20	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.26 Reference Exposure Unit Picayne Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in Picayne Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	6.73E-01	1.04	1.66	0.65	0.41	5.16E-01	1.04	1.66	0.50	0.31
Cadmium	8.30E-02	0.77	7.70	0.11	0.01	7.95E-02	0.77	7.70	0.10	0.01
Chromium	6.13E-02	2.40	24.0	0.03	0.003	5.65E-02	2.40	24.0	0.02	0.002
Copper	1.04E+00	5.60	9.34	0.19	0.11	9.78E-01	5.60	9.34	0.17	0.10
Lead	1.47E+00	4.70	8.90	0.31	0.16	9.83E-01	4.70	8.90	0.21	0.11
Mercury	2.90E-03	1.00	14.1	0.003	0.0002	2.14E-03	1.00	14.1	0.002	0.0002
Nickel	1.34E-01	1.70	3.40	0.08	0.04	1.21E-01	1.70	3.40	0.07	0.04
Selenium	9.10E-02	0.14	0.21	0.65	0.43	4.29E-02	0.14	0.21	0.31	0.20
Silver	1.31E-02	6.02	60.2	0.002	0.0002	1.05E-02	6.02	60.2	0.002	0.0002
Zinc	1.51E+01	75.4	754	0.20	0.02	1.42E+01	75.4	754	0.19	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A22.27 Reference Exposure Unit North Fork Animas River Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Muskrat Foraging in North Fork Animas River Above Burrows Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	7.41E-01	1.04	1.66	0.71	0.45	5.99E-01	1.04	1.66	0.58	0.36
Cadmium	2.82E-01	0.77	7.70	0.37	0.04	2.47E-01	0.77	7.70	0.32	0.03
Chromium	3.84E-02	2.40	24.0	0.02	0.002	3.09E-02	2.40	24.0	0.01	0.001
Copper	1.09E+00	5.60	9.34	0.19	0.12	9.70E-01	5.60	9.34	0.17	0.10
Lead	2.97E+00	4.70	8.90	0.63	0.33	2.18E+00	4.70	8.90	0.46	0.25
Mercury	5.95E-03	1.00	14.1	0.01	0.0004	4.76E-03	1.00	14.1	0.005	0.0003
Nickel	7.13E-02	1.70	3.40	0.04	0.02	6.79E-02	1.70	3.40	0.04	0.02
Selenium	7.91E-02	0.14	0.21	0.57	0.37	3.07E-02	0.14	0.21	0.22	0.14
Silver	1.94E-02	6.02	60.2	0.003	0.0003	1.38E-02	6.02	60.2	0.002	0.0002
Zinc	3.05E+01	75.4	754	0.40	0.04	2.52E+01	75.4	754	0.33	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Appendix 23

Raccoon Estimated Daily Dose Hazard Quotient Tables for the Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment

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Table A23.1 EU-01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Mineral Creek from Animas River to South Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.72E-01	1.04	1.66	0.36	0.22	2.72E-01	1.04	1.66	0.26	0.16
Cadmium	2.75E-02	0.77	7.70	0.04	0.004	2.42E-02	0.77	7.70	0.03	0.003
Chromium	3.11E-02	2.40	24.0	0.01	0.001	1.77E-02	2.40	24.0	0.01	0.001
Copper	8.10E-01	5.60	9.34	0.14	0.09	7.09E-01	5.60	9.34	0.13	0.08
Lead	1.64E+00	4.70	9.00	0.35	0.18	1.36E+00	4.70	9.00	0.29	0.15
Mercury	2.23E-02	1.00	14.1	0.02	0.002	1.08E-02	1.00	14.1	0.01	0.001
Nickel	2.83E-01	1.70	3.40	0.17	0.08	2.32E-01	1.70	3.40	0.14	0.07
Selenium	7.38E-01	0.14	0.21	5.27	3.45	2.90E-01	0.14	0.21	2.07	1.35
Silver	6.98E-02	6.02	60.2	0.01	0.001	4.02E-02	6.02	60.2	0.01	0.001
Zinc	6.94E+00	75.4	754	0.09	0.01	5.72E+00	75.4	754	0.08	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.2 EU-02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Mainstem Mineral Creek from South Fork to Middle Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.00E-01	1.04	1.66	0.48	0.30	3.76E-01	1.04	1.66	0.36	0.23
Cadmium	2.58E-02	0.77	7.70	0.03	0.003	2.18E-02	0.77	7.70	0.03	0.003
Chromium	1.17E-02	2.40	24.0	0.005	0.0005	8.45E-03	2.40	24.0	0.004	0.0004
Copper	5.45E-01	5.60	9.34	0.10	0.06	5.06E-01	5.60	9.34	0.09	0.05
Lead	2.29E+00	4.70	9.00	0.49	0.25	1.98E+00	4.70	9.00	0.42	0.22
Mercury	1.01E-02	1.00	14.1	0.01	0.001	6.18E-03	1.00	14.1	0.01	0.0004
Nickel	1.35E-01	1.70	3.40	0.08	0.04	1.12E-01	1.70	3.40	0.07	0.03
Selenium	1.57E-01	0.14	0.21	1.12	0.73	1.31E-01	0.14	0.21	0.94	0.61
Silver	2.47E-02	6.02	60.2	0.004	0.0004	1.28E-02	6.02	60.2	0.002	0.0002
Zinc	1.13E+01	75.4	754	0.15	0.02	7.26E+00	75.4	754	0.10	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.3 EU-03 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Mainstem Mineral Creek from Middle Fork Mineral Creek to Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.63E-01	1.04	1.66	0.25	0.16	1.90E-01	1.04	1.66	0.18	0.11
Cadmium	7.17E-02	0.77	7.70	0.09	0.01	4.48E-02	0.77	7.70	0.06	0.01
Chromium	2.08E-01	2.40	24.0	0.09	0.01	1.41E-01	2.40	24.0	0.06	0.01
Copper	1.15E+00	5.60	9.34	0.21	0.12	7.78E-01	5.60	9.34	0.14	0.08
Lead	3.65E+00	4.70	9.00	0.78	0.41	1.93E+00	4.70	9.00	0.41	0.21
Mercury	6.51E-03	1.00	14.1	0.01	0.0005	4.18E-03	1.00	14.1	0.004	0.0003
Nickel	3.69E-02	1.70	3.40	0.02	0.01	2.19E-02	1.70	3.40	0.01	0.01
Selenium	1.51E-01	0.14	0.21	1.08	0.71	1.20E-01	0.14	0.21	0.86	0.56
Silver	2.15E-02	6.02	60.2	0.004	0.0004	1.06E-02	6.02	60.2	0.002	0.0002
Zinc	2.10E+01	75.4	754	0.28	0.03	1.40E+01	75.4	754	0.19	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.4 EU-04 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Mineral Creek Upstream of Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.27E+00	1.04	1.66	1.22	0.77	1.00E+00	1.04	1.66	0.97	0.61
Cadmium	8.09E-02	0.77	7.70	0.11	0.01	5.95E-02	0.77	7.70	0.08	0.01
Chromium	1.18E-02	2.40	24.0	0.005	0.0005	9.15E-03	2.40	24.0	0.004	0.0004
Copper	2.08E+00	5.60	9.34	0.37	0.22	1.52E+00	5.60	9.34	0.27	0.16
Lead	1.12E+01	4.70	9.00	2.39	1.25	7.87E+00	4.70	9.00	1.67	0.87
Mercury	3.67E-02	1.00	14.1	0.04	0.003	1.99E-02	1.00	14.1	0.02	0.001
Nickel	3.50E-01	1.70	3.40	0.21	0.10	2.19E-01	1.70	3.40	0.13	0.06
Selenium	7.55E-02	0.14	0.21	0.54	0.35	7.55E-02	0.14	0.21	0.54	0.35
Silver	1.40E-01	6.02	60.2	0.02	0.002	1.40E-01	6.02	60.2	0.02	0.002
Zinc	3.62E+01	75.4	754	0.48	0.05	3.55E+01	75.4	754	0.47	0.05

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.5 EU-05 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in South Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	9.40E-02	1.04	1.66	0.09	0.06	7.35E-02	1.04	1.66	0.07	0.04
Cadmium	2.94E-02	0.77	7.70	0.04	0.004	2.19E-02	0.77	7.70	0.03	0.003
Chromium	1.49E-01	2.40	24.0	0.06	0.006	1.40E-01	2.40	24.0	0.06	0.01
Copper	2.02E-01	5.60	9.34	0.04	0.02	1.85E-01	5.60	9.34	0.03	0.02
Lead	4.75E-01	4.70	9.00	0.10	0.05	3.54E-01	4.70	9.00	0.08	0.04
Mercury	4.93E-03	1.00	14.1	0.005	0.0003	3.75E-03	1.00	14.1	0.004	0.0003
Nickel	4.48E-02	1.70	3.40	0.03	0.01	3.37E-02	1.70	3.40	0.02	0.01
Selenium	1.94E-01	0.14	0.21	1.39	0.91	1.70E-01	0.14	0.21	1.21	0.79
Silver	7.63E-03	6.02	60.2	0.001	0.0001	6.11E-03	6.02	60.2	0.001	0.0001
Zinc	5.80E+00	75.4	754	0.08	0.01	4.01E+00	75.4	754	0.05	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.6 EU-06 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Middle Fork Mineral Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.34E-01	1.04	1.66	0.13	0.08	1.10E-01	1.04	1.66	0.11	0.07
Cadmium	1.58E-02	0.77	7.70	0.02	0.002	1.34E-02	0.77	7.70	0.02	0.002
Chromium	7.86E-03	2.40	24.0	0.003	0.0003	6.74E-03	2.40	24.0	0.003	0.0003
Copper	2.23E-01	5.60	9.34	0.04	0.02	1.94E-01	5.60	9.34	0.03	0.02
Lead	5.94E-01	4.70	9.00	0.13	0.07	4.96E-01	4.70	9.00	0.11	0.06
Mercury	1.44E-03	1.00	14.1	0.001	0.0001	1.02E-03	1.00	14.1	0.001	0.0001
Nickel	7.00E-02	1.70	3.40	0.04	0.02	4.61E-02	1.70	3.40	0.03	0.01
Selenium	1.30E-01	0.14	0.21	0.93	0.61	1.18E-01	0.14	0.21	0.85	0.55
Silver	2.47E-02	6.02	60.2	0.004	0.0004	1.68E-02	6.02	60.2	0.003	0.0003
Zinc	2.24E+00	75.4	754	0.03	0.003	2.08E+00	75.4	754	0.03	0.003

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.7 EU-07 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in the Animas River from the Confluence with Arrastra Creek to Howardsville

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.97E-01	1.04	1.66	0.19	0.12	1.65E-01	1.04	1.66	0.16	0.10
Cadmium	7.77E-02	0.77	7.70	0.10	0.01	6.72E-02	0.77	7.70	0.09	0.01
Chromium	2.32E-02	2.40	24.0	0.01	0.001	1.99E-02	2.40	24.0	0.01	0.001
Copper	1.57E+00	5.60	9.34	0.28	0.17	1.37E+00	5.60	9.34	0.24	0.15
Lead	8.56E+00	4.70	9.00	1.82	0.95	7.31E+00	4.70	9.00	1.56	0.81
Mercury	1.26E-02	1.00	14.1	0.01	0.001	8.61E-03	1.00	14.1	0.01	0.001
Nickel	3.16E-01	1.70	3.40	0.19	0.09	2.74E-01	1.70	3.40	0.16	0.08
Selenium	1.05E-01	0.14	0.21	0.75	0.49	8.93E-02	0.14	0.21	0.64	0.42
Silver	2.28E-01	6.02	60.2	0.04	0.004	1.79E-01	6.02	60.2	0.03	0.003
Zinc	2.39E+01	75.4	754	0.32	0.03	1.94E+01	75.4	754	0.26	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.8 EU-08 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Cunningham Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	9.44E-02	1.04	1.66	0.09	0.06	7.08E-02	1.04	1.66	0.07	0.04
Cadmium	3.27E-02	0.77	7.70	0.04	0.004	2.83E-02	0.77	7.70	0.04	0.004
Chromium	1.97E-02	2.40	24.0	0.01	0.001	1.63E-02	2.40	24.0	0.01	0.001
Copper	6.61E-01	5.60	9.34	0.12	0.07	4.78E-01	5.60	9.34	0.09	0.05
Lead	3.77E+00	4.70	9.00	0.80	0.42	2.61E+00	4.70	9.00	0.56	0.29
Mercury	4.56E-03	1.00	14.1	0.005	0.0003	2.18E-03	1.00	14.1	0.002	0.0002
Nickel	1.70E-01	1.70	3.40	0.10	0.05	1.40E-01	1.70	3.40	0.08	0.04
Selenium	3.00E-01	0.14	0.21	2.14	1.40	1.43E-01	0.14	0.21	1.02	0.67
Silver	6.47E-02	6.02	60.2	0.01	0.001	4.67E-02	6.02	60.2	0.01	0.001
Zinc	5.63E+00	75.4	754	0.07	0.01	5.01E+00	75.4	754	0.07	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.9 EU-09 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in the Animas River from Howardsville to Minnie Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	1.32E-01	1.04	1.66	0.13	0.08	1.09E-01	1.04	1.66	0.11	0.07
Cadmium	8.82E-02	0.77	7.70	0.11	0.01	7.36E-02	0.77	7.70	0.10	0.01
Chromium	1.46E-01	2.40	24.0	0.06	0.01	1.40E-01	2.40	24.0	0.06	0.01
Copper	2.04E+00	5.60	9.34	0.36	0.22	1.62E+00	5.60	9.34	0.29	0.17
Lead	6.80E+00	4.70	9.00	1.45	0.76	5.38E+00	4.70	9.00	1.14	0.60
Mercury	1.46E-02	1.00	14.1	0.01	0.001	6.17E-03	1.00	14.1	0.01	0.0004
Nickel	1.18E-01	1.70	3.40	0.07	0.03	6.41E-02	1.70	3.40	0.04	0.02
Selenium	9.66E-02	0.14	0.21	0.69	0.45	8.74E-02	0.14	0.21	0.62	0.41
Silver	2.86E-02	6.02	60.2	0.005	0.0005	2.39E-02	6.02	60.2	0.004	0.0004
Zinc	2.08E+01	75.4	754	0.28	0.03	1.65E+01	75.4	754	0.22	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.10 EU-10 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in the Animas River from Minnie Gulch to Eureka

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.95E-01	1.04	1.66	0.38	0.24	3.50E-01	1.04	1.66	0.34	0.21
Cadmium	1.64E-01	0.77	7.70	0.21	0.02	9.70E-02	0.77	7.70	0.13	0.01
Chromium	2.34E-02	2.40	24.0	0.01	0.001	2.18E-02	2.40	24.0	0.01	0.001
Copper	3.38E+00	5.60	9.34	0.60	0.36	2.33E+00	5.60	9.34	0.42	0.25
Lead	1.13E+01	4.70	9.00	2.41	1.26	8.50E+00	4.70	9.00	1.81	0.94
Mercury	1.41E-02	1.00	14.1	0.01	0.001	5.78E-03	1.00	14.1	0.01	0.0004
Nickel	5.49E-01	1.70	3.40	0.32	0.16	3.95E-01	1.70	3.40	0.23	0.12
Selenium	3.55E-01	0.14	0.21	2.53	1.66	1.75E-01	0.14	0.21	1.25	0.82
Silver	9.64E-01	6.02	60.2	0.16	0.02	3.48E-01	6.02	60.2	0.06	0.01
Zinc	3.65E+01	75.4	754	0.48	0.05	2.40E+01	75.4	754	0.32	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.11 EU-11 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Upper South Fork Animas River Up to Confluence with Eureka Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.25E-01	1.04	1.66	0.31	0.20	2.27E-01	1.04	1.66	0.22	0.14
Cadmium	2.40E-02	0.77	7.70	0.03	0.003	2.10E-02	0.77	7.70	0.03	0.003
Chromium	2.98E-02	2.40	24.0	0.01	0.001	2.62E-02	2.40	24.0	0.01	0.001
Copper	6.72E-01	5.60	9.34	0.12	0.07	5.80E-01	5.60	9.34	0.10	0.06
Lead	1.88E+00	4.70	9.00	0.40	0.21	1.23E+00	4.70	9.00	0.26	0.14
Mercury	9.66E-04	1.00	14.1	0.001	0.0001	7.53E-04	1.00	14.1	0.001	0.0001
Nickel	3.98E-01	1.70	3.40	0.23	0.12	2.92E-01	1.70	3.40	0.17	0.09
Selenium	2.04E-01	0.14	0.21	1.46	0.96	1.38E-01	0.14	0.21	0.99	0.65
Silver	6.08E-02	6.02	60.2	0.01	0.001	4.58E-02	6.02	60.2	0.01	0.001
Zinc	5.26E+00	75.4	754	0.07	0.01	4.11E+00	75.4	754	0.05	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.12 EU-12 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Eureka Gulch Up to Confluence with Upper South Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.07E-01	1.04	1.66	0.20	0.12	1.47E-01	1.04	1.66	0.14	0.09
Cadmium	8.94E-02	0.77	7.70	0.12	0.01	7.29E-02	0.77	7.70	0.09	0.01
Chromium	2.32E-02	2.40	24.0	0.01	0.001	1.96E-02	2.40	24.0	0.01	0.001
Copper	1.58E+00	5.60	9.34	0.28	0.17	1.25E+00	5.60	9.34	0.22	0.13
Lead	4.11E+00	4.70	9.00	0.87	0.46	3.21E+00	4.70	9.00	0.68	0.36
Mercury	4.21E-03	1.00	14.1	0.004	0.0003	2.66E-03	1.00	14.1	0.003	0.0002
Nickel	4.45E-01	1.70	3.40	0.26	0.13	3.90E-01	1.70	3.40	0.23	0.11
Selenium	2.81E-01	0.14	0.21	2.01	1.31	1.42E-01	0.14	0.21	1.01	0.66
Silver	1.44E-01	6.02	60.2	0.02	0.002	8.00E-02	6.02	60.2	0.01	0.001
Zinc	2.84E+01	75.4	754	0.38	0.04	2.09E+01	75.4	754	0.28	0.03

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.13 EU-13 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Mainstem South Fork Animas River Up to Confluence

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	2.88E-01	1.04	1.66	0.28	0.17	1.99E-01	1.04	1.66	0.19	0.12
Cadmium	5.67E-02	0.77	7.70	0.07	0.01	5.46E-02	0.77	7.70	0.07	0.01
Chromium	3.07E-02	2.40	24.0	0.01	0.001	2.72E-02	2.40	24.0	0.01	0.001
Copper	1.24E+00	5.60	9.34	0.22	0.13	1.17E+00	5.60	9.34	0.21	0.13
Lead	4.55E+00	4.70	9.00	0.97	0.51	3.82E+00	4.70	9.00	0.81	0.42
Mercury	6.04E-02	1.00	14.1	0.06	0.004	2.92E-02	1.00	14.1	0.03	0.002
Nickel	4.93E-01	1.70	3.40	0.29	0.14	4.11E-01	1.70	3.40	0.24	0.12
Selenium	3.09E-01	0.14	0.21	2.21	1.44	1.74E-01	0.14	0.21	1.24	0.81
Silver	1.10E-01	6.02	60.2	0.02	0.002	8.80E-02	6.02	60.2	0.01	0.001
Zinc	1.79E+01	75.4	754	0.24	0.02	1.51E+01	75.4	754	0.20	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.14 EU-14 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in the Animas River from Eureka to Animas Forks

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	4.66E-01	1.04	1.66	0.45	0.28	3.67E-01	1.04	1.66	0.35	0.22
Cadmium	7.82E-02	0.77	7.70	0.10	0.01	6.50E-02	0.77	7.70	0.08	0.01
Chromium	2.09E-02	2.40	24.0	0.01	0.001	1.87E-02	2.40	24.0	0.01	0.001
Copper	2.16E+00	5.60	9.34	0.39	0.23	1.62E+00	5.60	9.34	0.29	0.17
Lead	7.76E+00	4.70	9.00	1.65	0.86	5.92E+00	4.70	9.00	1.26	0.66
Mercury	1.10E-02	1.00	14.1	0.01	0.001	6.82E-03	1.00	14.1	0.01	0.0005
Nickel	3.36E-01	1.70	3.40	0.20	0.10	2.68E-01	1.70	3.40	0.16	0.08
Selenium	1.11E-01	0.14	0.21	0.79	0.52	8.88E-02	0.14	0.21	0.63	0.42
Silver	1.98E-01	6.02	60.2	0.03	0.003	1.45E-01	6.02	60.2	0.02	0.002
Zinc	2.37E+01	75.4	754	0.31	0.03	1.77E+01	75.4	754	0.24	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.15 EU-15 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Lower West Fork Animas River to Confluence with Placer Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.32E-01	1.04	1.66	0.32	0.20	2.55E-01	1.04	1.66	0.25	0.15
Cadmium	7.12E-02	0.77	7.70	0.09	0.01	5.27E-02	0.77	7.70	0.07	0.01
Chromium	2.32E-02	2.40	24.0	0.01	0.001	1.81E-02	2.40	24.0	0.01	0.001
Copper	2.24E+00	5.60	9.34	0.40	0.24	1.53E+00	5.60	9.34	0.27	0.16
Lead	1.38E+01	4.70	9.00	2.93	1.53	9.18E+00	4.70	9.00	1.95	1.02
Mercury	2.82E-02	1.00	14.1	0.03	0.002	1.94E-02	1.00	14.1	0.02	0.001
Nickel	2.88E-01	1.70	3.40	0.17	0.08	2.03E-01	1.70	3.40	0.12	0.06
Selenium	8.48E-02	0.14	0.21	0.61	0.40	6.51E-02	0.14	0.21	0.47	0.30
Silver	2.44E-01	6.02	60.2	0.04	0.004	1.38E-01	6.02	60.2	0.02	0.002
Zinc	2.01E+01	75.4	754	0.27	0.03	1.29E+01	75.4	754	0.17	0.02

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.16 EU-16 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Placer Gulch to Confluence with Upper West Fork

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.28E-01	1.04	1.66	0.51	0.32	4.26E-01	1.04	1.66	0.41	0.26
Cadmium	2.83E-01	0.77	7.70	0.37	0.04	1.79E-01	0.77	7.70	0.23	0.02
Chromium	2.09E-02	2.40	24.0	0.01	0.001	1.73E-02	2.40	24.0	0.01	0.001
Copper	6.95E+00	5.60	9.34	1.24	0.74	4.56E+00	5.60	9.34	0.81	0.49
Lead	5.35E+01	4.70	9.00	11.4	5.94	3.85E+01	4.70	9.00	8.19	4.28
Mercury	1.17E-01	1.00	14.1	0.12	0.01	8.13E-02	1.00	14.1	0.08	0.01
Nickel	6.70E-01	1.70	3.40	0.39	0.20	3.76E-01	1.70	3.40	0.22	0.11
Selenium	3.13E-01	0.14	0.21	2.24	1.46	1.55E-01	0.14	0.21	1.11	0.73
Silver	8.76E-01	6.02	60.2	0.15	0.01	4.90E-01	6.02	60.2	0.08	0.01
Zinc	1.07E+02	75.4	754	1.42	0.14	4.87E+01	75.4	754	0.65	0.06

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.17 EU-17 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Upper West Fork Animas River from Placer Gulch Up to its Source

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	3.10E-01	1.04	1.66	0.30	0.19	2.27E-01	1.04	1.66	0.22	0.14
Cadmium	3.27E-02	0.77	7.70	0.04	0.004	2.67E-02	0.77	7.70	0.03	0.003
Chromium	4.10E-02	2.40	24.0	0.02	0.002	2.68E-02	2.40	24.0	0.01	0.001
Copper	1.41E+00	5.60	9.34	0.25	0.15	1.05E+00	5.60	9.34	0.19	0.11
Lead	2.01E+00	4.70	9.00	0.43	0.22	1.44E+00	4.70	9.00	0.31	0.16
Mercury	4.58E-03	1.00	14.1	0.005	0.0003	3.65E-03	1.00	14.1	0.004	0.0003
Nickel	4.85E-01	1.70	3.40	0.29	0.14	2.91E-01	1.70	3.40	0.17	0.09
Selenium	1.44E-01	0.14	0.21	1.03	0.67	8.91E-02	0.14	0.21	0.64	0.42
Silver	8.52E-02	6.02	60.2	0.01	0.001	5.00E-02	6.02	60.2	0.01	0.001
Zinc	8.37E+00	75.4	754	0.11	0.01	7.20E+00	75.4	754	0.10	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.18 EU-18 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in North Fork Animas River from Burrows Gulch to Animas Forks

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	4.54E-01	1.04	1.66	0.44	0.27	3.27E-01	1.04	1.66	0.31	0.20
Cadmium	5.81E-02	0.77	7.70	0.08	0.01	5.03E-02	0.77	7.70	0.07	0.01
Chromium	1.58E-02	2.40	24.0	0.01	0.001	1.30E-02	2.40	24.0	0.01	0.001
Copper	6.27E-01	5.60	9.34	0.11	0.07	5.50E-01	5.60	9.34	0.10	0.06
Lead	2.98E+00	4.70	9.00	0.63	0.33	2.21E+00	4.70	9.00	0.47	0.25
Mercury	8.73E-03	1.00	14.1	0.01	0.001	3.05E-03	1.00	14.1	0.003	0.0002
Nickel	2.09E-01	1.70	3.40	0.12	0.06	1.71E-01	1.70	3.40	0.10	0.05
Selenium	2.78E-01	0.14	0.21	1.99	1.30	8.89E-02	0.14	0.21	0.63	0.42
Silver	8.20E-02	6.02	60.2	0.01	0.001	5.76E-02	6.02	60.2	0.01	0.001
Zinc	1.20E+01	75.4	754	0.16	0.02	8.83E+00	75.4	754	0.12	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.19 EU-19 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Burrows Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	4.33E-01	1.04	1.66	0.42	0.26	3.80E-01	1.04	1.66	0.37	0.23
Cadmium	5.95E-02	0.77	7.70	0.08	0.01	5.58E-02	0.77	7.70	0.07	0.01
Chromium	2.03E-02	2.40	24.0	0.01	0.001	1.55E-02	2.40	24.0	0.01	0.001
Copper	1.19E+00	5.60	9.34	0.21	0.13	1.10E+00	5.60	9.34	0.20	0.12
Lead	3.39E+00	4.70	9.00	0.72	0.38	2.66E+00	4.70	9.00	0.57	0.30
Mercury	4.30E-03	1.00	14.1	0.004	0.0003	2.47E-03	1.00	14.1	0.002	0.0002
Nickel	2.75E-01	1.70	3.40	0.16	0.08	2.28E-01	1.70	3.40	0.13	0.07
Selenium	1.15E-01	0.14	0.21	0.82	0.54	6.95E-02	0.14	0.21	0.50	0.32
Silver	7.86E-02	6.02	60.2	0.01	0.001	5.39E-02	6.02	60.2	0.01	0.001
Zinc	8.39E+00	75.4	754	0.11	0.01	7.35E+00	75.4	754	0.10	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.20 EU-DR01 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in the Animas River, Durango Reach from 32nd St. Bridge to James Ranch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.05E-01	1.04	1.66	0.10	0.06	9.03E-02	1.04	1.66	0.09	0.05
Cadmium	3.21E-02	0.77	7.70	0.04	0.004	2.86E-02	0.77	7.70	0.04	0.004
Chromium	3.93E-02	2.40	24.0	0.02	0.002	3.32E-02	2.40	24.0	0.01	0.001
Copper	5.95E-01	5.60	9.34	0.11	0.06	5.21E-01	5.60	9.34	0.09	0.06
Lead	1.44E+00	4.70	9.00	0.31	0.16	1.20E+00	4.70	9.00	0.26	0.13
Mercury	2.24E-03	1.00	14.1	0.002	0.0002	1.59E-03	1.00	14.1	0.002	0.0001
Nickel	3.78E-01	1.70	3.40	0.22	0.11	3.40E-01	1.70	3.40	0.20	0.10
Selenium	3.54E-01	0.14	0.21	2.53	1.65	1.60E-01	0.14	0.21	1.15	0.75
Silver	6.23E-02	6.02	60.2	0.01	0.001	4.75E-02	6.02	60.2	0.01	0.001
Zinc	8.39E+00	75.4	754	0.11	0.01	7.13E+00	75.4	754	0.09	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.21 EU-DR02 Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in the Animas River, Durango Reach from Purple Cliffs to 32nd St. Bridge

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	8.24E-02	1.04	1.66	0.08	0.05	7.55E-02	1.04	1.66	0.07	0.05
Cadmium	3.21E-02	0.77	7.70	0.04	0.004	2.92E-02	0.77	7.70	0.04	0.004
Chromium	4.20E-02	2.40	24.0	0.02	0.002	3.66E-02	2.40	24.0	0.02	0.002
Copper	5.36E-01	5.60	9.34	0.10	0.06	4.86E-01	5.60	9.34	0.09	0.05
Lead	1.13E+00	4.70	9.00	0.24	0.13	9.96E-01	4.70	9.00	0.21	0.11
Mercury	5.16E-03	1.00	14.1	0.01	0.0004	3.66E-03	1.00	14.1	0.004	0.0003
Nickel	4.53E-01	1.70	3.40	0.27	0.13	3.97E-01	1.70	3.40	0.23	0.12
Selenium	2.14E-01	0.14	0.21	1.53	1.00	1.05E-01	0.14	0.21	0.75	0.49
Silver	4.39E-02	6.02	60.2	0.01	0.001	3.73E-02	6.02	60.2	0.01	0.001
Zinc	8.26E+00	75.4	754	0.11	0.01	7.44E+00	75.4	754	0.10	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.22 Reference Exposure Unit Bear Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Bear Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	1.16E-01	1.04	1.66	0.11	0.07	9.95E-02	1.04	1.66	0.10	0.06
Cadmium	1.91E-02	0.77	7.70	0.02	0.002	1.80E-02	0.77	7.70	0.02	0.002
Chromium	1.85E-02	2.40	24.0	0.01	0.001	1.85E-02	2.40	24.0	0.01	0.001
Copper	2.32E-01	5.60	9.34	0.04	0.02	2.17E-01	5.60	9.34	0.04	0.02
Lead	3.87E-01	4.70	9.00	0.08	0.04	3.17E-01	4.70	9.00	0.07	0.04
Mercury	7.22E-04	1.00	14.1	0.001	0.0001	6.62E-04	1.00	14.1	0.001	0.00005
Nickel	2.84E-01	1.70	3.40	0.17	0.08	2.73E-01	1.70	3.40	0.16	0.08
Selenium	1.30E-01	0.14	0.21	0.93	0.61	1.17E-01	0.14	0.21	0.84	0.55
Silver	4.99E-03	6.02	60.2	0.001	0.0001	2.90E-03	6.02	60.2	0.0005	0.00005
Zinc	3.57E+00	75.4	754	0.05	0.005	3.51E+00	75.4	754	0.05	0.005

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.23 Reference Exposure Unit Hermosa Creek Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Hermosa Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	8.85E-03	1.04	1.66	0.01	0.01	8.85E-03	1.04	1.66	0.01	0.01
Cadmium	5.47E-03	0.77	7.70	0.01	0.001	5.47E-03	0.77	7.70	0.01	0.001
Chromium	1.10E-01	2.40	24.0	0.05	0.005	1.10E-01	2.40	24.0	0.05	0.005
Copper	1.35E-01	5.60	9.34	0.02	0.01	1.35E-01	5.60	9.34	0.02	0.01
Lead	6.94E-02	4.70	9.00	0.01	0.01	6.94E-02	4.70	9.00	0.01	0.01
Mercury	3.19E-04	1.00	14.1	0.0003	0.00002	3.19E-04	1.00	14.1	0.0003	0.00002
Nickel	5.91E-01	1.70	3.40	0.35	0.17	5.91E-01	1.70	3.40	0.35	0.17
Selenium	1.91E-01	0.14	0.21	1.36	0.89	1.91E-01	0.14	0.21	1.36	0.89
Silver	9.91E-04	6.02	60.2	0.0002	0.00002	9.91E-04	6.02	60.2	0.0002	0.00002
Zinc	1.43E+00	75.4	754	0.02	0.002	1.43E+00	75.4	754	0.02	0.002

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.24 Reference Exposure Unit Maggie Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Maggie Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	9.95E-02	1.04	1.66	0.10	0.06	7.48E-02	1.04	1.66	0.07	0.05
Cadmium	1.77E-02	0.77	7.70	0.02	0.002	1.39E-02	0.77	7.70	0.02	0.002
Chromium	1.55E-02	2.40	24.0	0.01	0.001	1.36E-02	2.40	24.0	0.01	0.001
Copper	2.75E-01	5.60	9.34	0.05	0.03	2.41E-01	5.60	9.34	0.04	0.03
Lead	2.15E-01	4.70	9.00	0.05	0.02	1.96E-01	4.70	9.00	0.04	0.02
Mercury	2.60E-02	1.00	14.1	0.03	0.002	1.04E-02	1.00	14.1	0.01	0.001
Nickel	2.64E-01	1.70	3.40	0.16	0.08	2.47E-01	1.70	3.40	0.15	0.07
Selenium	1.85E-01	0.14	0.21	1.32	0.86	9.70E-02	0.14	0.21	0.69	0.45
Silver	2.77E-02	6.02	60.2	0.005	0.0005	1.26E-02	6.02	60.2	0.002	0.0002
Zinc	2.64E+00	75.4	754	0.03	0.003	2.31E+00	75.4	754	0.03	0.003

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.25 Reference Exposure Unit Mill Creek Estimated Daily Dose (EDDs) Hazard Quotients (HQs) for Raccoon Foraging in Mill Creek

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.10E-02	1.04	1.66	0.05	0.03	4.64E-02	1.04	1.66	0.04	0.03
Cadmium	2.81E-02	0.77	7.70	0.04	0.004	2.34E-02	0.77	7.70	0.03	0.003
Chromium	1.40E-01	2.40	24.0	0.06	0.006	1.29E-01	2.40	24.0	0.05	0.005
Copper	2.16E-01	5.60	9.34	0.04	0.02	1.70E-01	5.60	9.34	0.03	0.02
Lead	1.42E+00	4.70	9.00	0.30	0.16	1.30E+00	4.70	9.00	0.28	0.14
Mercury	3.08E-03	1.00	14.1	0.003	0.0002	2.29E-03	1.00	14.1	0.002	0.0002
Nickel	1.66E-02	1.70	3.40	0.01	0.005	1.49E-02	1.70	3.40	0.01	0.004
Selenium	1.48E-01	0.14	0.21	1.05	0.69	1.26E-01	0.14	0.21	0.90	0.59
Silver	7.39E-03	6.02	60.2	0.001	0.0001	5.70E-03	6.02	60.2	0.001	0.0001
Zinc	7.62E+00	75.4	754	0.10	0.01	5.69E+00	75.4	754	0.08	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.26 Reference Exposure Unit Picayne Gulch Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in Picayne Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**	**Total EDD (mg/kg BW-d)**	**TRV NOAEL (mg/kg BW-d)**	**TRV LOAEL (mg/kg BW-d)**	**No-effect HQ**	**Low-effect HQ**
Arsenic	5.22E-01	1.04	1.66	0.50	0.31	3.91E-01	1.04	1.66	0.38	0.24
Cadmium	2.48E-02	0.77	7.70	0.03	0.003	2.40E-02	0.77	7.70	0.03	0.003
Chromium	2.49E-02	2.40	24.0	0.01	0.001	2.29E-02	2.40	24.0	0.01	0.001
Copper	3.17E-01	5.60	9.34	0.06	0.03	2.93E-01	5.60	9.34	0.05	0.03
Lead	7.95E-01	4.70	9.00	0.17	0.09	5.05E-01	4.70	9.00	0.11	0.06
Mercury	1.44E-03	1.00	14.1	0.001	0.0001	8.43E-04	1.00	14.1	0.001	0.0001
Nickel	3.91E-01	1.70	3.40	0.23	0.12	3.50E-01	1.70	3.40	0.21	0.10
Selenium	1.43E-01	0.14	0.21	1.02	0.67	8.55E-02	0.14	0.21	0.61	0.40
Silver	5.37E-02	6.02	60.2	0.01	0.001	4.29E-02	6.02	60.2	0.01	0.001
Zinc	4.94E+00	75.4	754	0.07	0.01	4.63E+00	75.4	754	0.06	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Table A23.27 Reference Exposure Unit North Fork Animas River Estimated Daily Dose (EDD) Hazard Quotients (HQs) for Raccoon Foraging in North Fork Animas River Above Burrows Gulch

	RME exposure scenario					CTE exposure scenario				
COPECs	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ	Total EDD (mg/kg BW-d)	TRV NOAEL (mg/kg BW-d)	TRV LOAEL (mg/kg BW-d)	No-effect HQ	Low-effect HQ
Arsenic	5.80E-01	1.04	1.66	0.56	0.35	4.60E-01	1.04	1.66	0.44	0.28
Cadmium	7.25E-02	0.77	7.70	0.09	0.01	6.38E-02	0.77	7.70	0.08	0.01
Chromium	1.56E-02	2.40	24.0	0.01	0.001	1.26E-02	2.40	24.0	0.01	0.001
Copper	3.35E-01	5.60	9.34	0.06	0.04	2.90E-01	5.60	9.34	0.05	0.03
Lead	1.72E+00	4.70	9.00	0.37	0.19	1.23E+00	4.70	9.00	0.26	0.14
Mercury	5.17E-03	1.00	14.1	0.01	0.0004	3.49E-03	1.00	14.1	0.003	0.0002
Nickel	1.94E-01	1.70	3.40	0.11	0.06	1.84E-01	1.70	3.40	0.11	0.05
Selenium	1.29E-01	0.14	0.21	0.92	0.60	7.02E-02	0.14	0.21	0.50	0.33
Silver	7.97E-02	6.02	60.2	0.01	0.001	5.65E-02	6.02	60.2	0.01	0.001
Zinc	1.04E+01	75.4	754	0.14	0.01	8.49E+00	75.4	754	0.11	0.01

COPEC = Contaminant of Potential Ecological Concern

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TRV = Toxicity Reference Value

NOAEL = No Observable Adverse Effect Level

LOAEL = Lowest Observable Adverse Effect Level

mg/kg BW-d = Milligrams per kilogram of body weight per day

Attachment 1

Final
Upper Animas Baseline Ecological Risk Assessment

Final

UPPER ANIMAS BASELINE ECOLOGICAL RISK ASSESSMENT

Bonita Peak Mining District Superfund Site

San Juan County, COLORADO

February 2019

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LIST OF ABBREVIATIONS AND ACRONYMS

Ag	silver
Al	aluminum
As	arsenic
AUF	area use factor
BBridge	Bakers Bridge
BERA	baseline ecological risk assessment
Be	beryllium
BLM	Bureau of Land Management
BTAG	biological technical assistance group
BW	body weight
CCC	criteria continuous concentration
Cd	cadmium
CDPHE	Colorado Department of Public Health and the Environment
CO	Colorado
COPEC	contaminant of potential ecological concern
CDOW	Colorado Division of Wildlife
Cr	chromium
CSM	conceptual site model
CTE	central tendency exposure
Cu	copper
DL	detection limit
DW	dry weight
EcoSSL	ecological soil screening level
EDD	estimated daily dose
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
ER-L	effect range-low
ER-M	effect range-median
EU	exposure unit
Fe	iron
FIR	food ingestion rate
ft	feet
gpm	gallons per minute
HBI	Hilsenhoff Biotic Index
HQ	hazard quotient
HRW	hard reconstituted water
LANL	Los Alamos National Laboratory
LEL	lowest effect level
LOE	line of evidence
mg/kg	milligrams per kilogram (parts per million)
mg/kg.d	milligrams per kilogram per day
mg/kg bw.d	milligrams per kilogram body weight per day
MMI	multi-metric index
Mn	manganese

Ni	nickel
Pb	lead
PEC	probable effect concentration
PEL	probable effect level
RME	reasonable maximum exposure
Se	selenium
SEL	severe effect level
SGC	Sunnyside Gold Corporation
site	mainstem Cement Creek, mainstem Mineral Creek, and the Animas River at and below Silverton
SLERA	screening-level ecological risk assessment
T&E	threatened and endangered
TEC	threshold effect concentration
TEL	threshold effect level
TRV	toxicity reference value
UCL	upper confidence limit
WIR	water ingestion rate
WQC	water quality criteria
Zn	zinc

Summary of Document Drafts and Substantial Revisions	
February 2014	Agency, preliminary review draft (DCN EP8-1-1104); internal review step to identify data gaps and plan for additional data collection activities
March 2015	Agency review draft (DCN EP8-1-1104); internal review to solicit comments from agency reviewers; draft included analysis of additional exposure data collected during the 2014 field sampling season
April 2015	Public release draft (DCN EP8-2-1222); addressed agency comments and was posted on the Region 8 Upper Animas Mining District risk assessment webpage on July 20, 2015; draft was not finalized due to the Gold King Mine spill that occurred August 5, 2015; the April 2015 draft was put on hold until spill impacts could be thoroughly investigated; the scope of ecological risk assessment activities in the Animas River watershed greatly expanded after the spill; the April 2015 draft was revisited when the June 2018 Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment ([BERA] DCN 03072-5-06-R012-RA-0389) was drafted
June 2018	Current external review draft (Attachment 1 of the June 2018 Aquatic BERA); this draft includes an updated wildlife exposure and risk characterization analysis, results, and supporting text; the revised wildlife risk characterization analysis used a different set of avian and mammalian effect toxicity benchmarks than used in previous drafts; revised benchmarks reflect the agencies current risk characterization methodology and were the same as those used in the June 2018 Bonita Peak Mining District Aquatic BERA; besides wildlife risk analyses and supporting text, no substantial updates were made to what was published in the April 2015 BERA (DCN EP8-2-1222)
February 2019	Draft Final (Attachment 1 of the February 2018 Aquatic BERA); this draft includes revisions that were made to address biological technical assistance group (BTAG) comments made on the June 2018 external review draft; refer to BTAG comments and agency responses in Attachment 2 of the February 2018 Aquatic BERA for information on respective revisions

EXECUTIVE SUMMARY

ES.1 Introduction

The Animas River flows through the town of Silverton in San Juan County, Colorado (CO). This waterway is affected by flow which has come in contact with mineralized material, either naturally or as a result of mining activities, such as through the creation of mine adits. Affected water originates in the upper reaches of the two major tributaries of the Animas River in this area, namely Cement Creek and Mineral Creek, and from other tributaries of the Animas River further upstream of Silverton. The tributaries contain high levels of metals and acidity that are carried downstream to the Animas River. This evaluation did not attempt to separate natural contamination from past mining-related contamination but assessed the total risk from all sources combined.

The Exposure Units (EUs) evaluated in this Upper Animas Baseline Ecological Risk Assessment (Upper Animas BERA) consist of the following water bodies:

- *The Animas River above mainstem Cement Creek*: this reach of the Animas River covers about two river miles between sampling locations A60 and A68. All the sampling locations from this reach of the river were combined into a single EU. Location A68 is the furthest downstream in this reach and is located about 1,000 feet (ft) above the confluence with mainstem Cement Creek. Location A56, situated about 1,000 ft above A60 and just upgradient of the Mayflower Mill and the Arrastra Creek, represents regional "upstream" conditions. Note that this BERA did not consider this location to represent reference conditions because both the surface water and sediment samples collected at A56 carry a persistent contaminant signal which appears to be associated with mining or ore-related sources further upstream in the watershed.

- *The Animas River between mainstem Cement Creek and mainstem Mineral Creek*: this reach of the Animas River covers about one river mile between the confluences of the two creeks. Location A69A is about 3,000 ft downstream of the confluence with mainstem Cement Creek (just upstream of Idaho Gulch), whereas location A70B is just upstream of the confluence with mainstem Mineral Creek. Both of these sampling locations are combined into one EU.

- *The Animas River below mainstem Mineral Creek*: this reach of the Animas River covers about 30 river miles between sampling locations A71B and Bakers Bridge (BBridge). The following values represent the approximate distance (in river miles, where appropriate) separating the point where mainstem Mineral Creek enters the Animas River in Silverton and the downstream sampling locations: A71B—around 300 ft, A72—around 3,500 ft, A73/A73B—5.9 miles, A75D/A75B—18.9 miles, and BBridge—30 miles. Each sampling location on this reach of the river is considered as a distinct EU due to the large distances separating A71B and BBridge.

- *Mainstem Cement Creek*: the section evaluated in this BERA is represented by sampling locations CC48 and CC49 found on the creek within one mile of the confluence with the Animas River. Both sampling locations are combined into one EU.

- *Mainstem Mineral Creek*: the section evaluated in this BERA is represented by sampling location M34 found on the creek just upstream of the confluence with the Animas River.

The main goal of this BERA is to refine the risk estimates presented in the Screening-Level Ecological Risk Assessment (SLERA) (EPA, 2013a) for different types of receptor groups, as follows:

- Benthic invertebrates exposed to sediment in mainstem Cement Creek, mainstem Mineral Creek, the Animas River above Cement Creek, and the Animas River below Mineral Creek (note: no sediment samples were collected from the Animas River between mainstem Cement Creek and mainstem Mineral Creek);

- benthic invertebrates exposed to pore water collected from undisturbed bedded sediment in the Animas River;

- fish exposed to surface water in mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River; and

- four wildlife species representing different trophic levels exposed via ingestion of surface water, sediment, and food items from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

The analytes of interest to this BERA consist of Aluminum (Al), Arsenic (As), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Nickel (Ni), Selenium (Se), Silver (Ag), and Zinc (Zn). These metals are the Contaminants of Potential Ecological Concern (COPECs) investigated in the SLERA.

This BERA is a realistic evaluation to quantify risk to community and wildlife-level receptors exposed under current conditions. The evaluation recognizes that mainstem Mineral Creek upstream of the confluence with South Fork Mineral Creek, and mainstem Cement Creek, may not have supported viable fish or macroinvertebrate communities before large-scale mining activities started in the 19th century due to naturally high levels of metals and low pH levels in their surface waters. These two waterways are nonetheless included in this BERA to provide risk estimates and help identify risk drivers and exposure pathways of concern. It is expected that evaluating these waterways within a risk-based context will provide information to support a scientific management decision point for discussion among the stakeholders.

The surface water data represent dozens of samples collected from the five EUs between May 2009 and September 2014. The sediment data set is substantially smaller and consists of analytical data collected from those same waterways during five sampling events in May 2012, October 2012, May 2013, April 2014, and September 2014. The pore water data set consists of analytical data collected in April and September 2014. Samples obtained by the United States Environmental Protection Agency (EPA) and others before May 2009 as part of earlier investigations are not evaluated in this BERA in order to focus on "current" exposure conditions. The available information was reviewed to identify assessment endpoints and measures of effect, and to develop a Conceptual Site Model (CSM) which show the movement of contaminants from the sources to the receptors.

The effects evaluation uses chronic surface water benchmarks (hardness adjusted, if necessary), plus no-effect and effect sediment benchmarks, to quantify toxicity to aquatic community-level receptor groups exposed to surface water, sediment, and pore water. No-effect and effect Toxicity Reference Values (TRVs) for birds and mammals are used to assess the toxicity of metals via ingestion by wildlife receptors. In addition, surface water and sediment toxicity tests were performed in the laboratory on samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above Cement Creek and below Mineral Creek to measure effects to benthic invertebrates (the amphipod *Hyalella azteca*) and juvenile rainbow trout (*Oncorynchus mykiss*).

EPA and others assessed the benthic community structure and function in the five EUs and obtained benthic invertebrate samples for tissue residue analysis as part of additional sampling efforts performed in 2014 to enhance the existing database in support of this BERA.

The original surface water and sediment COPECs for benthic invertebrates and fish were re-selected in this BERA because more analytical data were generated since the SLERA was released in 2013. A metal detected at least once in sediment is retained for use in wildlife food chain modeling but only if it is also identified as an "Important Bioaccumulative Compound" in Table 4-2 of *Bioaccumulation testing and interpretation for the purpose of sediment quality assessment* (EPA, 2000).

Mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River are treated as separate EUs to derive Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) Exposure Point Concentrations (EPCs) for use in the baseline evaluation. The ProUCL software (EPA, 2013b) was used whenever possible (depending on the size of the datasets) to calculate 95% Upper Confidence Levels (UCLs) for use as the RMEs and arithmetic means for use as CTEs. To fine tune the exposure to aquatic community-level receptors, the surface water data are further split into three hydrologic periods, namely the pre-runoff period (February to April), runoff period (May and June), and the post-runoff period (July to November). No surface water data are available for December or January.

The sediment data set is too sparse (five samples) to be split up into the three hydrologic periods. Instead, the sediment analytical data were combined across seasons for each EU to calculate RME and CTE EPCs for the sediment COPECs.

The EPC calculation method varied depending on the EUs, as follows:

- *Animas River above mainstem Cement Creek*: the surface water, sediment, and pore water analytical data were combined across the six sampling locations into separate datasets to calculate COPEC-specific RME and CTE EPCs for these three matrices. Also, a benthic invertebrate sample was collected from two sample locations in this reach for use in tissue residue analysis. These two samples were combined to calculate a mean and maximum tissue concentration for each COPEC for use in wildlife food chain modeling.

- *Animas River between Cement and Mineral Creeks*: only two surface water data points are available from the two sampling locations in this reach of the river. No sediment or benthic invertebrate samples were collected. Hence, wildlife receptors could not be evaluated because that would have required either (a) sediment analytical data to estimate the tissue residue levels in the food items for use in the food chain models, or (b) measured benthic invertebrate tissue residue data. The surface water analytical data were summarized by sampling location for calculating COPEC-specific RME and CTE EPCs to evaluate the fish community.

- *Animas River below mainstem Mineral Creek*: the various EUs in this lower reach of the river are separated by several hundred feet to several miles. As a result, the BERA assumes that wildlife receptors would not be exposed across this entire reach. Instead, the surface water, sediment, pore water, and benthic invertebrate analytical data are summarized by sampling location to calculate COPEC-specific RME and CTE EPCs for use in food chain modeling and to assess exposure to the benthic invertebrates and the fish community. Note that only one benthic invertebrate tissue sample was collected at each sampling location in the Animas River below mainstem Mineral Creek. Hence, the invertebrate tissue RME and CTE EPCs used in the food chain models were the same at each EU.

- *Mainstem Cement Creek*: this BERA does not evaluate wildlife receptors foraging in this EU because the SLERA showed that current chemical conditions in this waterway are too degraded to provide forage for wildlife. The surface water and sediment data from the two sampling locations at the mouth of the creek were used to calculate COPEC-specific RME and CTE EPCs to evaluate risk to the fish and benthic invertebrate community. No pore water samples were collected from this EU.

- *Mainstem Mineral Creek*: this BERA does not evaluate wildlife receptors foraging in this EU because current chemical conditions in this waterway are too degraded to provide

enough forage for wildlife. The surface water, sediment, and pore water data from the sampling location at the mouth of the creek were used to calculate COPEC-specific RME and CTE EPCs to evaluate risk to the fish and benthic invertebrate community.

Exposure to the four wildlife receptor species foraging in the reaches of the Animas River above mainstem Cement Creek and below mainstem Mineral Creek, is quantified using a food chain model which calculates RME and CTE Estimated Daily Doses (EDDs) based on ingesting surface water, sediment, and food items. The food items consist of benthic invertebrates (measured COPEC levels), fish (estimated COPEC levels based on sediment data), and aquatic plants (estimated COPEC levels based on sediment data), depending on the target wildlife species. Contaminant levels in fish and aquatic plants are estimated by multiplying the sediment RME and CTE COPEC levels by published COPEC-specific sediment-to-fish accumulation factors or by using published regression equations. Contaminant levels in benthic invertebrates reflect measured tissue samples collected from the Animas River.

Risk is quantified using the Hazard Quotient (HQ) method, which compares measured exposures (i.e., RME and CTE surface water, sediment and pore water EPCs) or estimated exposures (RME and CTE wildlife EDDs) to chronic surface water benchmarks, no-effect and effect sediment benchmarks, and wildlife TRVs.

A COPEC-specific HQ is calculated using the following general equation:

$$HQ = EPC \text{ or } EDD/benchmark \text{ or } TRV$$

Where:

HQ	=	Hazard Quotient (unitless)
EPC	=	RME and CTE EPC (µg/L or mg/Kg)
EDD	=	RME and CTE EDD (mg/kg bw-day)
Benchmark	=	Chronic surface water benchmark or sediment no effect and effect Benchmark (µg/L or mg/kg, respectively)
TRV	=	No-effect and effect wildlife TRV (mg/kg bw-day)

HQs equal to or above 1.0 identify a potential for ecological risk, whereas HQs below 1.0 are used to eliminate chemicals with assurance that they did not pose a risk.

Besides assessing the potential impacts associated with RME and CTE exposures, the risk characterization for fish and benthic invertebrates also views each surface water and sediment sample as an individual exposure event in time. Hence, HQs were calculated for all available surface water and sediment samples and were used to prepare "scatter plots" by sampling station and hydrologic period (i.e., pre-runoff, runoff, and post-runoff for surface water samples only). Those plots were then used to identify patterns of risk across the waterways and hydrologic periods. Minisipper surface water analytical data collected on a daily basis between mid-April

2014 and mid-July 2014 at four locations on the Animas River were used semi-quantitatively in the risk characterization to support the risk conclusions pertaining to fish.

Finally, toxicity data from fish and benthic invertebrates exposed to surface water and sediment in the laboratory were evaluated statistically to determine which of the observed responses were significantly different from the laboratory control sample. An upstream surface water or sediment reference sample was not available for the statistical comparison due to a lack of Animas River reference locations that had not been impacted. As a result, the laboratory surface water and sediment control samples were used for this purpose.

Uncertainty is inherent in this BERA because many assumptions were made in order to proceed with the investigation. These assumptions affect all aspects of the assessment including the CSM, the effects analysis, the exposure analysis, and the risk characterization. The uncertainty analysis identifies and discusses the major assumptions made in this BERA. The end result is a balanced overview of the degree of uncertainty in this report's results to help risk managers understand the full extent of potential ecological risk to aquatic community and wildlife receptors living or feeding in mainstem Cement Creek, mainstem Mineral Creek, and the Animas River at and below Silverton.

ES.2 Risk conclusions for benthic invertebrates

Taken together, the four independent measurement endpoints evaluated in this BERA (i.e., sediment HQs, pore water HQs, sediment toxicity, and community structure and function) indicate that the benthic invertebrate community is impacted in sections of the Animas River between A60 and BBridge, and in mainstem Cement and Mineral Creeks. The two creeks are the most impaired. In addition, comparing Multi-Metric Index (MMI) scores obtained from the Animas River starting in the early 1990s indicates that the benthic invertebrate community at sampling location A68 (located in the Animas River above mainstem Cement Creek) and at sampling locations A72 and A73 (located in the Animas River below mainstem Mineral Creek) have largely remained impaired over time. The MMI scores at locations further downstream on the Animas River (i.e., A75D and James Ranch [located below BBridge]) show a largely unimpaired benthic invertebrate community, whereas the benthic invertebrate community at BBridge appears to be moderately impaired.

ES.3 Risk conclusions for fish

- **Mainstem Cement Creek**

The chemical conditions in surface water from mainstem Cement Creek are highly toxic to fish, particularly due to low pH and high Al, and to a lesser extent by the presence of Cd, Cu, and Zn. The toxicity tests show that surface water collected from this EU in November 2012 (i.e., post-runoff period) is acutely toxic to juvenile rainbow trout. The preponderance of evidence suggests

that the fish community in mainstem Cement Creek (if present) would experience lethal stress under current conditions.

- **Mainstem Mineral Creek**

The chemical conditions in surface water from mainstem Mineral Creek appear less severe than in mainstem Cement Creek for the local fish community. However, serious pH drops during the pre-runoff period coupled with high Al levels during the pre-runoff and post-runoff periods suggests that fish may experience high stress in the winter as well as summer and fall, but that survivors could possibly recover during the rest of the year (spring). The toxicity tests show that surface water collected from this EU in November 2012 (i.e., post-runoff period) and April 2013 (pre-runoff period) is acutely toxic to juvenile rainbow trout. The preponderance of evidence suggests that the fish community in mainstem Mineral Creek (if present) would likely experience high stress under current conditions.

- **Animas River above mainstem Cement Creek**

The chemical conditions in surface water from this reach of the Animas River between A60 and A68 indicates the presence of one or more sources of metal contamination located further upstream in the watershed. The chemical signature of the surface water suggests that chronic toxicity to the fish community is possible, particularly due to the presence of Al, Cd, and Zn. Low pH, on the other hand, is not an issue in this reach. The presence of significant acute toxicity measured in juvenile rainbow trout acutely exposed to surface water from this reach further confirms the results of the chemical analyses. The preponderance of evidence suggests that the fish community in this reach of the Animas River is likely to be stressed during much of the year.

- **Animas River between mainstem Cement Creek and mainstem Mineral Creek**

Little chemical information on the quality of the surface water is available because only two samples were collected, and no acute toxicity testing was performed. The limited surface water data suggest that this reach of the Animas River is likely to be lethal to fish, mostly due to low pH and high levels of Al, with secondary stress caused by Cd and Zn.

- **Animas River below mainstem Mineral Creek**

The chemical signature of the surface water in this reach of the Animas River reflects the major inputs from mainstem Mineral and Cement Creek, and the reach of the Animas River above mainstem Cement Creek. Surface water samples collected from sampling location A72 during the pre and post-runoff periods are acutely toxic to juvenile rainbow trout. Surface water samples collected during the same two hydrologic periods from the EUs further downstream do not show acute toxicity, suggesting that the effect has been "diluted out". However, the preponderance of evidence shows that Al, Cd, and Zn in surface water are likely to exert chronic effects on the fish

community to at least the BBridge EU located about 30 miles downstream from Silverton. This conclusion is supported by two additional lines of evidence:

- Daily surface water samples collected between April and July 2014 using "MiniSipper" sampling devices positioned at locations A73, A75D and BBridge showed the presence of low-grade and multi-week chronic toxicity associated with dissolved Al, Cd, and Zn during the pre-runoff and runoff periods.

- A fisheries survey performed by the Colorado Division of Wildlife (CDOW) in 2010 on the Animas River in the vicinity of sampling locations A72, A73, and A75D/A75B showed a severe decline of the trout population at all three locations between 2005 and 2010. CDOW ascribed this trout population collapse to a drastic reduction in surface water quality apparently associated with the discontinuance of a water treatment project in the Gladstone area on Cement Creek upgradient from Silverton. A 2014 follow-up fisheries survey by CDOW in the vicinity of sampling location A75D/A75B showed a continued decline in the local brook trout population.

ES.4 Risk conclusions for wildlife receptors

- **Animas River above mainstem Cement Creek**

A potential for high-level risk to American dipper from Pb exposure was identified in this reach. The American dipper was used as a surrogate species to perform an assessment of risk to the southwestern willow flycatcher, which is a federally and state-listed bird species. Evaluation of the surrogate species suggests that the flycatcher may be at risk from foraging in the Animas River above mainstem Cement Creek between sampling location A60 and A68. It is important to note that this conclusion was based on one line of evidence (food chain exposure modeling) and conservative exposure and effects assumptions. Low Pb risks were also identified in the other three wildlife receptors; namely belted kingfisher and muskrat. Of these receptors, kingfisher was determined to be most at risk from Pb exposure with effect HQs ranging from 3.6 to 4.2. Low-level Cu risks were also identified for American dipper with effect HQs ranging from 1.7 to 1.9.

- **Animas River below mainstem Mineral Creek**

Wildlife risks were evaluated for six sampling locations in this approximate 30-mile reach. All of these sampling locations were on the Animas River, downgradient from the Mineral Creek confluence. Risks from Pb exposure showed a precipitous decline throughout this reach for every wildlife receptor. However, American dipper effect HQs were still elevated, ranging from 5.3 just below Mineral Creek (A73) to 2.7 in the most downriver sampling location at BBridge. The same trend was noted in the belted kingfisher, except that risks were much lower than for the American dipper. Unlike Pb, risks to insectivorous wildlife from Cu exposure increased in this reach; namely in A73B and A75B. Benthic invertebrates (diet of insectivorous wildlife) were not

collected for tissue residue analysis from sampling locations A73B and A75B. Hence, the levels of metals in benthic tissues at these two locations were estimated using conservative published sediment-to-benthic invertebrate regression models and uptake factors for use in the food chain model. It is noteworthy that the only two sampling locations with excessive risk from Cu are A73B and A75B. Given this pattern, it was concluded that the elevated risk to insectivorous wildlife from Cu exposure in these sampling locations may be biased high and not reflect actual exposure regimes. Exposure to the remaining COPECs were of little to no concern to any of the other wildlife receptors.

1.0 GENERAL INTRODUCTION

1.1 Scope

This report is a Baseline Ecological Risk Assessment (BERA) for the aquatic habitats in the Upper Animas River Mining District, located in San Juan County, CO. This report is a follow-up to a Screening-Level Ecological Risk Assessment (SLERA) finalized in 2013 (EPA, 2013a).

The SLERA identified numerous Contaminants of Potential Ecological Concern (COPECs) for community-level and wildlife receptors associated with mainstem Cement Creek, mainstem Mineral Creek and the Animas River just upstream and for about 30 river miles downstream of Silverton. Those COPECs were further analyzed to determine if they represented a risk to various receptor groups in the three waterways. As such, the SLERA provided an initial and conservative assessment of risk and helped determine if enough information was available to support decision making. The SLERA identified unacceptable risk to both community-level and wildlife receptors, which prompted the need for additional sampling to provide more data for use in this BERA.

These data were collected in 2012 and 2013 for inclusion in an initial draft BERA report submitted to the Environmental Protection Agency (EPA) in February 2014. This expanded evaluation did not attempt to separate natural background contamination from past mining-related contamination, but instead assessed the risk from all sources combined. The draft BERA was reviewed by EPA and helped identify remaining data gaps that were addressed during additional sampling in April, May and September 2014 (EPA, 2014). This BERA is the result of these efforts.

The Animas River is divided into three reaches to support this BERA, as follows:

- *The Animas River above mainstem Cement Creek*: this reach of the Animas River covers about two river miles between sampling locations A60 and A68. Location A56, which is situated about 1,000 ft upgradient of A60, represents regional "upstream" conditions. A56 is located just above the Mayflower Mill and Arrastra Creek. Location A68 is about 1,000 ft upstream of the confluence with Cement Creek and is therefore not influenced by the creek (see **Figure 1.1**). Note that the naming of this stretch of the Animas River is arbitrary, and that no samples collected upgradient from sampling location A56 are included in this BERA. Also, the text of this BERA does not refer to sampling location A56 as "reference" because sources of contamination are known to exist in the watershed upstream from A56.

- *The Animas River between mainstem Cement Creek and mainstem Mineral Creek*: this reach of the Animas River covers about one river mile between the confluences of the two creeks. Location A69A is about 3,000 ft downstream of the confluence with

mainstem Cement Creek (just upstream of Idaho Gulch), whereas location A70B is just upstream of the confluence with mainstem Mineral Creek (see **Figure 1.1**).

- *The Animas River below mainstem Mineral Creek*: this reach of the Animas River covers about 30 river miles between sampling locations A71B and Bakers Bridge (BBridge) (see **Figures 1.1 and 1.2**). The following values represent the approximate distance (in river miles, where appropriate) separating the point where mainstem Mineral Creek enters the Animas River in Silverton and the downstream sampling locations: A71B (300 ft), A72 (3,500 ft), A73/A73B (5.9 miles), A75D/A75B (18.9 miles), and BBridge (30 miles). Note that the naming of this stretch of the river is also arbitrary, and that no samples collected downgradient from BBridge are assessed in this BERA.

Two additional waterways are also included in this BERA, as follows:

- *Mainstem Cement Creek*: the section evaluated in this BERA is represented by sampling locations CC48 and CC49, found on the creek just upstream of the confluence with the Animas River (see **Figure 1.1**). The SLERA (EPA, 2013a) also evaluated two more locations upstream from CC48, but these are not included in this BERA because the SLERA showed that neither one could support aquatic life under current conditions.

- *Mainstem Mineral Creek*: the section evaluated in this BERA is represented by sampling location M34, found on the creek just upstream of the confluence with the Animas River (see **Figure 1.1**).

Each of these five stream and river reaches are evaluated as separate Exposure Units (EUs) to select COPECs, calculate exposures, and quantify the potential for ecological risk.

1.2 General ecological risk assessment approach

The following guidance and reference documents were used to prepare this BERA:

- EPA, 1997. *Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final*. Environmental Response Team, Edison, NJ.

- EPA, 1998. *Guidelines for Ecological Risk Assessment*. EPA/630/R-95/002F. EPA (1997) provides the general framework for planning and conducting the investigation.

1.3 Goals and objectives

Benthic invertebrates and fish represent the valued ecological resources to be protected in mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above, across from,

and below Silverton (the "site"). In addition, four representative species of aquatic-dependent birds and mammals were also retained as ecological resources to be protected in the Animas River. These community-level and wildlife receptors provide the basis to develop site goals and objectives, and to select assessment endpoints for this BERA.

The ecological risk management goal for the site is defined as follows:

> "*Promote healthy communities of aquatic and wildlife receptors in the waterways affected by site-related contamination."*

Four ecological risk assessment objectives were identified to accomplish this goal:

- Identify the presence of site-related COPECs that may pose a threat to one or more of the receptor groups;
- Document the potential exposure to those receptor groups using the available analytical datasets;
- Develop risk estimates and discuss major uncertainties; and
- Provide data for risk managers to determine the potential for ecological risk and to have enough information to support the risk management decision-making process.

This BERA recognizes that mainstem Mineral Creek upstream of the confluence with South Fork Mineral Creek, and mainstem Cement Creek, may not have supported a healthy, diverse fish or invertebrate community before large-scale mining activities started in the 19th century due to naturally-high levels of metals and low pH levels in those surface waters (Church *et al*., 1999). These two waterways are nonetheless included in this report in order to provide a conservative risk evaluation and help identify risk drivers and exposure pathways of concern. It is expected that evaluating these naturally impaired waterways within a risk-based context will provide more information to support a scientific management decision point for discussion among the various stakeholders.

2.0 BASELINE PROBLEM FORMULATION

2.1 Data processing

2.1.1 Compiling a database for use in this BERA

The final product of the data evaluation and summarization process is a comprehensive database for all the surface water, sediment, pore water and benthic invertebrate tissue analytical data collected between May 2009 and September 2014 for the site.

Individual data sets were developed by compiling analytical results for each matrix of interest (i.e., surface water, sediment, pore water, benthic invertebrate tissues), analyte group (i.e., total metals, dissolved metals, and pH), EU (i.e., mainstem Cement Creek, mainstem Mineral Creek, and the three Animas River reaches), and sampling locations within each EU, if applicable.

- **Appendix 1** provides the analytical data for pH, hardness, and total and dissolved metals concentrations measured in surface water from mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River between May 2009 and September 2014.
- **Appendix 2** provides the analytical data for total metals in bulk sediment samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River in between 2012 and September 2014.
- **Appendix 3** provides the analytical data for hardness and dissolved metals measured in the pore water samples collected from the Animas River.
- **Appendix 4** provides the tissue residue data (both wet weight and Dry Weight [DW]) for the benthic invertebrates collected from the Animas River in September 2014.

Tables 2.1, 2.2 and 2.3 summarize the surface water, sediment, and pore water sampling efforts, respectively, that have occurred in the various EUs between May 2009 and September 2014. (Note: Section 4.3 explains how surface water samples collected in different months between May 2009 and September 2014 are combined into three distinct hydrologic periods for use in the exposure calculations). The surface water sampling efforts in support of this BERA focused heavily on sampling locations A68 (Animas River above mainstem Cement Creek), A72 (Animas River below mainstem Mineral Creek), CC48 (mainstem Cement Creek close to the confluence with the Animas River) and M34 (mainstem Mineral Creek close to the confluence with the Animas River). The other sampling locations were either not sampled or sampled only occasionally.

2.1.2 Data summarization method

The analytical data for total metals (unfiltered samples), dissolved metals (filtered samples), and pH in mainstem Cement Creek, mainstem Mineral Creek, and the three Animas River reaches are summarized separately by waterway, as follows:

- frequency of detection (number of detected values over the number of samples analyzed),
- minimum detected value (with data qualifier),
- maximum detected value (with data qualifier), and
- sampling location of the maximum detected value.

The following procedures were applied to compile data for a metal in a given matrix to calculate the summary statistics used in this BERA:

- Results assigned qualifiers indicating that an analyte was positively detected or presumptively present (i.e., data without flags or flagged as "D" [diluted] or "J" [estimated]) were retained as reported for use in the exposure calculations.

- Results assigned qualifiers indicating that an analyte was not positively detected (i.e., data flagged as "U" [non-detected] or "UJ" [estimated non-detected]) were retained at one-half their Detection Limit (DL).

- Any results considered of inadequate quality (i.e., data qualified as "R") were not used in the risk calculations.

- Analytical results for samples collected from the same location but during different sampling events were considered unique samples and were not combined.

- Analytical data from duplicate samples (i.e., samples collected at the same location and date) were averaged. These data were handled as follows:

    - If both samples had a detected value, the average concentration and the most conservative of the two data qualifiers was used as the maximum value (e.g., if one value had no flag and the second value was flagged as "J", then the average concentration was calculated and flagged as "J").

    - If one of the duplicates had a detected value and the other had an undetected value, then only the detected value and its associated flag (if applicable) was used as the maximum value. This approach was necessary because in some cases the undetected value was substantially higher than the detected value due to a difference in the way the samples were diluted, thus affecting the DLs. Taking an average of these two numbers would have artificially inflated the exposure concentration.

- If the values in both samples were non-detect, then the highest of the two method DLs was used.

2.2 Problem formulation

2.2.1 Environmental setting and contaminants at the site

2.2.1.1 Brief site description and history

The information summarized in this subsection was obtained from Church, S.E., P. von Guerard, and S.E. Finger, eds., 2007. *Integrated investigations of environmental effects of historical mining in the Animas River watershed, San Juan County, Colorado. U.S. Geological Survey Professional Paper 1651*, 1,096p. plus CD-ROM (in two volumes), and EPA (2012) *Final Sampling and Analysis Plan/Quality Assurance Project Plan. 2012 Sampling Events. Upper Animas Mining District, Gladstone, San Juan County, Colorado*.

The mining district is located in the northernmost headwaters of the Animas River watershed in San Juan County, CO. It covers the drainage basin of the Animas River at and upstream of the town of Silverton, CO, its two main tributaries (i.e., Cement Creek and Mineral Creek), and the Animas River below the confluence with Mineral Creek. Elevations in the watershed range between about 9,000 ft and 13,500 ft.

The discovery of gold and silver brought miners to the area in the early 1870s. The discovery of silver in the base-metal ores was the major factor in establishing Silverton as a permanent settlement. Between 1870 and 1890, the richer ore deposits were discovered and mined. Not until 1890 was a serious attempt made to mine and concentrate the larger low-grade ore bodies in the area. Twelve concentration mills operated in the valley by 1900. All sent their products to the Kendrick and Gelder Smelter near the mouth of Cement Creek in Silverton.

Mining and milling operations slowed down around 1905, and mines were consolidated into fewer and larger operations with the facilities for milling large volumes of ore. After 1907, mining and milling continued in the basin whenever prices were favorable. Gladstone, located about eight miles upstream of Silverton on Cement Creek, is the site of an historic mining town developed in the 1880s in response to the onset of mining. The town was the central location and railroad terminus for milling and shipping mine ores from the surrounding valley. Gladstone declined in the 1920s and no remnants of it remain visible today.

The Sunnyside Mine was the only active year-round mine left in the county by the 1970s. This mine ceased production in 1991 and underwent extensive reclamation. The Gold King Mine's permit with the Division of Reclamation, Mining and Safety was revoked by the Colorado Mined Land Reclamation Board and the financial warranty bond was forfeited in 2005.

The Sunnyside Mine was accessed through the American Tunnel which has its portal in Gladstone on Cement Creek. The American Tunnel drained up to 1,600 gallons per minute (gpm) of water prior to bulkhead installations. The Standard Metals Corporation constructed a lime feed and settling pond-type treatment facility in Gladstone in 1979. Water discharging from the American Tunnel was treated as required by the water discharge permit. The facility operations and mine ownership were later transferred to the Sunnyside Gold Corporation (SGC). SGC installed eleven bulkheads within the Sunnyside Mine as part of a court-ordered consent decree to terminate their discharge permit. These bulkheads greatly reduced the volume of discharge from the American Tunnel. After bulkheading, between 70 and 100 gpm continued to flow from the American Tunnel, presumably from near-surface groundwater.

The treatment facility, operations, and permit were transferred to the Gold King Mines Corporation in January 2003. The settling ponds were deeded to the San Juan Corporation by SGC prior to the lease between the Gold King Mines and San Juan Corporations. The treatment facility continued to treat the American Tunnel discharge and the Gold King discharge until September 2004. The San Juan Corporation required SGC to reclaim the four settling ponds (completed in 2005) when the San Juan Corporation and the SGC lease were terminated. The Gold King Mines Corporation was subsequently evicted, and the balance of the Gold King Mines Corporation land was acquired by the San Juan Corporation as the lien-holder. The American Tunnel portal reclamation and the removal of some out-buildings were completed in 2006. The Bureau of Land Management (BLM) manages land associated with the American Tunnel portal and its immediate vicinity, whereas the San Juan Corporation owns most of the surrounding land.

Many abandoned mines exist within a two-mile radius of Gladstone. They include: the Upper Gold King 7 Level, American Tunnel, Grand Mogul, Mogul, Red and Bonita, Eveline, Henrietta, Joe and John, and Lark mines. Some of these mines have acid mine drainages that produce flows of between 30 and 300 gpm that directly or indirectly enter Cement Creek and eventually reach the Animas River. The Animas River Stakeholder Group, the BLM, and the Division of Reclamation, Mining and Safety have completed remediation projects at the Eveline, Henrietta, Joe and John, and Lark mines.

Existing and historical data suggest that conditions have changed recently at several locations where site-impacted waters enter upper Cement Creek. For example, flows have increased at the Red and Bonita mine and the upper Gold King 7 Level. The data also show higher levels of Aluminum (Al), Cadmium (Cd), Copper (Cu), Manganese (Mn) and Zinc (Zn) in Cement Creek, and downstream in the Animas River at and below Silverton between 2005 and 2007. These increases coincide with the end of active water treatment in Gladstone in 2005 and the installation of bulkheads at the American Tunnel.

The headwaters and tributaries of Cement Creek, Mineral Creek, and the Animas River originate in treeless alpine regions. With a few exceptions, the streams follow high-gradient, narrow

glaciated valleys. The vegetation along those valleys is rather sparse in the presence of extensive areas of exposed rock and talus (i.e., a sloping mass of rock debris at the base of a cliff).

Past surveys of fish and benthic invertebrate communities showed that the headwaters of the Animas River above Silverton, the main stems of Cement and Mineral Creeks, and several smaller tributaries support little or no aquatic life due to the presence of site-related contamination. On the other hand, South Fork Mineral Creek and several tributaries of the upper Animas River drain basins that provide substantial acid-neutralizing capacity and support viable trout populations. The Animas River between Maggie Gulch (located about eight river miles upstream from Silverton) and the mouth of Cement Creek in Silverton, supports brook trout and a moderately-impaired invertebrate community (see Chapters D and E18 in Church *et al*., 2007), which suggests substantial improvements in surface water quality since the 1970s. Note, however, that sections of the Animas River further upstream from Maggie Gulch are still severely impacted by past mining activities. The stream biota in the Animas River downstream from Silverton are also degraded due to input from Cement and Mineral Creeks (see Chapters A, D, E18, and E19 in Church *et al*., 2007).

2.2.1.2 Past sampling of environmental media

This evaluation uses analytical data from surface water and sediment collected between 2009 and 2014 from the Animas River, mainstem Cement Creek, and mainstem Mineral Creek. The BERA also evaluates two rounds of pore water samples collected from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek in April and September 2014. This approach ensures that the aquatic exposures reflected "current" conditions.

2.2.1.3 Suspected contaminants

Acid conditions result from the interaction of sulfide minerals, water, and oxygen, which together yield highly-acidified drainage water. This water dissolves metals, such as Al, Cd, Cu, and Zn, present in bedrock, veins, ore, tailings, and waste rock. These dissolved metals are then transported over land or via groundwater to small tributaries that connect to the site.

The higher pH of the surface water in the Animas River above the confluence with mainstem Cement Creek could cause some of the dissolved metals brought in by the two creeks to precipitate out of solution and become integrated into the substrate. Metals may also be carried in particulate form (e.g., fine tailings) by the water current and deposited in lower-energy areas of the affected waterways. Previous investigations showed that numerous metals in surface water samples from the three targeted waterways exceeded applicable water quality standards (see Chapter D in Church *et al*., 2007).

2.2.2 Ecological resources potentially at risk

The ecological resources of concern in this BERA consist of (a) fish exposed to metals in surface water, (b) benthic invertebrates exposed to metals in sediment and pore water, and (c) representative species of wildlife receptors exposed to metals in surface water, sediment, and prey items obtained from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

A list of Threatened and Endangered (T&E) species was obtained from the Colorado Wildlife Heritage Foundation and from the Colorado Parks and Wildlife (2016) species of concern list for San Juan County, CO. Two mammals identified on the lists are the lynx (*Lynx Canadensis)* and the wolverine (*Gulo gulo).* The lynx is listed as federally threatened and state endangered, while the wolverine is listed as state endangered. The boreal toad (*Bufo boreas boreas)* is listed as state endangered. For birds, the southwestern willow flycatcher (*Empidonax trailii extimus)* is listed as federally endangered and state endangered. This protected species, if present in the riparian habitat along the Animas River at and below Silverton, is assumed to have the potential for exposure to site-derived contamination.

The southwestern willow flycatcher is a small passerine bird which breeds in dense riparian habitats along rivers, streams, or wetlands and feeds on insects. The riparian vegetation can be dominated by dense growths of willows (*Salix* sp.), seepwillow (*Baccharis* sp.), or other shrubs and medium-sized trees. An over story of cottonwood (*Populus* sp.), tamarisk (*Tamarix* sp.), or other large trees may be present, but this is not necessary. In some areas, the flycatcher nests in habitats dominated by tamarisk and Russian olive (*Eleagnus angustifolia*). A key characteristic of breeding habitat appears to be the presence of dense vegetation, usually throughout all vegetation layers present within the habitat.

Almost all southwestern willow flycatcher breeding habitats are less than 20 yards from water. At some sites, surface water is present early in the nesting season, but gradually dries up as the season progresses. Ultimately, the breeding site must have a water table high enough to support riparian vegetation.

Suitable riparian habitat for the southwestern willow flycatcher is available along the shoreline of the Animas River downstream of Silverton, and especially at the lower elevations below BBridge and James Ranch. This BERA conservatively assumes that the species might be present based on its listing in San Juan County and the existence of riparian habitat. The American dipper (see further below) served as a surrogate for the southwestern willow flycatcher.

2.3 Preliminary fate and effects evaluation

A preliminary evaluation of the fate and transport of site-related contamination helps identify potentially complete exposure pathways. A brief summary of the fate and effects information,

together with data on the ecotoxicity of site-related contamination to the community-level and wildlife receptors are discussed below.

2.3.1 Fate and transport

The information provided by Church *et al*. (2007) was reviewed to determine which fate and transport mechanisms might result in complete exposure pathways to aquatic, community-level receptors in the three targeted waterways or to wildlife receptors feeding on aquatic food items in the Animas River (Note: The BERA assumes that wildlife receptors forage only in the Animas River because fish and aquatic invertebrates appear to be largely absent from mainstem Cement and large portions of Mineral Creeks under current conditions).

The goal was to identify the major elements of a complete exposure pathway, which consist of the following components:

- Source(s) of contamination,
- release and transport mechanisms,
- contact points and exposure media,
- routes of entry, and
- key receptors.

Each of these components is discussed below.

- **Sources of contamination**

The major sources of contamination relating to past mining in the watersheds of Cement Creek, Mineral Creek, and the Animas River above Silverton consist of one or more of the following activities: tunneling to reach the ore veins and to drain groundwater out of mine workings, disposal of waste and overburden rock, and disposal of mine tailings on land and in waterways.

Additionally, natural sources of regional contamination consist of groundwater that has come in to contact with undisturbed mineralized materials.

- **Release and transport mechanisms**

Some of the rocks are enriched with sulfide minerals (e.g., pyrrhotite, pyrite and chalcopyrite). These minerals react with water and atmospheric oxygen over time. The oxidation process generates sulfuric acid, which in turn causes metals to dissolve out of host rock, vein rock, waste rock, and tailings. This highly-acidic and metal-rich effluent is toxic to aquatic receptors due to its low pH and high dissolved metals content.

The following release and transport mechanisms may potentially affect the concentration and spatial distribution of metals in the affected waterways:

- Dissolution and leaching of metals from mine waste, host rock, or vein rock into groundwater,
- migration of metals in groundwater to sediment and surface water in adjacent surface water bodies, and its attenuation by dilution or dispersion and sorption,
- transport of metals adsorbed to soil and tailings particles via terrestrial runoff,
- transport of metals in surface water runoff, and
- trophic transfer of metals incorporated in aquatic food chains.

The potential release of site-related contamination and its transport from the sources to points of contact with aquatic receptors in the three targeted waterways depends on its chemical speciation, concentration, presence of nearby surface water bodies, and the extent and duration of precipitation or snowmelt events. Surface water runoff and groundwater infiltration are particularly important transport mechanisms for soluble species of metals.

- **Contact point and exposure media**

Mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of Animas River above, across, and below Silverton are the contact points evaluated in this BERA. The exposure media are as follows:

- Surface water,
- sediment,
- pore water, and
- prey items for wildlife receptors (only in the Animas River above and below Silverton).

- **Routes of entry**

The main routes of entry evaluated in this BERA for aquatic community-level receptors, and wildlife receptors feeding on aquatic prey, are as follows:

- Direct contact with surface water, sediment or pore water via dermal or gill absorption (aquatic community-level receptors),
- surface water ingestion (wildlife receptors),
- incidental sediment ingestion (wildlife receptors), and
- ingestion of contaminated food items (wildlife receptors).

Exposure to metals via inhalation or skin absorption is omitted because it is considered to be minor for wildlife receptors feeding on aquatic food items in an aquatic environment.

- **Key receptors**

    - **Aquatic receptors**

    This BERA assumes that benthic invertebrates live on and within the substrate in mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River. It also assumes that fish live in the water column of mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River.

    - **Wildlife receptors feeding on aquatic food items**

    This BERA assumes that the following types of wildlife receptors could become exposed to site-related contamination while feeding in the three reaches of the Animas River: (a) invertivorous birds, (b) omnivorous birds, (c) piscivorous birds, and (d) herbivorous mammals. Wildlife receptors were not evaluated for risk in mainstem Cement Creek and mainstem Mineral Creek because these two waterways are too impacted under current conditions to provide forage to consistently sustain wildlife populations. Wildlife receptors are also not evaluated for risk from the Animas River between mainstem Cement Creek and mainstem Mineral Creek in Silverton because this reach was not sampled for sediment, which was needed to estimate the contaminant levels in the food items ingested by the wildlife receptors.

- **Ecotoxicity**

Acidity and metals are the two major chemical stressors in the aquatic habitats of interest to this BERA.

Acidity/low pH

Sulfuric acid is released when water and oxygen interact with sulfide-rich materials. Low pH is toxic to aquatic receptors. Sensitive species of fish and aquatic invertebrates experience increased mortality at a pH of around 6.0. For example, brook trout populations are known to disappear from streams when pH drops to the lower 5.0 range for an extended period of time. Other trout species (e.g., rainbow trout or brown trout) are considered more sensitive to increased acidity and are therefore affected sooner than brook trout.

Metals

High acidity solubilizes metals, resulting in metals-enriched surface water runoff. Dissolved metals are of the highest concern because, unlike metals associated with the particulate fraction, they are bioavailable to exert direct toxicity to aquatic receptors.

The relative sensitivity of four trout species (namely, brook trout, brown trout, rainbow trout and cutthroat trout) to Cd, Cu, and Zn was determined in support of this BERA (see **Appendix 5**). The four trout species included in this evaluation may be found in the Animas River above and below Silverton. The three metals of concern are known to be associated with past and current mining and non-mining-related releases in the Animas River watershed. Al is also a key contaminant present in the Animas River. However, this metal is not included in **Appendix 5** because not enough trout-specific toxicity data were found to derive acute and chronic toxicity threshold values.

A literature search was performed to obtain 96-hour acute toxicity data on juvenile life stages to derive acute toxicity thresholds for the three target metals. These thresholds were standardized to a hardness of 50 mg $CaCO_3$/L to allow for a direct comparison of species sensitivity to the three metals.

The table below summarizes the results of this effort. **Appendix 5** provides additional details on the literature search criteria and statistical analysis of the data.

Relative sensitivity of four trout species to three metals in surface water			
Trout Species	**Target metal**	**Acute toxicity thresholds**	**Relative sensitivity**
Brook trout	cadmium	1.15 µg/L	1
brown trout	cadmium	1.21 µg/L	2
rainbow trout	cadmium	1.33 µg/L	3
rainbow trout	copper	13.4 µg/L	1
brown trout	copper	18.1 µg/L	2
brook trout	copper	22.7 µg/L	3
cutthroat trout	copper	24.4 µg/L	4
rainbow trout	zinc	121 µg/L	1
cutthroat trout	zinc	141 µg/L	2
brown trout	zinc	283 µg/L	3
brook trout	zinc	732 µg/L	4

The information provided in the table above can be summarized as follows:

Cadmium

- Acute toxicity data for brook trout, brown trout, and rainbow trout were available to calculate Cd acute toxicity thresholds. Due to a lack of published toxicity data, it is not known how much more or less sensitive cutthroat trout may be compared to these three species.
- The difference in acute toxicity thresholds between the three trout species was minimal and unlikely to be significant.
- Cd was by far the most acutely toxic of the three target metals to trout.

Copper

- Acute toxicity data were available to calculate Cu acute toxicity thresholds for all four trout species.
- The rainbow trout was over two times more sensitive to Cu than the cutthroat trout. The sensitivities of brown trout and brook trout fell between these extremes.
- The acute toxicity of Cu fell in between that of Cd and Zn.

Zinc

- Acute toxicity data were available to calculate Zn acute toxicity thresholds for all four trout species.
- The rainbow trout was six times more sensitive to Zn than the brook trout. The sensitivities of cutthroat trout and brown trout fell between these extremes.
- Zn was the least acutely toxic of the three target metals.

Based on this information, it can be concluded that the rainbow trout appears to be consistently very sensitive to the three metals. The relative sensitivities of the other three species to Cu and Zn are not so consistent and vary by species.

Both acidity and dissolved metals affect osmoregulation in aquatic organisms by changing the integrity of the cell junctions in the gill tissues. The cell junctions become "leaky" with increasing levels of H^+ (protons) or metals, thereby allowing blood electrolytes to diffuse out of the gill tissue, and water to diffuse into the bloodstream. Death results when blood electrolyte levels drop below a critical physiological threshold, which varies from species to species.

2.3.2 Ecosystems potentially at risk

The potentially impacted aquatic habitats evaluated in this BERA consist of mainstem Cement Creek, mainstem Mineral Creek, and three reaches of the Animas River, as follows: Animas

River above the confluence with mainstem Cement Creek (about 2 miles, between sampling locations A60 to A68), Animas River between mainstem Cement Creek and mainstem Mineral Creek (about 1 mile, represented by sampling locations A69A and A70B), and Animas River below mainstem Mineral Creek (about 30 miles, between sampling locations A71B and BBridge).

2.3.3 Complete exposure pathways

Routes of exposure are the means by which COPECs can be transferred from a contaminated medium to ecological receptors. This BERA evaluates the following receptors and exposure routes:

- *Benthic invertebrates*: direct contact with sediment and pore water collected from mainstem Cement Creek (sediment only), mainstem Mineral Creek (sediment only), and the Animas River above mainstem Cement Creek (sediment and pore water) and the Animas River below mainstem Mineral Creek (sediment and pore water). Exposure of benthic invertebrates to substrate from the Animas River between mainstem Cement Creek and mainstem Mineral Creek could not be evaluated because no sediment samples were collected from this reach.

- *Fish*: direct contact with surface water in all three waterways.

- *Invertivorous birds*: ingestion of surface water, sediment, and benthic invertebrates from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

- *Omnivorous birds*: ingestion of surface water, sediment, benthic invertebrates, and aquatic plants from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

- *Piscivorous birds*: ingestion of surface water, sediment, and fish from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek (note: the belted kingfisher, which is the modeled piscivorous bird, is assumed to ingest a small amount of sediment because, even though this species primarily eats fish captured from within the water column, it is also known to feed on crayfish, stonerollers, and sculpin found right on the substrate).

- *Herbivorous mammals*: ingestion of surface water, sediment, and aquatic plants from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

2.4 Target receptors

2.4.1 Introduction

Endpoints are selected to help quantify the risks to representative receptors that may be exposed to metals and low pH associated with current mine releases.

Assessment endpoints represent explicit expressions of the key ecological resources to be protected from harm. They should reflect sensitive populations, communities, or trophic guilds. Four criteria used for selecting the proposed assessment endpoints for the BERA are listed below. The ecological resource should:

- Have relevance to the local ecosystem,
- be susceptible to the stressors of concern,
- have biological, social, or economic value, and
- be relevant to the risk management goals for the site.

By considering these selection criteria, risks identified to one or more of the assessment endpoints will help inform risk management decisions at the site.

Measures of effect represent measurable ecological characteristics, quantified through laboratory or field experimentation, which can be related back to the valued ecological resources chosen as the assessment endpoints. Measures of effect are required because it is often not possible to directly quantify risk to an assessment endpoint. The measures of effect represent the same exposure pathway(s) and mechanisms of toxicity as the assessment endpoints in order to be relevant and useful.

Risk questions establish a link between assessment endpoints and their predicted responses when exposed to COPECs. The risk questions should provide a basis to develop the study design and evaluate the results of the site investigation in the analysis phase and during risk characterization (EPA, 1997).

2.4.2 Representative species or communities

It is neither practical nor possible to evaluate the potential for ecological risk to all of the individual parts of the local aquatic ecosystem potentially affected by site-related contamination. Instead, key components are identified to select those species or groups most likely to experience exposure to the stressors.

2.4.2.1 Community-level receptors

Benthic invertebrates

Benthic invertebrates form an integral link in all aquatic ecosystems. They play a key role in nutrient and energy transfers within those systems. They also process and assimilate organic material, feed on other invertebrates, and are themselves consumed by fish, birds, and mammals.

Metals with the potential to bioaccumulate can be transferred from the surface water, sediment or pore water into the benthic invertebrate community and up the food chain, thereby harming higher-level receptors. Significant alterations in invertebrate communities could also impact the energy cycling at the base of the aquatic food chain.

The substrate in the three waterways of interest in this BERA should be able to support a diverse benthic invertebrate community. Key invertebrates include amphipods and the aquatic life stages of numerous insect species (e.g., mayflies, stoneflies, caddisflies, dragonflies, etc.).

Note that it is considered possible that mainstem Mineral Creek upstream of the confluence with South Fork Mineral Creek, and mainstem Cement Creek, may not have supported a healthy, diverse macroinvertebrate community before large-scale mining activities started in the 19th century (Church *et al*., 1999) due to naturally high levels of metals and low-pH levels. However, this BERA conservatively evaluates the potential ecological risk to a hypothetical benthic invertebrate community in these waterways in order to assess the current conditions. The outcome of this evaluation should be interpreted in a broader context, which considers naturally-altered surface water and substrate conditions.

Fish

The Animas River should be able to support a healthy fish community, consisting of cold-water stream species, such as trout and sculpin. The aquatic environment should provide such a community with a diverse food base, suitable feeding and spawning areas, refuges for juvenile fish, and other essential environmental services.

The presence of metals in the surface water and sediment can impair the local fish community in two general ways: (1) mortality of sensitive early-life stages exposed to dissolved metals in the water column or pore water, or (2) high metal concentrations in aquatic biota via food chain uptake, which could affect reproduction and the long-term survival of the exposed fish.

As with the benthic invertebrate community, it is considered possible that mainstem Mineral Creek upstream of the confluence with South Fork Mineral Creek, and mainstem Cement Creek, may not have supported fish before large-scale mining activities started in the 19th century (Church *et al*., 2007). However, this BERA conservatively evaluates the potential ecological risk to a hypothetical fish community in these waterways in order to assess the current conditions.

The outcome of this evaluation should be interpreted in a broader context, which considers naturally altered surface water conditions.

2.4.2.2 Wildlife receptors

The Colorado Parks and Wildlife Natural Diversity Information Source was accessed online to obtain a list of known or likely species occurrence in San Juan County, CO (see **Appendix 6**). This county encompasses the Animas River upstream and downstream of Silverton.

The information below lists select bird and mammal species found in San Juan County that may obtain some or all of their food from an aquatic environment. Note, however, that it is unknown if any of these species actually inhabit the reaches of the Animas River specifically evaluated in this BERA.

Birds:

- great blue heron (*Ardea Herodias*): piscivore
- belted kingfisher (*Ceryle alcyon*): piscivore
- American dipper (*Cinclus mexicanus*): aquatic insectivore
- Canada goose (*Branta Canadensis*): herbivore
- mallard (*Anas platyrhynchos*): aquatic and terrestrial herbivore and invertivore
- common merganser (*Mergus merganser*): piscivore
- spotted sandpiper (*Actitis macularius*): benthivore
- northern rough-winged swallow (*Stelgidopteryx serripennis*): aquatic insectivore
- barn swallow (*Hirundo rustica*): aquatic insectivore

Mammals:

- American beaver (*Castor Canadensis*): herbivore
- big brown bat (*Eptesicus fuscus*): insectivore
- common muskrat (*Ondatra zibethicus*): herbivore
- mink (*Mustela vison*): carnivore, including fish and crayfish
- water shrew (*Sorex palustris*): aquatic insectivore

Four kinds of bird and mammal species are assessed in this BERA using food chain modeling to calculate metal-specific daily exposures from drinking surface water, ingesting sediment, and feeding on aquatic food items from the Animas River above and below Silverton. This BERA does not calculate exposures for wildlife receptors that might feed in mainstem Cement Creek and mainstem Mineral Creek because these two waterways do not support viable aquatic invertebrate and fish communities under current conditions and therefore cannot provide a food base. This BERA evaluates the following target wildlife receptors:

- Invertivorous birds: represented by the American dipper (*Cinclus mexicanus*)

The American dipper is a small passerine bird, which forages on the bottom of fast-moving rocky streams in mountainous regions of the western US. It dives to the bottom of the stream where it seeks out mainly aquatic insects and their larvae, but also small crustaceans (e.g., juvenile crayfish) or tiny fish and tadpoles. This species was selected for use in food chain modeling to represent birds, which feed on aquatic insects and benthic invertebrates. It also serves as a surrogate for the southwestern willow flycatcher, a listed species of passerine insectivore listed for San Juan County, CO, which may or may not be present in the riparian habitat of the Animas River above or below Silverton.

- Omnivorous birds: represented by the mallard (*Anas platyrhynchos*)

The mallard is a medium-sized dabbling duck with a flexible diet consisting of aquatic and terrestrial plants (including leaves, stems, seeds, roots and tubers), but also aquatic invertebrates (e.g., crustaceans and aquatic insects), and terrestrial invertebrates (e.g., worms, snails, slugs, beetles). This species was selected for use in food chain modeling to represent avian herbivores that also have the ability to switch to an invertivorous diet, particularly during the egg-laying season.

- Piscivorous birds: represented by the belted kingfisher (*Ceryle alcyon*)

The belted kingfisher is a piscivore which feeds mostly on small fish that swim near the surface or in shallow areas of ponds, lakes, rivers, and streams. Depending on food availability and season, they may also feed on other aquatic species such as crayfish, mussels, insects, and amphibians, among others. The bird catches its prey by diving head-first into the water in flight or jumping from a perch along the shoreline. This species was selected for use in food chain modeling to represent piscivorous birds.

- Herbivorous mammals: represented by the muskrat (*Ondatra zibethicus*)

The muskrat is an aquatic rodent which feeds primarily on aquatic plants such as marsh grasses, sedges, cattails, bulrushes and green algae. The herbivorous diet can be complemented by small amounts of crayfish, mollusks, fish, frogs, turtles, and young birds. This species was selected for use in food chain modeling to represent semi-aquatic herbivorous mammals.

2.4.3 Selecting assessment endpoints and measures of effect

2.4.3.1 Assessment endpoints and risk questions

The BERA uses the following assessment endpoints to evaluate the potential risks to the aquatic receptors, and wildlife receptors feeding on aquatic food items from the Animas River above and below Silverton. A risk question is appended to each assessment endpoint.

The BERA assumes that by evaluating and protecting the assessment endpoints, all of the aquatic habitats, and the wildlife receptors feeding on them, are protected as well.

- **Maintain a stable and healthy benthic invertebrate community**: *are the metal levels in sediment and pore water from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below Mineral Creek high enough to impair the benthic invertebrates in these waterways?*

- **Maintain a stable and healthy fish community**: *are the metal levels in surface water from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek, between mainstem Cement Creek and mainstem Mineral Creek, and below Mineral Creek high enough to impair the fish in these waterways?*

- **Maintain stable and healthy invertivorous bird populations**: *are the metal levels in surface water, sediment, and benthic invertebrates high enough to impair invertivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

- **Maintain stable and healthy omnivorous bird populations**: *are the metal levels in surface water, sediment, benthic invertebrates, and aquatic plants high enough to impair omnivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

- **Maintain stable and healthy piscivorous bird populations**: *are the metal levels in surface water and fish high enough to impair piscivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

- **Maintain stable and healthy herbivorous mammal populations**: *are the metal levels in surface water, sediment, and aquatic plants high enough to impair herbivorous mammals foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

2.4.3.2 Measures of effect

Assessment endpoint #1:

Maintain a stable and healthy benthic invertebrate community: *Are the metal levels in sediment and pore water from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below Mineral Creek high enough to impair the benthic invertebrates in these waterways?*

The BERA uses up to four measures of effect, depending on the EU, to assess the potential impacts of metals to this receptor group, as follows:

1.A Compare the metal levels measured in sediment samples to sediment benchmarks.

1.B Compare the metal levels measured in field-collected pore water samples to chronic surface water benchmarks.

1.C Assess survival and biomass in the amphipod *Hyalella azteca* exposed in the laboratory for ten days to sediment samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

1.D Assess the benthic community structure and function based on field-collected invertebrate samples.

Assessment endpoint #2:

Maintain a stable and healthy fish community: *Are the metal levels in surface water from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek, between mainstem Cement Creek and mainstem Mineral Creek, and below mainstem Mineral Creek high enough to impair the fish in these waterways?*

This BERA uses two measures of effect to assess the potential impacts of metals to this receptor group, as follows:

2.A Compare metal levels measured in surface water samples to chronic surface water benchmarks.

2.B Assess survival in juvenile rainbow trout (*Oncorhynchus mykiss*) exposed for 96 hours in the laboratory to surface water samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

Assessment endpoint #3:

Maintain stable and healthy invertivorous bird populations: *are the metal levels in surface water, sediment, and benthic invertebrates high enough to impair invertivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

This BERA uses one measure of effect to assess the potential impacts of metals ingested by this receptor group, as follows:

3.A Use metal concentrations measured in sediment and benthic invertebrates in a food chain model to calculate metal-specific EDDs from ingesting surface water, sediment, and benthic invertebrates, and compare these EDDs to avian TRVs.

Assessment endpoint #4:

Maintain stable and healthy omnivorous bird populations: *are the metal levels in surface water, sediment, benthic invertebrates, and aquatic plants high enough to impair omnivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

This BERA uses one measure of effect to assess the potential impacts of metals ingested by this receptor group, as follows:

4.A Use metal concentrations measured in sediment samples to estimate metal residues in aquatic plants; use the estimated plant residues and the measured benthic invertebrate residues in a food chain model to calculate metal-specific EDDs from ingesting surface water, sediment, and food, and compare these EDDs to avian TRVs.

Assessment endpoint #5:

Maintain stable and healthy piscivorous bird populations: *are the metal levels in surface water and fish high enough to impair piscivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

This BERA uses one measurement endpoint to assess the potential impacts of metals ingested by this receptor group:

5.A Use metal concentrations measured in sediment samples to estimate metal residues in fish; use food chain modeling to calculate metal-specific EDDs from ingesting surface water and fish and compare these EDDs to avian TRVs.

Assessment endpoint #6:

Maintain stable and healthy herbivorous mammal populations: *are the metal levels in surface water, sediment, and aquatic plants high enough to impair herbivorous mammals foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

This BERA uses one measurement endpoint to assess the potential impacts of metals ingested by this receptor group:

6.A Use metal concentrations measured in sediment samples to estimate metal residues in aquatic plants; use food chain modeling to calculate metal-specific EDDs from ingesting surface water, sediment, and aquatic plants, and compare these EDDs to mammalian TRVs.

2.5 Conceptual site model

The CSM provides the foundation of a problem formulation. The CSM was developed based on knowledge of natural and man-made sources, contaminants, complete exposure pathways, and likely ecological receptors. The model shows how metals move from the contaminant sources through the exposure media to the receptors. **Figure 2.1** presents the CSM for this BERA.

The primary source of contamination to the local waterways consists of water which has come into contact with local rock, either naturally or as a result of mining activities, such as through the creation of adits. Sulfuric acid is released when water and oxygen interact with the sulfide-rich mine wastes, host rock, or vein rock. This acid dissolves metals that enter the waterways as surface runoff, or via the groundwater (e.g., seeps; adits). Fine tailings material may also be present in the substrate of the waterways as a result of entrainment further upstream in the watershed. This material can serve as a secondary source of metals, mainly to the benthic invertebrate community.

The surface waters in mainstem Cement Creek and mainstem Mineral Creeks carry high loads of total and dissolved metals, and high acidity, into the Animas River in the vicinity of Silverton, even though substantial dilutions take place at that point. The benthic invertebrates and fish in the affected waterways become exposed to mine-derived and naturally-high levels of metals mainly by direct contact with surface water, sediment or pore water, whereas the wildlife receptors foraging in the Animas River become exposed by ingesting surface water and sediment, consuming fish, aquatic invertebrates, or plants. The current metal levels are high enough, and pH levels low enough, to cause mainstem Cement Creek and mainstem Mineral Creek to be essentially devoid of aquatic life, and to potentially affect aquatic life in the Animas River at and below Silverton.

3.0 COPEC SELECTION & BASELINE ECOLOGICAL EFFECTS EVALUATION

3.1 Matrices of concern

This BERA uses the analytical data from samples of surface water, sediment, pore water, and benthic invertebrates to assess current exposures to aquatic, community-level receptors and wildlife receptors.

3.2 Total metals versus dissolved metals

The surface water data consist of both total metals (i.e., unfiltered) and dissolved metals (i.e., filtered), whereas the pore water data consist only of dissolved metals.

- With two exceptions, exposures of the aquatic, community-level receptors to surface water samples collected from mainstem Cement Creek, mainstem Mineral Creek and the three Animas River reaches are quantified using dissolved metals because these data represent the fraction which is bioavailable, and hence toxic, to aquatic invertebrates and fish. The exceptions are Al and Iron (Fe) in surface water, for which the chronic benchmark (Fe) or the hardness-dependent equation needed to derive a chronic benchmark (Al) are based on total recoverable metals (Colorado Department of Public Health and the Environment [CDPHE], 2013).

- Exposures of the benthic invertebrate community to pore water samples collected from the Animas River above mainstem Cement Creek, the Animas River below mainstem Mineral Creek, and in mainstem Mineral Creek are quantified using only dissolved metals, even for Al and Fe. The reason is that none of the pore water samples were analyzed for total metals. Additionally, none of the pore water samples were measured for pH. This variable is one of the two additional input parameters (the other one is hardness, which was available) required to derive a chronic benchmark for total Al using the CDPHE (2013) equation. As a result, the toxicity of Al in the pore water samples is determined by comparing dissolved Al levels to the standard default chronic Al benchmark of 87 µg/L.

- The wildlife exposures associated with ingesting surface water from the Animas River were quantified using total metals concentrations. The reason is that the full amount of metal in water ingested while drinking becomes part of the daily dose of a wildlife receptor.

These different approaches ensure that the exposure of each receptor group to surface water is properly accounted for to the best ability of the available data.

3.3 Toxicity benchmarks

3.3.1 Surface water benchmarks

The metals concentrations measured in surface water and pore water samples are compared to surface water screening benchmarks to select COPECs for the aquatic, community-level receptors. The Colorado State Water Quality Criteria (WQC) regulation (CDPHE, 2013) is the primary source of surface water benchmarks used in the evaluation.

The metal concentrations are compared to the chronic WQC (referred to as the Criteria Continuous Concentration [CCC]). The WQC for Al, Silver (Ag), Cd, Chromium (Cr), Cu, Mn, Lead (Pb), Nickel (Ni), and Zn were adjusted for hardness in order to calculate hardness-specific benchmarks. Chronic toxicity thresholds summarized by Buchman (2008) are also used when Colorado State WQC are not available. Per standard guidance, hardness-specific benchmarks are not calculated for any hardness values above 400 mg of $CaCO_3$/L. If ambient hardness was greater than this cap, respective hardness-specific benchmarks are calculated using a hardness of 400 mg of $CaCO_3$/L.

Table 3.1 summarizes the chronic surface water benchmarks and hardness-dependent equations used to select the surface water COPECs for aquatic, community-level receptors and for use in the subsequent risk evaluation.

3.3.2 Sediment benchmarks

The metal concentrations measured in bulk sediment samples collected from the site are compared to no effect sediment benchmarks, to select COPECs for the benthic invertebrate receptors. The Threshold Effect Concentrations (TECs), which consist of the Threshold Effect Level (TEL), the TEL for *H. azteca* in 28-day tests (TEL-HA28), the Effect Range-Low (ER-L) and the Lowest Effect Level (LEL), are the sources of sediment benchmarks used in COPEC selection.

The following hierarchy (in order of preference) was used to obtain these no-effect sediment benchmarks:

- MacDonald *et al.* (2000); consensus-based TECs,
- Ingersoll *et al.* (1996); TELs,
- Long *et al.* (1995); ER-Ls, and
- Thompson *et al*. (2005); LELs.

The Long *et al.* (1995) reference is included, even though its benchmarks pertain specifically to estuarine and marine environments. The reason is that this reference is the only one that provides a sediment benchmark for Ag.

In addition, following the COPEC selection process, the metals in sediment are further evaluated using effect sediment benchmarks, which consisted of Probable Effect Concentrations (PECs), the Probable Effect Level (PEL), the Effect Range-Median (ER-M), and the Severe Effect Level (SEL).

The following hierarchy (in order of preference) is used to obtain these effect sediment benchmarks:

- MacDonald *et al.* (2000); consensus-based PECs,
- Ingersoll *et al.* (1996); PELs,
- Long *et al.* (1995); ER-Ms, and
- Thompson *et al*. (2005); SELs.

Table 3.1 summarizes the no-effect sediment benchmarks used to select the sediment COPECs for benthic invertebrates and the effect sediment benchmarks that are also used in the subsequent risk evaluation. The shaded values represent the sediment benchmarks retained for these purposes.

3.4 TRVs for wildlife receptors

The following hierarchy was used to obtain the mammalian and avian no effect TRVs for comparison to the EDDs in the wildlife risk characterization:

- EPA Ecological Soil Screening Levels (Eco SSLs) (http://www.epa.gov/ecotox/ecossl/).

- Los Alamos National Laboratory (LANL) ECORISK Database

- Sample *et al.*, 1996, Toxicological Benchmarks for Wildlife: 1996 Revision, ES/ER/TM-86/R3, http://www.esd.ornl.gov/programs/ecorisk/documents/tm86r3.pdf

This BERA uses the no-effect and effect TRVs for birds and mammals primarily obtained from the Ecological Soil Screening Level (EcoSSL) documents (EPA, 2007e) and the LANL (2016) ECORISK Database, except for mercury in birds. The no-effect TRVs were derived from the same toxicity studies used by EPA (2007e) to develop the soil-based EcoSSLs. The effect TRVs were derived by LANL (2016) by either applying an uncertainty factor or 10 to the EcoSSL no-effect TRV or using the Lowest Observable Adverse Effect Level associated with the same study used to derive no-effect TRVs. Note that the no-effect and effect mercury TRVs for birds were obtained from Sample *et al*. (1996) because neither EPA (2007e) nor LANL (2016) provided toxicity values for this metal. The TRVs were derived by selecting the most-applicable toxicity study for each COPEC obtained from an independent review of primary toxicity literature. Additional details on how the LANL TRVs were developed can be found in LANL (2014; 2016).

Tables 3.2 and 3.3 present the no-effect and effect TRVs for birds and mammals, respectively. These two tables provide TRVs only for those metals identified as "important bioaccumulative compounds" in Table 4-2 of EPA (2000).

3.5 COPEC selection process

The surface water and sediment COPECs are presented in the next subsections. Ca, Mg, K, and Na were automatically eliminated as COPECs for aquatic community receptors and wildlife receptors because these four compounds represent essential physiological electrolytes that are not expected to cause toxicity at prevailing concentrations (EPA, 2001).

The surface water samples collected during the three flow periods (i.e., pre-runoff period [February to April], runoff period [May and June], and post-runoff period [July through November]) were combined into one dataset for each of the five EUs. Hence, COPECs are selected for individual EUs across the three flow periods. This approach is conservative because the highest concentrations measured during the pre-runoff, runoff, and post-runoff periods are used to select the COPECs that would apply to all three flow periods.

3.5.1 Surface water COPECs for aquatic community-level receptors

The surface water COPEC selection process for aquatic community-level receptors evaluates the metals in two ways, depending on whether the toxicity of a metal is hardness-independent or hardness-dependent, as follows:

- Hardness-independent surface water toxicity

The toxicity of Arsenic (As), Beryllium (Be), Fe, and Selenium (Se) in surface water does not depend on hardness (CDPHE, 2013). COPEC selection for these four compounds consists of comparing maximum dissolved (As, Be, and Se) or total (Fe) metal concentrations measured in surface water samples to the published chronic surface water screening benchmarks.

- Hardness-dependent surface water toxicity

CDPHE (2013) states that the toxicity of Ag, Al, Cd, Cr, Cu, Mn, Ni, Pb, and Zn depend on surface water hardness (in addition to pH for Al; see CDPHE, 2013 for details). It would have been inaccurate to automatically select the highest concentration of each of these metals to select surface water COPECs because a lesser concentration could be more toxic if the hardness is much lower.

Under those circumstances, the only reliable way to identify the most-toxic surface water concentration is to: (1) calculate hardness-adjusted HQs for each target metal in each surface water sample (note: A hardness-adjusted HQ is obtained by dividing a metal concentration by its toxicity benchmark adjusted for the hardness of the water sample associated with that metal), (2)

identify the highest HQ for a target metal in all of the surface water samples, and (3) select the metal concentration associated with that HQ as the concentration for use in COPEC selection.

This approach ensures that the metal concentration associated with the highest HQ is used in the surface water COPEC selection process. **Appendix 7** summarizes the hardness-adjusted HQs for the hardness-dependent metals measured in the surface water samples.

Surface water COPECs for mainstem Mineral Creek

Mainstem Mineral Creek was sampled at one location (M34) for the purpose of this BERA. Twenty-four surface water samples were collected between May 2009 and September 2014. **Table 3.4** summarizes the COPEC selection process at this EU.

- As, Cr, Cu, Pb, Mn, Ni, and Se are eliminated because their maximum concentrations do not exceed their respective chronic surface water benchmarks.

- pH, Al, Be, Cd, Fe, Ag, and Zn are retained as COPECs for further evaluation because the concentrations associated with the highest HQs exceed their respective chronic surface water benchmarks.

Be is retained as a COPEC even though it is not present above its analytical DL in any of the surface water samples collected from this EU. It is flagged because half of the highest DL exceeds the chronic surface water benchmark. This analyte is discussed as an uncertainty in the risk characterization because it cannot be further evaluated quantitatively.

Surface water COPECs for mainstem Cement Creek

Mainstem Cement Creek was sampled at two locations (i.e., CC48 and CC49) for the purpose of this BERA. However, except for a single sample collected at CC49 in October of 2012, all the remaining surface water samples were collected from CC48 between May 2009 and September 2014. **Table 3.5** summarizes the COPEC-selection process at this EU.

- As, Cr, Ni, and Se are eliminated because the maximum concentrations do not exceed the respective chronic surface water benchmarks.

- pH, Al, Be, Cd, Cu, Fe, Pb, Mn, Ag, and Zn are retained as COPECs for further evaluation because the concentrations associated with the highest HQs exceed the respective chronic surface water benchmarks.

Ag is retained as a COPEC even though it is not present above its analytical DL in any of the surface water samples collected from this EU. It is flagged as a COPEC because half of the highest DL exceeds its chronic surface water benchmark. This analyte is discussed as an uncertainty in the risk characterization because it cannot be further evaluated quantitatively.

Surface water COPECs for the Animas River above mainstem Cement Creek

This reach of the Animas River was sampled at six locations between May 2009 and September 2014. However, over half of the samples were collected at sampling location A68. **Table 3.6** summarizes the COPEC selection process at this EU.

- As, Cr, Ni, and Se are eliminated because the maximum concentrations do not exceed the respective chronic surface water benchmarks.

- pH, Al, Be, Cd, Cu, Fe, Pb, Mn, Ag, and Zn are retained as COPECs for further evaluation because the concentrations associated with the highest HQs exceed the respective chronic surface water benchmarks.

Be and Ag are retained as COPECs even though neither analyte is present above the analytical DL in any of the surface water samples collected from this EU. They are flagged because half of the highest DLs exceed their chronic surface water benchmarks. Both analytes are discussed as uncertainties in the risk characterization because they cannot be further evaluated quantitatively.

Surface water COPECs for the Animas River between mainstem Cement Creek and mainstem Mineral Creek

This reach of the Animas River was sampled only once at two locations in October of 2012. **Table 3.7** summarizes the COPEC selection process at this EU.

- As, Cr, Pb, Ni, Se, and Ag are eliminated because the maximum concentrations do not exceed the respective chronic surface water benchmarks.

- pH, Al, Be, Cd, Cu, Fe, Mn, and Zn are retained as COPECs for further evaluation because the concentrations associated with the highest HQs exceed the respective chronic surface water benchmarks.

Be is retained as a COPEC even though it is not present above its analytical DL in either of the two surface water samples collected from this EU. It is flagged because half of the highest DL exceeds the chronic surface water benchmark. This analyte is discussed as an uncertainty in the risk characterization because it cannot be further evaluated quantitatively.

Surface water COPECs for the Animas River below mainstem Mineral Creek

This reach of the Animas River was sampled at seven locations between May 2009 and September 2014. However, about half of the samples came from sampling location A72. **Table 3.8** summarizes the COPEC-selection process at this EU.

- As, Cr, Pb, Ni, and Se are eliminated because the maximum concentrations do not exceed the respective chronic surface water benchmarks.

- pH, Al, Be, Cd, Cu, Fe, Mn, Ag, and Zn are retained as COPECs for further evaluation because the concentrations associated with the highest HQs exceed the respective chronic surface water benchmarks.

Be and Ag are retained as COPECs even though neither analyte is present above its DL in any of the surface water samples collected from this EU. They are flagged because half of the highest DL exceeds the chronic surface water benchmarks. Both analytes are discussed as an uncertainty in the risk characterization but cannot be further evaluated quantitatively.

Table 3.9 summarizes all of the surface water COPECs for the aquatic, community-level receptors in mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River retained for further evaluation.

3.5.2 Sediment COPECs for benthic invertebrates

The sediment COPEC selection process for benthic community-level receptors is based on comparing maximum concentrations measured in bulk sediment samples collected from mainstem Mineral Creek, mainstem Cement Creek, and two of the three reaches of the Animas River against the no-effect sediment benchmarks identified in **Table 3.1**. Note that no sediment samples were collected from the Animas River flowing between mainstem Cement and Mineral Creeks. The sediment data from the Animas River are combined by reach to select the COPECs.

Sediment COPECs for mainstem Mineral Creek

This waterway was sampled twice for sediment in October 2012 and September 2014 at sampling location CC49. **Table 3.10** summarizes the COPEC selection process at this EU.

- Cr, Fe, Mercury (Hg), Ni, and Ag are eliminated from further consideration because the maximum concentrations do not exceed the respective sediment screening benchmarks.

- Al, As, Cd, Cu, Pb, Mn, Se, and Zn are retained as COPECs for further evaluation because the maximum concentrations exceed the respective sediment screening benchmarks.

Be is retained as a COPEC even though it is not present above its analytical DL in the sediment sample collected from this EU. This analyte is flagged as a COPEC because it lacks a screening benchmark. It is as an uncertainty in the risk characterization but cannot be further evaluated quantitatively.

Sediment COPECs for mainstem Cement Creek

This waterway was sampled once for sediment in October 2012 at sampling location CC49. **Table 3.11** summarizes the COPEC selection process at this EU.

- Al, Cd, Cr, Fe, Mn, Hg, Ni, and Se are eliminated from further consideration because the maximum concentrations do not exceed the respective sediment screening benchmarks.

- As, Cu, Pb, Ag, and Zn are retained as COPECs for further evaluation because the maximum concentrations exceed the respective sediment screening benchmarks.

Be is retained as a COPEC even though it is not present above its analytical DL in the sediment sample collected from this EU. This analyte is flagged as a COPEC because it lacks a screening benchmark. It is discussed as an uncertainty in the risk characterization but cannot be further evaluated quantitatively.

Sediment COPECs for the Animas River above mainstem Cement Creek

This reach of the Animas River was sampled at six locations between May 2012 and September 2014. **Table 3.12** summarizes the COPEC selection process at this EU.

- Al, Cr, Fe, and Ni are eliminated as COPECs because the maximum concentrations fall below the screening benchmarks.

- As, Cd, Cu, Pb, Mn, Hg, Se, Ag, and Zn are retained as COPECs because the maximum concentrations exceed the screening benchmarks.

Be is also retained as COPECs because it lacks a screening benchmark. This analyte is discussed as an uncertainty in the risk characterization but cannot be further evaluated quantitatively.

Sediment COPECs for the Animas River below mainstem Mineral Creek

This reach of the Animas River was sampled at six locations between May 2012 and September 2014. **Table 3.13** summarizes the COPEC selection process at this EU.

- Cr, Fe, and Hg are eliminated as COPECs because the maximum concentrations fall below the screening benchmarks.

- Al, As, Cd, Cu, Pb, Mn, Ni, Se, Ag, and Zn are retained as COPECs because the maximum concentrations exceed the screening benchmarks.

Be is also retained as a COPEC because it lacks a screening benchmark. This analyte is discussed as an uncertainty in the risk characterization but cannot be further evaluated quantitatively.

Table 3.14 summarizes all of the sediment COPECs for the benthic invertebrate community in mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River that were retained for further evaluation.

3.5.3 Pore water COPECs for benthic invertebrates

Similar to surface water, the pore water COPEC selection process evaluates the metals in two ways, depending on whether the toxicity of a metal is hardness-independent or hardness-dependent, as follows:

- Hardness-independent metals

The toxicity of As, Be, Fe, and Se in pore water does not depend on hardness. Pore water COPEC selection for these four compounds consists of comparing maximum dissolved metal concentrations measured in the pore water samples to chronic surface water screening benchmarks.

- Hardness-dependent metals

CDPHE (2013) states that the toxicity of Ag, Al, Cd, Cr, Cu, Mn, Ni, Pb, and Zn in water depends on surface water hardness (in addition to pH for Al; see CDPHE, 2013 for details. Note, however, that pH was not measured in the pore water samples and that the COPEC selection process for Al is therefore based on comparing dissolved Al concentrations against the standard Al chronic surface water benchmark of 87 µg/L). It would have been inaccurate to automatically retain the highest concentration of each of these metals to select pore water COPECs because a lesser concentration could be more toxic if the hardness was much lower.

Under those circumstances, the only reliable way to identify the most toxic pore water concentration is to: (1) calculate hardness-adjusted HQs for each target metal in each pore water sample, (2) identify the highest HQ for a target metal in all of the pore water samples, and (3) select the metal concentration associated with that HQ as the concentration to select pore water COPECs.

This approach ensures that the metal concentration associated with the highest HQ is used in the pore water COPEC selection process. **Appendix 8** summarizes the hardness-adjusted HQs for the hardness-dependent metals measured in the pore water samples. Pore water COPECs were identified for the Animas River above mainstem Cement Creek, the Animas River below mainstem Mineral Creek, and mainstem Mineral Creek. Pore water samples were not collected

from the Animas River flowing between mainstem Cement and Mineral Creeks, or from mainstem Cement Creeks.

Pore water COPECs for the Animas River above mainstem Cement Creek

This reach of the Animas River was sampled at up to six locations in April 2014 and September 2014. **Table 3.15** summarizes the COPEC selection process at this EU.

- As, Cr, Fe, and Ni are eliminated as COPECs because the maximum concentrations fall below the screening benchmarks.

- Al, Be, Cd, Cu, Pb, Mn, Se, Ag, and Zn are retained as COPECs because the concentrations associated with the highest HQs exceed the screening benchmarks.

Be, Se, and Ag are retained as COPECs even though they are not present above their DLs in any of the pore water samples collected from this EU. They are flagged because half of the highest DL exceed the chronic surface water benchmarks. These three analytes are discussed as an uncertainty in the risk characterization but cannot be further evaluated quantitatively.

Pore water COPECs for the Animas River below mainstem Mineral Creek

This reach of the Animas River was sampled at up to five locations in April 2014 and September 2014. **Table 3.16** summarizes the COPEC selection process at this EU.

- As, Cr, Cu, Pb, Ni, and Se are eliminated as COPECs because the concentrations associated with the highest HQs fall below the screening benchmarks.

- Al, Be, Cd, Fe, Mn, Ag, and Zn are retained as COPECs because their maximum concentrations exceed the screening benchmarks.

Be and Ag are retained as COPECs even though they are not present above the DLs in any of the nine pore water samples collected from this reach. They are flagged because half of the highest DLs exceed the chronic surface water benchmarks. These two analytes are discussed as an uncertainty in the risk characterization but cannot be further evaluated quantitatively.

Pore water COPECs for mainstem Mineral Creek

Mainstem Mineral Creek was sampled once in September 2014. **Table 3.17** summarizes the COPEC selection process at this EU.

- Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Ni, Se and Zn are eliminated as COPECs because the maximum concentrations fall below the screening benchmarks.

- Be and Ag are retained as COPECs because the maximum concentrations exceed the screening benchmarks.

Be and Ag are retained as COPECs even though they are not present above the DLs in the one pore water sample collected from this EU. They are flagged because half the DLs exceed the chronic surface water benchmarks. These two analytes are discussed as an uncertainty in the risk characterization but cannot be further evaluated quantitatively.

Table 3.18 summarizes all of the pore water COPECs for the benthic invertebrate community in mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below mainstem Mineral Creek retained for further evaluation.

3.5.4 COPECs for wildlife receptors

The approaches outlined above does not apply to the four wildlife receptors evaluated using food chain modeling. The reason is that the exposures are not from direct contact with surface water or sediment, but from ingesting surface water, sediment, and aquatic food items. Therefore, a metal was automatically retained as a wildlife COPEC for evaluation in the food chain models if it met the following two conditions: 1) it was present above its analytical DL in at least one surface water sample or one sediment sample, and 2) it was identified as an "important bioaccumulative compound" in Table 4-2 in EPA, 2000. *Bioaccumulation testing and interpretation for the purpose of sediment quality assessment, Status and needs.* EPA-823-R-00-001, February 2000. Metals that fall into the bioaccumulative category consist of As, Cd, Hexavalent Chromium (CrVI), Cu, Pb, methylmercury (MeHg), Ni, Se, Ag, and Zn. Note that CrVI and MeHg are not expected to be present in surface water and sediment from the Animas River at concentrations above conservative screening levels. However, as a conservative measure, oxidized Cr (i.e., CrIII) and inorganic Hg, if detected, are retained for evaluation in the wildlife food chain models.

3.6 Toxicity testing

3.6.1 Surface water

EPA Region 8 performed three sets of surface water toxicity tests in October 2012, November 2012, and April 2013 at the Golden, CO, laboratory. These tests consisted of exposing juvenile rainbow trout (*O. mykiss*) for 96 hours at 12°C to undiluted samples from the Animas River, mainstem Cement Creek, and mainstem Mineral Creek, and to various dilutions. **Appendices 9a and 9b** provide more details on the study design and rationale. Toxicity tests were conducted to characterize the effects of mine waste-impacted surface water on a site-relevant, sensitive fish species under acute exposure conditions. Use of 96-hour tests allowed for efficient characterization of acute toxicity for many sampling locations in an off-site testing laboratory.

3.6.1.1 Surface Water Collection and dilutions

October 2012

Site-specific toxicity testing:

Surface water samples were collected in October 2012 from six sampling locations, as follows (see **Figure 1.1 and 1.2**):

- *Animas River above mainstem Cement Creek*: sampling locations A56 ("upstream") and A68.

- *Animas River below mainstem Mineral Creek*: sampling locations A72, A73B, A75B, and BBridge.

These surface water samples represented composites collected in the mid-water column across the width of the Animas River. They were tested undiluted for acute toxicity.

Serial dilution toxicity testing:

Flow-weighted surface water samples were also collected from mainstem Mineral Creek (sampling location M34) and mainstem Cement Creek (sampling location CC48). The samples were, (a) combined in a 61% (M34) + 39% (CC48) ratio (M34/CC48), (b) diluted using water from "upstream" sampling location A56 to generate water representing 6.25%, 12.5%, 25%, 50% and 100% CC48/M34, and (c) tested for acute toxicity.

Finally, the flow-weighted M34/CC48 surface water sample was diluted using water from sampling locations A68 to generate water representing 6.25%, 12.5%, 25%, and 50% M34/CC48 samples and then tested for acute toxicity.

November 2012

Surface water samples were collected in November 2012 from four sampling locations, as follows:

- *Animas River above mainstem Cement Creek*: sampling location A68

- *Animas River below mainstem Mineral Creek*: sampling location A72

- *Mainstem Cement Creek*: sampling location CC48

- *Mainstem Mineral Creek*: sampling location M34

All these surface water samples represented composite samples collected in the mid-water column across the width of each of the waterways.

Site-specific toxicity testing

Surface water from sampling locations M34, A68 and A72 were tested undiluted for acute toxicity.

Serial dilution testing

Surface water from sampling location A68 was used as a diluent to generate dilutions of surface water from sampling locations A72, as follows: 0% (full strength A68 water), 5%, 10%, 25%, 50%, 75%, and 100% (full strength A72 water). Each of these dilutions was then tested for acute toxicity.

Surface water from sampling location A68 was used as a diluent to generate dilutions of surface water collected from sampling location CC48, as follows: 0% (full strength A68), 1%, 3%, 6%, 12%, 25%, and 50% (50% CC48 water). Each of these dilutions was then tested for acute toxicity.

Surface water from sampling location A68 was used as a diluent to generate dilutions of a flow-weighted mixture of water samples collected from M34 and CC48 (M34/CC48), as follows: 0% (full strength A68 water), 4%, 9%, 20%, 40%, 65%, and 85% (85% of M34/CC48 flow-weighted mixture water). Each of these dilutions was then tested for acute toxicity.

April 2013

Site-specific toxicity testing:

Surface water samples were collected in April 2013 from six sampling locations, as follows:

- *Animas River above mainstem Cement Creek*: sampling location A68
- *Animas River below mainstem Mineral Creek*: sampling locations A72, A73, A73B, and A75B
- *Mainstem Mineral Creek*: sampling location M34

All these surface water samples represented composite samples collected in the mid-water column across the width of each waterway. They were tested full-strength (i.e., undiluted) for acute toxicity.

Serial dilution toxicity testing

Animas River water (A72) diluted by Hard Reconstituted Water (HRW)

The surface water sample collected from sampling location A72 was serially diluted with HRW to determine what dilutions of site water would cause acute toxicity to juvenile rainbow trout. The serial dilutions resulted in Animas River A72 surface water samples of 12%, 25%, 35%, 50%, 75%, and 88% strength.

Combined Mineral Creek and Cement Creek water (M34/CC48) diluted by A68 and HRW

The flow-weighted mixed surface water sample M34/CC48 was serially diluted either with Animas River water collected at sampling location A68 or with HRW to determine what dilutions would cause acute toxicity to juvenile rainbow trout. The serial dilutions resulted in M34/CC48 samples of 25%, 50%, 75%, 80%, 90%, and 95% strength (using water from sampling location A68 as diluent) or 25%, 50%, 75%, 90%, and 95% strength (using HRW as diluent).

3.6.1.2 Interpretation of the surface water toxicity test results

October 2012

Table 3.19 summarizes the outcome of the October 2012 toxicity tests.

Site-specific acute toxicity testing:

100% of the juvenile rainbow trout exposed for 96 hours to undiluted Animas River water survived at sampling locations A56 ("upstream" location), A68, A73B, A75B, and BBridge. On the other hand, complete mortality was observed in juvenile rainbow trout exposed for 96 hours to undiluted Animas River water collected from A72.

These results showed that at least 3,500 ft of the Animas River below mainstem Mineral Creek up to sample location A72 was acutely toxic to juvenile rainbow trout in October of 2012. Sampling location A73B, situated about 5.9 miles downstream from sampling location A72, was not acutely toxic during that same period. This finding showed that ongoing dilution of the Animas River with surface water from various drainages flowing into the Animas River downstream of sampling location A72 mitigated the acute toxicity to juvenile rainbow trout during this sampling period.

Serial dilution acute toxicity testing

A flow-weighted sample of M34/CC48 was serially diluted either with surface water collected from sampling location A56 ("upstream" location) or from sampling location A68. The results

showed that the M34/CC48 mixture was acutely toxic to juvenile rainbow trout only when it was tested undiluted (acute mortality was not significant when the M34/CC48 mixture was diluted 50% with A56 water). The M34/CC48 mixture was also acutely toxic when it was diluted 50% with A68 water.

November 2012

Table 3.20 summarizes the outcome of the November 2012 acute toxicity tests.

Site-specific acute toxicity testing:

Ninety-two and a half percent of the juvenile rainbow trout survived a 96-hour exposure to undiluted Animas River water collected from sampling location A68. On the other hand, all juvenile rainbow trout died after 96 hours of exposure to surface water collected from sampling location M34 on mainstem Mineral Creek. Additionally, only 2.5% of juvenile rainbow trout survived a 96-hour exposure to surface water collected from sampling location A72 on the Animas River about 3,500 ft below mainstem Mineral Creek.

These results showed that surface water from mainstem Mineral Creek and from the Animas River down to at least sampling location A72 was acutely toxic to juvenile rainbow trout in November of 2012. The testing structure did not allow for an estimation of how much further downstream from A72 this acute toxicity would be expressed. However, the serial dilution of surface water from sampling location A72 with surface water from sampling location A68 (see below) showed that this water was not acutely toxic to juvenile rainbow trout when tested at a strength of 75%. This evidence suggested that a relatively small amount of dilution of the Animas River surface water with uncontaminated water further downstream would be expected to mitigate the acute toxicity measured at sampling location A72.

Serial dilution acute toxicity testing

Surface water collected from sampling location A72 was serially diluted with surface water collected further upstream on the Animas River at sampling location A68. Survival of juvenile rainbow trout acutely exposed to the surface water sample collected at A72 was not significantly different from the control when that sample was at 75% strength. Only undiluted A72 sample resulted in acute toxicity.

Surface water from sampling location CC48 resulted in 100% mortality when it was diluted 50% using water from sampling location A68 as the diluent. The CC48 surface water had to be diluted by a factor of four using A68 water as the diluent in order to mitigate the acutely toxic effects.

A similar pattern was observed using the flow-weighted M34/CC48 sample. This sample at 40% strength, using surface water from sampling location A68 as the diluent, was not acutely toxic to

juvenile rainbow trout, whereas mortality was 100% when the M34/CC48 sample was tested at 65% strength using the same diluent source.

April 2013

Table 3.21 summarizes the outcome of the April 2013 acute toxicity tests.

Site-specific acute toxicity testing:

Survival in juvenile rainbow trout exposed to Animas River surface water from sampling locations A73 (98%), A73B (97.5%), and A75B (100%) was not significantly different from the controls. On the other hand, survival was significantly reduced in Animas River surface water from sampling location A68 (67.5% survival) and A72 (0% survival), and in mainstem Mineral Creek from location M34 (15% survival).

These results showed that at least 3,500 ft of the Animas River below mainstem Mineral Creek was acutely toxic to juvenile rainbow trout in April of 2013. Sampling location A73, situated about 5.9 miles downstream from sampling location A72, was not acutely toxic during that same period. This finding showed that ongoing dilution of the Animas River with surface water from various gulches and creeks flowing into the Animas River downstream of sampling location A72 mitigated the acute toxicity to juvenile rainbow trout.

Serial dilution acute toxicity testing:

Survival in juvenile rainbow trout exposed for 96 hours to Animas River surface water from sampling location A72 was not affected up to sample strength of 88% when HRW was used as the diluent. The data suggested that a relatively small amount of dilution with uncontaminated water removed the acute toxicity measured in full-strength surface water from sampling location A72. This conclusion is tempered by the fact that the diluent was not Animas River water collected upstream of the confluence with mainstem Mineral Creek. Rather, HRW was used as the diluent, which may have affected the toxicity of the hardness-dependent metals present in the A72 sample.

Seasonal patterns in acute toxicity to juvenile rainbow trout

Table 3.22 summarizes survival in juvenile rainbow trout acutely exposed to undiluted surface water samples in October 2012, November 2012, and April 2013.

The patterns can be interpreted as follows:

- Sample location A68 is upstream of the confluence with mainstem Cement Creek. Acute toxicity to juvenile rainbow trout was not present in surface water samples collected from this location in October and November 2012 but was observed in April 2013. It is not

known if the source of this toxicity originated at the Mayflower Mill or further upstream since surface water from sampling location A56 ("upstream" location) was not tested for acute toxicity in April 2013.

- The surface water samples collected from sampling location A72 in October 2012, November 2012, and April 2013 were uniformly acutely toxic to juvenile rainbow trout. This toxicity most likely originated from mainstem Cement Creek and mainstem Mineral Creek, both of which independently showed severe acute toxicity in November 2012 and April 2013.

- The test data showed that acute toxicity to juvenile rainbow trout was consistently present at sampling location A72 (i.e., about 3,500 ft below the confluence with mainstem Mineral Creek) but was consistently absent at sampling locations A73/A73B (i.e., about 5.9 miles downstream).

3.6.2 Sediment toxicity testing

Two sediment toxicity tests were performed in December 2012 and November 2014 at the EPA regional laboratory in Golden, CO. The tests consisted of exposing juvenile amphipods (*H. azteca*) for ten days at 23°C to sediment samples collected from the Animas River (A56 ["upstream" location], A60, A68, A72, A73, A73B, A75D, A75B, and BBridge), mainstem Cement Creek (CC49), and mainstem Mineral Creek (M34). The test endpoints consisted of survival and biomass. **Appendices 10a and 10b** provide details on the study design and rationale. Toxicity tests were conducted to characterize the effects of mine waste-impacted sediments on a sensitive benthic invertebrate species under sub-chronic exposure conditions. Use of 10-day tests allowed for efficient characterization of subchronic toxicity for many sampling locations in an off-site testing laboratory. Tests also provided growth/biomass endpoint data that is usually a more sensitive endpoint than mortality and only measured after longer-term exposures.

"Biomass" was defined as the total DW of the surviving organisms across replicates in a sediment sample at the end of the test divided by the number of organisms introduced in that sample at the start of the test. This measure was sensitive to mortality because death reduces the number of remaining organisms, which thereby decreases the final combined weight of the survivors at the end of the test, even if the individual survivors maintained or gained weight.

Table 3.23 provides the results of the two sediment toxicity tests. Note that the responses measured in both tests were compared to the laboratory control sample, instead of regional upstream samples because they do not represent unimpacted conditions. The results of the two tests can be summarized as follows:

- The laboratory control samples in the December 2012 and November 2014 tests showed 97.5% and 92.5% survival, respectively, with measurable growth in both tests. These

responses met the two test acceptability criteria, namely over 80% survival plus measurable growth after ten days of exposure. Hence, the results of both tests were acceptable for use in decision making.

- Survival in the December 2012 test in sediment samples collected from locations A56, A68, A72, A73B, A75B, BBridge, CC49, and M34 were significantly lower compared to the laboratory control sample. Survival in the Animas River sediment samples during the November 2014 test was statistically lower than the laboratory control sample only at location A56 (note: CC49, M34, A73B, and A75B were not tested for toxicity in November 2014).

- Biomass in both the December 2012 and November 2014 tests was significantly lower at all sample locations compared to the laboratory control.

3.6.3 Benthic invertebrate survey

Macroinvertebrate samples were collected in September 2014 from seven EUs on the Animas River above mainstem Cement Creek (i.e., A56 ["upstream"], A60, and A68) and below mainstem Mineral Creek (i.e., A72, A73, A75D and BBridge). One sample each was also collected from the mouth of mainstem Cement Creek (i.e., CC49) and the mouth of mainstem Mineral Creek (i.e., M34). Note that additional benthic samples were collected from several other non-EU locations on the Animas River, including reference location A73EC (Elk Creek near the confluence with the Animas River), reference location A75 CC (Cascade Creek near the confluence with the Animas River), and James Ranch, which is a sampling location on the Animas River downstream of BBridge. These data are included in the discussion below to provide a broader perspective.

Samples for Multi-Metric Index (MMI) analysis were collected by using a modified rectangular kick net and field samplers used their feet and hands to disturb and dislodge organisms from substrate in a one-square meter immediately upstream of the net for a 60-second collection interval. This collection method was used at all sampling locations and the technique followed similar protocol that was used in past monitoring efforts.

Additional benthic invertebrate samples were collected for metals tissue analysis at each of the sample locations listed in this section. Sampling for tissue samples followed similar procedures as described above except for the timed interval for MMI analysis. For tissue analysis, the field sampler focused on taking additional time and adding additional preferred habitat areas in order to get the required amount of sample for metals analysis. Efforts were made to collect as many organisms as possible with the goal of gathering one gram of DW material for tissue residue analysis.

The benthic invertebrate samples were preserved with ethanol in the field for counting and identification. Additional benthic invertebrate samples for tissue analysis were placed on ice for

transportation then stored in an ultra-low temperature freezer until analysis. The data were reported as 300-count subsamples (based on protocols for MMI calculation provided by CDPHE). **Appendix 11** provides the raw counts and summarizes the community data. A subset of the measures listed below are identified with an asterisk (*) and are provided in **Table 3.24** by sampling location.

- MMI scores
- Total number of organisms (# per sample)
- *Number of taxa per sample
- *Shannon-Weaver Diversity (H')
- *Hilsenhoff Biotic Index (HBI)
- *Total # of Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa
- *EPT Index (% of total number of taxa)
- *Ephemeroptera abundance (% of total number)
- # of Ephemeroptera (mayflies) taxa
- # of Plecoptera (stoneflies) taxa
- # of Trichoptera (caddisflies) taxa
- *% EPT (% of total number)
- *# of intolerant taxa
- *Tolerant organisms (% of total number)
- Dominant taxon (% of total number)
- *Filterers (% of total number)
- *Scrapers (% of total number)
- # Clinger Taxa
- *Clingers (% of Total Number)

MMI scores

The MMI bioassessment tool is composed of separate benthic invertebrate indices calibrated to respond to stressors affecting aquatic communities in one of three biotypes. A biotype is defined as an aggregation of macrobenthos sites that have similar general environmental attributes, such as elevation, stream slope, and ecoregion. The sampling locations on the Animas River of interest to this BERA fall into two biotypes, as follows:

- *Biotype 1 (Transition):* A75D, BBridge, James Ranch and A75CC (reference)

- *Biotype 2 (Mountain):* A56, A60, A68, A72, A73, M34, CC49, and A73EC (reference)

MMIs are calibrated specifically for each biotype. The MMI is composed of several metrics selected to represent categories of community characteristics, including richness, composition, functional feeding group, mode of locomotion, and pollution tolerance. The metrics were chosen for their ability to (a) discriminate between reference and stressed sites, (b) represent multiple

metric categories, (c) be ecologically meaningful, and (d) not duplicate other metrics in the index (CDPHE, 2010; 2017).

The metrics included in the two biotypes are as follows:

- *Biotype 1 (Transition):* total taxa, predator-shredder taxa, clinger taxa, % Ephemeroptera, Beck's Biotic Index, Shannon Diversity Index, and Hilsenhoff Biotic Index.

- Biotype 2 (Mountain): EP taxa, % Chironomidae, sensitive plains families, predator-shredder taxa, clinger taxa, % non-insect, Shannon Diversity Index, and Hilsenhoff Biotic Index.

The MMI scores are compared against aquatic life thresholds which were obtained by analyzing the biological condition at selected reference sites in each of the biotypes (CDPHE, 2010; 2017). **Attachment 1** below represents the two biotypes for the Animas River and their associated thresholds for impairment of aquatic life use.

Attachment 1: Aquatic Life Use Thresholds			
Biotype		**Attainment Threshold**	**Impairment Threshold**
Biotype 1	Transition	52	42
Biotype 2	Mountains	50	42

In addition, the Hilsenhoff Biotic Index and the Shannon Diversity Index are used as auxiliary metrics that supplement the MMI for Class 1 waters with MMI scores between the attainment and impairment thresholds (CDPHE, 2010; 2017). A site is considered impaired if a Class 1 fails to meet the criteria shown in **Attachment 2** below for either auxiliary metric.

Attachment 2: Auxiliary Metric Thresholds for Class 1 Waters with MMI Scores Between the Attainment and Impairment Thresholds			
Biotype		**Hilsenhoff Biotic Index**	**Shannon Diversity Index**
1	Transition	<5.4	>2.4
2	Mountains	<5.1	>3.0

Shannon-Weaver Diversity Index (H')

The *Shannon-Weaver Diversity Index* determines species diversity. This index calculates the number of different species in a sample (species richness), and the proportion of individuals of a particular species compared to the number of individuals of other species in the sample. This comparison shows how rare or common a species is in a group. The index is calculated as follows:

$$H' = -\sum_{i=1}^{s} (P_i * \ln P_i)$$

where:

H' = the Shannon diversity index
P_i = fraction of the sample consisting of species i (i.e., the proportion of a species i relative to the total number of species present in a sample)
S = numbers of species present

A high H' represents a diverse and evenly-distributed community. A low H' represents a less diverse community. An H' of zero represents a community containing a single species.

The Hilsenhoff Biotic Index (HBI)

The HBI estimates the overall tolerance of the community in a sample to organic pollution, weighted by the relative abundance of each taxonomic group. Species are assigned a tolerance value ranging between zero and ten, with zero for the most-sensitive species and ten for the least-sensitive species.

The HBI is calculated as follows:

$$HBI = \frac{\sum n_i \times a_i}{N}$$

where:

n = number of specimens in taxon i
a = tolerance value for taxon i
N = total number of specimens in the sample

The HBI increases with decreasing water quality. Note that the taxon-specific tolerance values used in the HBI calculations were originally developed to assess organic pollution, but that the Animas River system is impacted mainly by mining-related inorganic pollution.

EPT

The EPT-related measures pertain to the number of mayfly, stonefly, and caddisfly taxa present in a sample. The EPT species are considered sensitive to pollution. As a result, impacted waters typically have lower numbers of EPT taxa than pristine waters.

Intolerant taxa

The *intolerant taxa* represent species in a sample that are intolerant to the presence of pollution. The number of intolerant taxa typically decreases with increasing contamination.

Filterers, scrapers, and clingers

These measures estimate what fraction of benthic species in a sample is represented by filter-feeders, scrapers, and clingers.

Table 3.24 summarizes the macroinvertebrate community data collected in September 2014. A subset of these data and MMI scores are plotted in **Figure 3.1**. **Appendix 20** provides the MMI scores associated with this sampling event. The discussion below focuses specifically on the Animas River and the following benthic invertebrate metrics: MMI scores, # of taxa, the Shannon-Weaver Diversity Index, # of EPT taxa, the EPT index, the % EPT. Focusing the data interpretation on the EPT metrics is appropriate because the EPT species are considered highly sensitive to aquatic pollution.

- The **MMI score** (**Fig. 3.1a**) is highest at the two reference locations (A73EC [Elk Creek] and A75CC [Cascade Creek]). The score shows impairment of aquatic life use at sampling locations A56 and A68 (but not A60) in the Animas River above mainstem Cement Creek. The score also shows impairment of aquatic life use at sampling locations A72, A73, and BBridge (but not A75D or James Ranch) in the Animas River below mainstem Mineral Creek.

- The **# of taxa** (**Fig. 3.1b**) is highest at the two reference locations (A73EC and A75CC). This metric drops, on average, in the Animas River above mainstem Cement Creek, and reaches its lowest level at sampling locations A72 and A73. The # of taxa further downstream from A73, and up to James Ranch, rebounds to the levels observed in the Animas River above mainstem Cement Creek but does not reach the levels measured at the two reference locations.

- The **Shannon-Weaver Diversity Index** (**Fig. 3.1c**) is high at the two reference locations (A73EC and A75CC). It stays high (except for location A56) in the Animas River above mainstem Cement Creek and reaches its lowest level at sampling location A73. The metric further downstream from location A73, and up to James Ranch, rebounds to the levels observed in the Animas River above mainstem Cement Creek. However, except for location A75D, this metric in the Animas River below mainstem Mineral Creek does not reach the levels measured at the two reference locations.

- The **# of EPT taxa** (**Fig. 3.1b**) is highest at the two reference locations (A73EC and A75CC). This metric drops in the Animas River above mainstem Cement Creek and reaches its lowest level at sampling location A72. The # of EPT taxa further downstream

from A72, and up to James Ranch, rebounds back close to the levels observed in the Animas River above mainstem Cement Creek but does not reach the levels measured at the two reference locations.

- The **EPT Index** (which represents the # of EPT taxa as a % of the total # of taxa; **Fig. 3.1e**) is high in the two reference locations (A73EC and A75CC). It drops (except at location A56) in the Animas River above mainstem Cement Creek and reaches its lowest level at location A72. The metric further downstream from location A72, and up to James Ranch, remains low (except for location A73) and does not rebound to the levels observed in the Animas River above mainstem Cement Creek or the two reference locations.

- The **%EPT** (which represents the fraction of the total number of organisms consisting of EPT; **Fig. 3.1e**) is highest at the two reference locations (A73EC and A75CC). It drops sharply in the Animas River above mainstem Cement Creek and recovers in the Animas River below Mineral creek but not (except at location A73) to the levels measured at the two reference locations.

The general pattern for the September 2014 benthic invertebrate survey shows a stressed benthic community in sections of the Animas River both above mainstem Cement Creek (between sampling locations A56 and A68) and below mainstem mineral Creek. The impacts of the contamination entering the Animas River from mainstem Cement and Mineral Creek are felt most strongly at sampling locations A72 and A73. The benthic invertebrate community starts recovering downstream of A73 and up to James Ranch but not to the levels typically observed at the two reference locations (A73EC and A75CC).

4.0 BASELINE EXPOSURE ESTIMATES

4.1 Introduction

The exposure analysis for this BERA consisted of the following two components: (a) quantify surface water, sediment, and pore water exposures to community-level receptors in mainstem Cement Creek, mainstem Mineral Creek, and the three Animas River reaches, and (b) perform wildlife exposure modeling in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek to calculate RME and CTE EDDs (mg/kg.bw-day).

4.2 Aquatic EUs

This BERA identifies discrete aquatic EUs to summarize the sediment, surface water, and pore water analytical data, and to quantify exposures to aquatic, community-level and wildlife receptors. The aquatic EUs were defined as follows:

- *Mainstem Cement Creek* is assessed by combining data from two sampling locations:
    - Location CC48: situated about one mile upstream of the confluence with the Animas River in Silverton. This location was sampled numerous times for surface water between May 2009 and September 2014, but not for sediment or pore water.
    - Location CC49: situated between CC48 and the confluence with the Animas River in Silverton. This location was sampled once for sediment and once for surface water in October 2012, but not for pore water.
- *Mainstem Mineral Creek* is assessed at one sampling location, as follows:
    - Location M34 is situated in mainstem Mineral Creek less than a half of a mile above the confluence with the Animas River in Silverton. This location was sampled numerous times for surface water between May 2009 and September 2014, twice for sediment in October 2012 and September 2014, and once for pore water in September 2014.
- *The Animas River above mainstem Cement Creek*:

This reach covers about two miles of the Animas River between sampling locations A60 and A68. Location A56 is situated on the Animas River about a quarter mile upgradient from A68, above the Mayflower Mill and Arrastra Creek. This location is not part of the EU and is therefore not included in the exposure calculations. A56 represents “upstream” conditions reflective of other sources of contamination further upgradient in the watershed. Location A68 is about a quarter mile upstream of the confluence with Cement Creek.

This BERA assumes that exposure to benthic invertebrates, fish, and wildlife receptors is best represented by the chemical conditions measured across all of the sampling locations in this reach. Hence, all surface water, sediment, pore water, and benthic invertebrate tissue analytical data collected between A60 and A68 are combined into one EU.

- *The Animas River between mainstem Cement Creek and mainstem Mineral Creek*

This reach covers about one mile of the Animas River across from Silverton. Location A69A is about 2,500 ft downstream of the confluence with Cement Creek, whereas location A70B is just upstream of the confluence with Mineral Creek.

Only one surface water sample and no sediment samples were collected from each of these two sampling locations. Exposure to wildlife receptors could not be evaluated in this reach of the Animas River because sediment analytical data are not available to estimate the contaminant levels in the food items for evaluation in the food chain models.

- *The Animas River below mainstem Mineral Creek*

This reach covers about 30 river miles between sampling locations A71B and BBridge. Location A71B is immediately downstream of the confluence with Mineral Creek.

This BERA assumes that exposure via surface water, sediment, and pore water to benthic invertebrates and fish in this reach of the Animas River is best represented by the chemical conditions measured at each separate sampling location. Hence, each sampling location represents its own EU for the community-level receptors. The same assumption is used to calculate exposures to the wildlife receptors. The reason is that the distance between many of the sampling locations is too great to assume that any of the receptor groups would be continuously exposed across these locations.

4.3 Seasonal effects

Surface water samples were collected throughout the year between May 2009 and September 2014 to investigate differences in metal loads across seasons. The surface water exposures for the aquatic community-level receptors were calculated at each of the sampling locations for three specific hydrologic periods across years, as follows:

- *Pre-runoff period*: February, March, and April (2010, 2011, and 2014 data combined),

- *Runoff period*: May and June (2009, 2010, 2011, 2013, and 2014 data combined), and

- *Post-runoff period*: July, August, September, October, and November (2009, 2010, 2011, 2012, and 2014 data combined). No surface water samples were collected in the months of December or January.

This approach ensures that the surface water exposures reflect the seasonal differences that exist in metal concentrations in the three waterways during the 2009 to 2014-time period.

The surface water exposures for the wildlife receptors were calculated at each EU across the three runoff periods.

4.4 Exposure point concentrations

The EPCs used in the exposure calculations consist of RMEs and CTEs for metals in surface water, sediment, and pore water. Depending on the structure of a dataset, the RMEs represent either 95% Upper Confidence Limits (UCLs) derived using the ProUCL software, or the maximum detected values if UCLs could not be calculated due to limited datasets. If a data set was big enough to calculate 95% UCLs, but one or more of the UCLs exceeded their maximum concentrations, then the maximum concentration is used in the exposure calculations. All the CTEs represent arithmetic means, including half of the DL for non-detected compounds. Only the metals identified as COPECs in Section 3 are used to calculate EPCs.

Appendix 12 provides the ProUCL outputs (data permitting) for hardness and dissolved metals in surface water to derive EPCs for aquatic, community-level receptors. **Appendix 13** provides the ProUCL outputs for total metals in surface water (data permitting) to derive EPCs for wildlife receptors in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek. **Appendix 14** provides the ProUCL outputs for sediment (data permitting) to derive EPCs for benthic invertebrates and the wildlife receptors in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek. **Appendix 15** provides the ProUCL outputs for the pore water samples collected from the Animas River above mainstem Cement Creek (note: not enough pore water samples were collected from the individual sampling locations on mainstem Mineral Creek or from the Animas River below mainstem Mineral Creek to run ProUCL).

The Animas River above mainstem Cement Creek, and between Cement Creek and Mineral Creek, is considered as two separate EUs to calculate EPCs for community-level, aquatic receptors and the four wildlife receptors. On the other hand, the six sampling locations on the Animas River below mainstem Mineral Creek are treated as separate EUs to calculate EPCs for both the community-level, aquatic receptors and the four wildlife receptors.

The concentrations of key surface water metals to this BERA (i.e., Al, Cd, Cu, Mn, Pb, and Zn) are also assessed on a sample-by-sample basis. These analytes are evaluated by calculating HQs based on dividing the measured concentrations by the hardness-adjusted surface water benchmarks (see **Appendix 7**). The HQs are then plotted by analyte, sampling location, and

hydrologic period to create "scatter plots" which provide a visual overview of spatial and temporal changes in surface water risk. The results of this evaluation are further discussed in Section 5.

4.4.1 Aquatic community-level receptors

The aquatic, community-level receptors are assumed to be directly exposed to surface water, sediment, and pore water in mainstem Cement Creek, mainstem Mineral Creek, the Animas River between mainstem Cement Creek and mainstem Mineral Creek, and at the individual sampling locations on the Animas River below mainstem Mineral Creek.

4.4.1.1 Surface water

The EPCs for dissolved metals in surface water are provided in **Table 4.1** (mainstem Mineral Creek), **Table 4.2** (mainstem Cement Creek), **Table 4.3** (Animas River above mainstem Cement Creek), and **Table 4.4** (Animas River between mainstem Cement and Mineral Creeks). Additionally, **Tables 4.5 to 4.11** provide the EPCs in surface water samples collected from sampling locations A71B, A72, A73, A73B, A75D, A75B, and BBridge on the Animas River below mainstem Mineral Creek.

4.4.1.2 Sediment

The EPCs for metals in sediment samples are provided in **Table 4.12** (mainstem Mineral Creek), **Table 4.13** (mainstem Cement Creek), and **Table 4.14** (Animas River above mainstem Cement Creek). Additionally, **Tables 4.15 to 4.20** provide the EPCs for metals in sediment collected from sampling locations A72, A73, A73B, A75D, A75B, and BBridge on the Animas River below mainstem Mineral Creek.

4.4.1.3 Pore water

The EPCs for dissolved metals in pore water samples are provided in **Table 4.21** (mainstem Mineral Creek), **Table 4.22** (Animas River above mainstem Cement Creek), and **Tables 4.23 to 4.27** for sampling locations A72, A73, A73B, A75D, and BBridge on the Animas River below mainstem Mineral Creek.

4.4.2 Wildlife receptors

The four wildlife receptors are assumed to forage across the two miles of Animas River above mainstem Cement Creek and at each of the individual sampling locations on the Animas River below mainstem Mineral Creek. The Animas River reach flowing between mainstem Cement and Mineral Creeks is omitted from food chain modeling because no sediment data were available to derive tissue residues needed to calculate daily doses. The two creeks are also

omitted because the SLERA showed that they cannot support a healthy forage base for use by wildlife receptors.

4.4.2.1 Surface water

The EPCs for total metals in surface water used for food chain modeling are provided in **Table 4.28** (Animas River above mainstem Cement Creek), and **Tables 4.29 to 4.34** that show the EPCs for total metals measured in surface water samples collected from sampling locations A72, A73, A73B, A75D, A75B, and BBridge on the Animas River below mainstem Mineral Creek.

4.4.2.2 Sediment

The EPCs for metals in sediment samples are provided in **Table 4.14** (Animas River above mainstem Cement Creek) and **Tables 4.15 to 4.20** that show the EPCs for metals measured in sediment collected from sampling locations A72, A73, A73B, A75D, A75B, and BBridge on the Animas River below mainstem Mineral Creek.

4.4.2.3 Benthic invertebrates

Appendix 4 provides the tissue residue data (both wet weight and DW) for the benthic invertebrates collected from the Animas River in September 2014. Invertebrate tissue EPCs were based on a single composite sample for most of the sampling locations. Therefore, EPC derivation tables were not provided herein. Measured and estimated benthic invertebrate tissue metals concentrations are provided in wildlife receptor EDD derivation summary tables (Section 4.5).

4.5 Wildlife food chain modeling

Section 2.4.2.2 presents the four wildlife receptors evaluated in this BERA using exposure modeling. These receptors are the American dipper (representing invertivorous birds), the mallard (representing omnivorous birds), the belted kingfisher (representing piscivorous birds), and the muskrat (representing herbivorous mammals).

Wildlife species are assumed to be exposed to COPECs in the Animas River by direct ingestion of surface water, incidental ingestion of sediment, and by feeding on contaminated food items that have accumulated metals from the sediment. This BERA calculates total EDDs for each wildlife receptor to estimate their exposure using a standard exposure equation which incorporates species-specific natural history parameters.

Table 4.35 presents the intake equations for each wildlife receptor species. **Table 4.36** provides the species-specific exposure parameters (e.g., Body Weights (BWs), ingestion rates, relative consumption of food items, etc.), as well as the reference sources and assumptions on which these values were based. This BERA assumes two different diets for the omnivorous mallard: (a)

100% benthic invertebrates to model the diet of female mallards during the egg-laying period (the "100% diet"), and (b) a half and half diet of benthic invertebrates and plants to model the diet of mallards for the rest of the year (the "50%-50% diet").

The exposure calculations assume that the target wildlife receptors consume aquatic invertebrates, aquatic plants, or fish, depending on the species. **Tables 4.37, 4.38 and 4.39** provide the literature-derived regression models and uptake factors used to estimate metal concentrations in these food items based on measured COPEC levels in sediment in the Animas River. The food intake equations and the estimated COPEC tissue levels are all based on DW. Note that the benthic invertebrate tissue levels used in the dose calculations are measured values from organisms collected from the Animas River in September 2014, except for sampling locations A73B and A75B from which benthic invertebrates were not collected.

4.6 Wildlife EDDs

The COPEC specific wildlife EDDs were calculated using the input parameters summarized in Section 4.5. **Tables 4.40 to 4.46** provide the EDDs for the American dipper, **Tables 4.47 to 4.53** and **Tables 4.54 to 4.60** provide the EDDs for the mallard 100% diet, and 50%-50% diet, respectively. **Tables 4.61 to 4.67** provide the EDDs for the belted kingfisher, and **Tables 4.68 to 4.74** to provide the EDDs for the muskrat.

5.0 RISK CHARACTERIZATION

5.1 Introduction

The potential for ecological risk is determined during risk characterization. The exposure analysis and effects analysis described in previous sections of this report are integrated to determine the likelihood of adverse effects to the assessment endpoints, given the assumptions inherent in the analysis phase.

Table 5.1 summarizes the risk estimation approaches for each of the receptor groups evaluated in this BERA. Risk was quantified mostly using the HQ method, which compares measured exposures (i.e., surface water, sediment, and pore water EPCs) or estimated exposures (wildlife EDDs) to corresponding toxicity values (i.e., chronic surface water benchmarks or no-effect and effect sediment benchmarks, plus wildlife no-effect and effect TRVs).

COPEC-specific HQs are then calculated using the following general equation:

$$HQ = EPC \text{ or } EDD/benchmark \text{ or } TRV$$

Where:

HQ	=	Hazard Quotient (unitless)
EPC	=	Exposure Point Concentration (µg/L or mg/kg)
EDD	=	Estimated Daily Dose (mg/kg bw-day)
Benchmark	=	surface water or sediment benchmark (µg/L or mg/kg)
TRV	=	wildlife Toxicity Reference Value (mg/kg bw-day)

HQs at or above 1.0 identify a potential for ecological risk under the exposure and toxicity assumptions used in this evaluation. Note that the text below uses the terms low risk (one or more CTE effect HQs >1.0 but <5.0), moderate risk (one or more CTE effect HQs >5.0 but <10), or high risk (one or more CTE effect HQs >10.0), even though it is understood that risk does not increase in a linear fashion with increasing HQs. However, this terminology is used to qualitatively highlight differences in risk.

Besides assessing the potential impacts associated with RME and CTE surface water and sediment exposures, the risk characterization for community-level aquatic receptor groups also views each surface water and sediment sample as representing an individual event in which organisms are exposed to COPECs. Hence, HQs were calculated for all available surface water and sediment samples and were plotted by sampling station and period. Risk may be acceptable if the community as a whole remains healthy and stable over time. It is assumed that community-level risks are unlikely to occur if all the HQs measured within a particular EU fall below 1.0. On the other hand, community-level risks are more likely to occur if most or all of the individual

HQs exceed 1.0. Finally, some impact may occur, but without resulting in community-level effects, if only a small portion of the HQs exceeds 1.0.

Finally, the risk characterization does not quantify "incremental risk" by subtracting reference risk from site risk. Hence, the risks summarized in this section for each EU represent "total" risk.

Uncertainty is an inherent feature of this BERA because many assumptions were made in order to proceed with the evaluation. These assumptions affect all aspects of the assessment, including the CSM, the effects analysis, the exposure analysis, and the risk characterization. The uncertainty analysis identifies and discusses the major assumptions made in this BERA. The end result is a balanced overview of uncertainty to help risk managers understand the full extent of potential ecological risk to receptors living or feeding in mainstem Cement Creek, mainstem Mineral Creek, and the three Animas River reaches.

5.2 Community-level aquatic receptors - Benthic Invertebrates

Assessment endpoint 1: Maintain a stable and healthy benthic invertebrate community. *Are the metal levels in sediment from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below mainstem Mineral Creek high enough to impair the benthic invertebrates in these waterways?*

The potential for ecological risk to the benthic invertebrate community in the three waterways was assessed as follows.

5.2.1 Measurement endpoint 1A

Compare the metal levels measured in sediment samples to sediment benchmarks.

5.2.1.1 Mainstem Mineral Creek

Table 5.2 presents the no effect and effect HQs for benthic invertebrates exposed to COPECs in sediment from mainstem Mineral Creek.

All six sediment COPECs have no-effect HQs above 1.0. But only three of those six COPECs have an effect HQ above 1.0, with the highest HQs associated with Pb (RME effect HQ = 1.9 and CTE effect HQs = 1.4).

The data suggests that sediment in mainstem Mineral Creek close to the confluence with the Animas River present low levels of risk to the local benthic invertebrate community.

5.2.1.2 Mainstem Cement Creek

Table 5.3 presents the no-effect and effect HQs for benthic invertebrates exposed to COPECs in sediment from mainstem Cement Creek. The RME and CTE EPCs are identical to each other because only one sediment sample was collected from this EU.

All five sediment COPECs have no-effect HQs above 1.0. But only two of those five COPECs have effect HQs above 1.0, with the highest HQs associated with Pb (RME and CTE effect HQs = 2.2).

The data suggests that sediment in mainstem Mineral Creek close to the confluence with the Animas River presented low levels of risk to the local benthic invertebrate community.

5.2.1.3 Animas River

Animas River above mainstem Cement Creek

Table 5.4 presents the no-effect and effect HQs for benthic invertebrates exposed to COPECs in sediment from the Animas River above mainstem Cement Creek. Except for Hg and Se, all seven remaining COPECs have RME or CTE effect HQs above 1.0.

The three COPECs with the highest effect HQs consist of Pb (RME effect HQ = 13.5 and CTE effect HQ = 11.8), Mn (RME effect HQ = 10.5 and CTE effect HQ = 8.8) and Zn (RME effect HQ = 8.8 and CTE effect HQ = 6.9).

The data suggests that sediment in the Animas River above mainstem Cement Creek present high levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location A72 below mainstem Mineral Creek**

Table 5.5 presents the no-effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location A72. Al, Cd, Ni, Se, and Ag have RME and CTE effects HQs below 1.0 and are therefore of no further concern.

The three COPECs with the highest effect HQs consist of Pb (RME effect HQ = 4.5 and CTE effect HQ = 3.7), Mn (RME effect HQ = 2.5 and CTE effect HQ = 1.8) and Zn (RME effect HQ = 1.8 and CTE effect HQ = 1.4).

The data suggest that sediment at sampling location A72 presents low levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location A73 below mainstem Mineral Creek**

Table 5.6 presents the no-effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location A73. Al, Ni, Se, and Ag have RME and CTE effects HQs below 1.0 and are therefore of no further concern.

The three COPECs with the highest effect HQs consist of Pb (RME effect HQ = 5.7 and CTE effect HQ = 4.0), Mn (RME effect HQ = 5.5 and CTE effect HQ = 3.6) and Zn (RME effect HQ = 3.0 and CTE effect HQ = 2.3).

The data suggests that sediment at sampling location A72 present low levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location A73B below mainstem Mineral Creek**

Table 5.7 presents the no-effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location A73B. Al, Cd, Ni, Se, and Ag have RME and CTE effects HQs below 1.0 and are therefore of no further concern.

The three COPECs with the highest effect HQs consist of Pb (RME effect HQ = 4.6 and CTE effect HQ = 4.2), Zn (RME effect HQ = 3.7 and CTE effect HQ = 2.4) and Mn (RME effect HQ = 3.6 and CTE effect HQ = 2.6).

The data suggest that sediment at sampling location A73B present low levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location A75D below mainstem Mineral Creek**

Table 5.8 presents the no-effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location A75D. Al, As, Ni, Se, and Ag have RME and CTE effect HQs below 1.0 and are therefore of no further concern.

The three COPECs with the highest effect HQs consist of Zn (RME effect HQ = 6.1 and CTE effect HQ = 3.8), Mn (RME effect HQ = 5.3 and CTE effect HQ = 3.6) and Pb (RME effect HQ = 2.9 and CTE effect HQ = 2.3).

The data suggests that sediment at sampling location A75D present low levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location A75B below mainstem Mineral Creek**

Table 5.9 presents the no effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location A75B. Al, Ni, Se, and Ag have RME and CTE effect HQs below 1.0 and are therefore of no further concern.

The three COPECs with the highest effect HQs consist of Zn (RME effect HQ = 11.6 and CTE effect HQ = 4.8), Pb (RME effect HQ = 3.4 and CTE effect HQ = 2.3) and Mn (RME effect HQ = 3.2 and CTE effect HQ = 2.3).

The data suggests that sediment at sampling location A75B present low levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location Bakers Bridge below mainstem Mineral Creek**

Table 5.10 presents the no-effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location BBridge. Al, As, Ni, Se, and Ag have RME and CTE effects HQs below 1.0 and are therefore of no further concern.

The three COPECs with the highest effect HQs consist of Zn (RME effect HQ = 18.6 and CTE effect HQ = 10.1), Mn (RME effect HQ = 10.9 and CTE effect HQ = 6.2) and Cd (RME effect HQ = 3.7 and CTE effect HQ = 2.0).

The data suggests that sediment at sampling location BBridge present moderate to high levels of risk to the local benthic invertebrate community.

Risk conclusion for measurement endpoint 1A

Mainstem Mineral Creek and mainstem Cement Creek have the lowest risk levels associated with metals in sediment. Pb, Mn, and Zn show a consistent potential for risk across all the Animas River EUs. The HQ data for the three risk drivers were used to calculate a geometric mean of the no effect RME and CTE HQs, and the effect RME and CTE HQs at each of the Animas River EUs. These averaged HQs were then plotted for visualization (see **Figure 5.1**). The reach above mainstem Cement Creek represents the highest levels of risk for benthic invertebrates exposed to sediment. Risk from Pb, Mn, and Zn is still present in the Animas River below mainstem Mineral Creek, but at a lower level.

The risk from Zn in sediment increases at sampling location A75B (situated just downstream of the confluence with Cascade Creek) and is higher still at the BBridge sampling location situated about eleven miles further downstream. This pattern suggests that, in response to the decrease in gradient of the River near BBridge, metals may have been deposited. Or an unknown source of metals could be present in this stretch of the Animas River.

Figure 5.2 shows the sample-specific no-effect and effect sediment HQs for Al, As, Cd, Cu, Pb, Mn, Ag, and Zn at each EU. This approach assumes that each sediment sample represents an exposure point within a particular EU (instead of calculating the EU-wide RME and CTE EPCs for deriving the HQs presented above). The same general pattern is apparent from these data, namely: (a) the sediment quality at the mouths of mainstem Cement and Mineral Creeks is no worse, and in many cases substantially better, than in the reaches of the Animas River above and below these two creeks, (b) Pb, Mn and Zn are the major sediment risk drivers to the benthic invertebrate community in the Animas River, and (c) sediment risk is typically higher in the Animas River above mainstem Cement Creek compared to below mainstem Mineral Creek, indicating the presence of one or more contaminant sources further upstream.

5.2.2 Measurement endpoint 1B

Compare the metal levels measured in pore water samples collected from substrate in the field to chronic surface water benchmarks.

The pore water risk characterization consists of calculating RME and CTE HQs for all the pore water COPECs identified across the various EUs. A complicating factor in these risk calculations is that the toxicity of many COPECs depends on hardness. Hence, the pore water RME and CTE EPCs for the hardness-sensitive metals presented in Section 4 needed to be compared to chronic benchmarks adjusted for "reasonable minimum" and "average" pore water hardnesses (note: the toxicity of hardness-sensitive metals increases with decreasing hardness; hence, a reasonable minimum hardness was required as a conservative value for use in the pore water HQ calculations).

A reasonable minimum hardness was obtained as follows:

- The pore water hardness data were organized by EU (note: not enough pore water samples were available to calculate hardness by hydrologic period).
- For datasets too small to be evaluated using the ProUCL software, an average and a minimum pore water hardness was obtained from the available data to derive the pore water HQs for the hardness-sensitive metals.
- For the larger dataset (i.e., Animas River above mainstem Cement Creek), a 95% UCL and an average pore water hardness were calculated, after which the difference between the 95% UCL and the average was subtracted from the average to obtain a "reasonable minimum" pore water hardness value. Both the average and reasonable minimum hardness values were then used to calculate chronic benchmarks and derive the pore water HQs for the hardness-sensitive metals.

Table 5.11 summarizes the procedure used to obtain the hardness values required to calculate the pore water RME HQ and CTE HQs for the hardness-sensitive metals. Note that the RME and CTE HQs for Al were derived using only the standardized chronic benchmark of 87 µg/L, even though CDPHE (2013) has determined that the toxicity of Al in surface water is sensitive to

hardness. The reason for using this simplifying step is that CDPHE (2013) also requires evaluating pH as an additional variable to determine if the hardness-sensitive equation or the standard benchmark of 87 µg/L should be used. The pH of the pore water samples are not available.

5.2.2.1 Mainstem Mineral Creek

Table 5.12 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water from mainstem Mineral Creek.

Two COPECs are retained for further evaluation but neither one is present above its analytical DL in the one pore water sample collected from this EU. The RME and CTE HQs equal 1.5 for Be and 1.9 for Ag.

These results are inconclusive because they are derived from non-detect data. However, the lack of risk from the other COPECs suggests that pore water is unlikely to be a major risk factor in this EU. This conclusion is highly tentative because it is based on a single sample.

5.2.2.2 Animas River

Animas River above mainstem Cement Creek

Table 5.13 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water from the Animas River above mainstem Cement Creek. Eight of the nine COPECs have RME and CTE chronic HQs above 1.0. Cd, Cu and Zn are the three COPECs with the highest HQs.

The HQs for these three metals indicate the presence of moderate to high risk to benthic invertebrates exposed to pore water at this EU. However, a review of the analytical data (see **Appendices 3.1 and 3.2**) shows that this risk is driven by unusually high concentrations measured at sampling location A61 in April 2014 ([Cd] = 100 µg/L; [Cu] = 2,250 µg/L; [Zn] = 29,900 µg/L) and in September 2014 ([Cd] = 106.5 µg/L; [Cu] = 95.9 µg/L; [Zn] = 18,490 µg/L). Lower, but still substantial levels of these three metals were also measured at sampling location A65 during the same two 2014 pore water sampling events. It is unclear if these high levels represent potential hot spots. It is noteworthy that the metal levels in the pore water samples collected from sampling locations A60 (April and September 2014) and A64 (April 2014 only—a pore water sample was not collected from A64 in September 2014), appear more normal. A60 is located upstream of A61, whereas A64 is located between A61 and A65.

The data suggests that pore water, at least in some locations of the Animas River above mainstem Cement Creek, presents high risk to the local benthic invertebrate community, but that this risk may be localized.

- **Animas River at sampling location A72 below mainstem Mineral Creek**

Table 5.14 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water collected from sampling location A72. Al, Be, Cd, Ag, and Zn have RME and CTE chronic HQs above 1.0.

The three COPECs with the highest chronic HQs consist of Zn (low hardness RME chronic HQ = 8.8), Al (RME chronic HQ = 5.9), and Cd (low hardness RME chronic HQ = 5.0).

The data suggest that pore water at sampling location A72 presents a moderate risk to the local benthic invertebrate community.

- **Animas River at sampling location A73 below mainstem Mineral Creek**

Table 5.15 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water collected from sampling location A73. Be, Cd, Ag, and Zn have RME and CTE chronic HQs above 1.0.

The three COPECs with the highest chronic HQs consist of Zn (low hardness RME chronic HQ = 4.0), Cd (low hardness RME chronic HQ = 3.5), and Ag (low hardness RME chronic HQ = 1.6).

The data suggests that pore water at sampling location A72 presents low risk to the local benthic invertebrate community.

- **Animas River at sampling location A73B below mainstem Mineral Creek**

Table 5.16 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water collected from sampling location A73B. Be and Ag have RME and CTE chronic HQs above 1.0.

These two COPECs are retained for further evaluation but neither one is present above its analytical DL in the one pore water sample collected from this EU in September 2014. The RME and CTE chronic HQs equal 1.5 and 11 for Be and Ag, respectively.

These results are inconclusive because they are derived from non-detect data. However, the lack of risk from the other COPECs suggests that pore water is unlikely to be a major risk driver in this EU. This conclusion is highly tentative because it is based on a single sample.

- **Animas River at sampling location A75D below mainstem Mineral Creek**

Table 5.17 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water collected from sampling location A75D. Be, Cd, Ag, and Zn have RME and CTE chronic HQs above 1.0.

The three COPECs with the highest chronic HQs consist of Ag (low hardness RME chronic HQ = 3.6), Cd (low hardness RME chronic HQ = 1.9), and Zn (low hardness RME chronic HQ = 1.6).

Ag was not detected in either pore water samples collected in 2014. The Ag HQs are derived using one-half the highest DL and are therefore highly uncertain. The data suggest that pore water at sampling location A75D present low risk to the local benthic invertebrate community.

- **Animas River at sampling location Bakers Bridge below mainstem Mineral Creek**

Table 5.18 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water collected from sampling location BBridge. Be, Fe, Mn, and Ag have RME and CTE chronic HQs above 1.0.

The three COPECs with the highest chronic HQs consist of Mn (low hardness RME chronic HQ = 3.3), Ag (RME chronic HQ = 2.3), and Be (RME chronic HQ = 1.5).

Be and Ag were not detected in either pore water samples. Their HQs are derived using one-half the highest DL and are therefore highly uncertain. The data suggest that pore water at sampling location BBridge presents low risk to the local benthic invertebrate community.

Risk conclusion for measurement endpoint 1B

High pore water risk in bedded sediment was identified in the Animas River above mainstem Cement Creek. Much of that risk is associated with one sampling location (A61) that shows unusually high levels of contamination in the pore water samples collected in April and September 2014. The sample locations upstream (A61) and downstream (A64) from A61 appear much less impacted, suggesting that the high contaminant levels at A61 may represent a pore water "hot spot".

Low to moderate pore water risk is associated with most of the sampling locations in the Animas River below mainstem Cement Creek.

5.2.3 Measurement endpoint 1C

Assess survival and growth of H. azteca exposed for ten days to field-collected sediment samples.

Section 3.6.2 summarizes the results of the two sediment toxicity tests performed in December 2012 and November 2014. All the field-collected samples resulted in a statistically significant response, either in terms of increased mortality (particularly in the December 2012 test) or reduced biomass (in both toxicity tests). The most toxic samples are associated with CC49 (mainstem Cement Creek; 0% survival), M34 (mainstem Mineral Creek; 8.8% survival) and

sampling location A73B (5.0 %) survival). Except for sampling location A56, survival in the other locations tested both in December 2012 and November 2014 is substantially higher (i.e., A68, A72, and BBridge), suggesting a temporal aspect to sediment quality or an improvement in sediment quality. However, biomass was still significantly affected in November 2014. The survival in sediment from "upstream" location A56 equaled 62.5% in December 2012 and 43.8% in December 2014. This pattern indicates that sediment at this location is impacted by one or more sources further upgradient that are unrelated to inputs from mainstem Cement Creek or mainstem Mineral Creek.

Risk conclusion for measurement endpoint 1C

The two, ten-day *H. azteca* sediment toxicity tests identified severe effects, either on survival, growth, or both of these endpoints combined, in all of the sediment samples. The lowest survival was measured in the samples collected from M34, CC49, A72 and A73B. However, survival and biomass measured in all the other sampling locations were also significantly lower compared to the laboratory control sample. It is concluded that acute toxicity is present at all of the sediment sampling locations tested in December 2012 and November 2014 between A56 and BBridge.

5.2.4 Measurement endpoint 1D

Section 3.6.3 describes the results of the 2014 benthic community survey. In the fall of 2010, Mr. Chester Anderson (B.U.G.S. Consulting) prepared a benthic community data analysis report for the Animas River Stakeholder's Group (see **Appendix 16**). This report summarized the results of benthic surveys performed in the Animas River, Cement Creek, and Mineral Creek in 1992, 1996, 1997, 2004, 2006, 2007, 2009, and 2010. Mr. David Rees from Timberline Aquatics took these historic data and reworked them to generate standardized MMIs to allow for direct comparisons with the 2014 benthic survey. **Appendix 20** summarizes the outcome of this effort.

The MMI was calculated for stations along the Animas River from 1992 to 2014 in order to assess the benthic aquatic community over time. In order to derive standardized MMIs, all taxa were normalized across the years to make valid comparisons across the sampling locations. The pre-2014 data did not have specific taxa identified to the lowest level needed for the MMI. The data re-evaluation performed by Timberline Aquatics used the lowest-available taxonomic level from the historical data. The 2014 data were then adjusted to match these lower-resolution values. As a result, the MMI scores presented below may be biased low because some species groups (particularly Chironomids) are not identified to the lowest-possible level. Also, the collection methods for the historical data varied across years (e.g., Surber, kicknet, or undocumented collection methods) which could also affect some of the MMI scores.

To simplify the graphs and the data interpretation, it was decided to (a) plot the MMI scores for the locations on the Animas River downstream of mainstem Mineral Creek (see **Figure 5.3a**) separate from locations A68 and M34 (see **Figure 5.3b**), (b) plot only those locations with data for at least four different sampling years (this restriction removed locations A53, A55, A56, A60,

CC49, and BBridge), and (c) plot only those years when at least three locations were sampled (this restriction removed sampling years 1992 [n=2], 2003 [n=1], 2005 [n=1], and 2006 [n=1]). Note, however, that **Appendix 20** provides all the MMI scores.

The historic MMI scores can be interpreted as follows:

- The benthic invertebrate community has been unimpaired at reference location A75CC, A75D (Animas River below mainstem Mineral Creek) and James Ranch (Animas River below BBridge) over the last 20 years. One exception occurred at the James Ranch location in 2003 when the MMI score showed short-term impairment (see **Appendix 20**; the 2003 sample year was excluded from **Figure 5.3a** for reason (c) in the previous paragraph)

- The benthic invertebrate community has been chronically impaired at A72, A73, and M34 over the last 20 years.

- The benthic invertebrate community has been intermittently impaired at A73EC (reference location) and A68.

Risk conclusion for measurement endpoint 1D

The MMI scores indicate that the conditions for the benthic invertebrate community at sampling locations A72 and A73 in the Animas River, and at sampling location M34 in mainstem Mineral Creek, have remained impaired since the mid-1990s. The occasional impairment at sampling location A68 points to a source of contamination further upstream in the watershed. The benthic invertebrate community at sampling locations A75D and James Ranch is unimpaired.

Risk conclusion for assessment endpoint 1 (benthic invertebrate community)

Taken together, the four independent measurement endpoints (i.e., comparison of bulk sediment chemistry to sediment benchmarks, comparison of field-collected pore water chemistry to surface water benchmarks, sediment toxicity tests, and recent plus past benthic community survey results) show a strong potential for risk to the benthic invertebrate community in various sections of the Animas River, as well as in mainstem Cement and Mineral creeks.

The sediment HQ evaluation and sediment toxicity test results do not provide a consistent picture. The sediment HQ analysis identifies sediment samples CC49 and M34 as the least impacted by metals, whereas sediment samples A75B, BBridge, and the Animas River upstream of Cement Creek are the most impacted by metals. This pattern is contrary to the outcome of the sediment toxicity test, which shows the highest toxicity at CC49 and M34 and lower (relative) toxicity in the Animas River above mainstem Cement Creek, plus A75B and BBridge.

Appendices 17a and 17b compare the *H. azteca* mortality and biomass responses from the two sediment toxicity tests (summarized in **Table 3.23**) against the HQs of key "risk-driving" metals measured in pore water and corresponding sediment samples collected from each of the toxicity test vessels in December 2012 and November 2014. The data analysis proceeded as follows:

- The evaluation focused on metals that yielded the highest HQs. Those metals are Al, As, Cd, Cu, Pb, Mn, and Zn.
- The sediment toxicity tests pore water HQs for the non-hardness dependent metals were obtained by dividing the detected concentrations (or half the DL for non-detect metals) of the dissolved metals measured in pore water by their corresponding chronic surface water benchmarks presented in **Table 3.1**
- The sediment toxicity tests pore water HQ for the hardness-dependent metals were obtained using the equations presented in **Table 3.1** to first calculate chronic surface water benchmarks based on the sample's hardness value and then dividing the dissolved concentrations of the hardness-dependent metals measured in pore water by these sample-specific surface water benchmarks (note: Al HQs were calculated using the standard benchmark of 87 µg/L).
- The sediment toxicity tests sediment HQs were calculated by dividing the detected concentrations (or half the DL for non-detect metals) by their corresponding effect sediment benchmarks presented in **Table 3.1**.

The results, which do not provide a consistent pattern, can be interpreted as follows:

December 2012 test (**Appendix 17a**)

- The highest risk potential to *H. azteca* is associated with exposure to Pb, Mn and Zn in the bulk sediment, followed by As, Cd, and Cu.
- Toxicity to *H. azteca* from exposure to pore water in the test sediment appears to be sporadic across the sampling locations, except for Mn.
- Only for sampling location CC49 can it be stated with some level of confidence that pore water may have been a likely cause of the observed toxicity to *H. azteca*.
- The high toxicity at sampling location M34 is puzzling giving the relative absence of pore water or bulk sediment risk (e.g. compare the response and chemistry of M34 to A68). This observation suggests the presence of an unaccounted factor resulting in high toxicity to benthic invertebrates in mainstem Mineral Creek.

November 2014 test (**Appendix 17b**)

- The highest risk potential to *H. azteca* is associated with exposure to Pb, Mn and Zn in the bulk sediment, followed by Cd and Cu.
- Toxicity from exposure to pore water in the test sediment is most pronounced for Cd, followed by Mn and Zn. However, the highest Cd risk associated with pore water

exposure occurs at the sample collected from location A60, even though *H. azteca* survival and biomass in that sample are no worse than at other locations.

- With some exceptions, the initial and final pore water HQs are remarkably similar. This pattern suggested that equilibrium between the pore water and bulk sediment was established within 24 hours of adding the sediment samples to the test beakers, and that the daily surface water renewal in the test beakers over the ten-day test did not affect the composition of the pore water.

The chemistry versus toxicity evidence, although contradictory, was weighed in favor of the sediment toxicity test because it measured direct effects on a sensitive benthic invertebrate species exposed for ten days to field-collected sediment samples. Additionally, the two sediment toxicity tests met the test acceptability criteria for both survival and growth and are therefore valid for use in this report. The exact cause of toxicity to *H. azteca* (and by extension the benthic invertebrate community) is unclear, but the effects on survival and growth are uncontroversial.

5.3 Community-level aquatic receptors – fish

The risk characterization for fish based on analytical chemistry uses two separate but complimentary approaches.

The first approach is identical to the one described in Section 5.2.2 to derive "reasonable minimums" and average hardness values for use in calculating hardness-specific chronic surface water benchmarks for deriving HQs. **Table 5.19** presents the surface water hardness values for each EU and hydrologic period.

The second approach consists of assessing key surface water COPECs (i.e., pH, Al, Cd, Cu, Mn, Pb, and Zn) on a sample-by-sample basis by creating HQ scatter plots. These plots are provided in **Figure 5.4.a-c** (pH), **Figure 5.5.a-c** (total Al), **Figure 5.6.a-c** (dissolved Cd), **Figure 5.7.a-c** (dissolved Cu), **Figure 5.8.a-c** (dissolved Mn), **Figure 5.9.a-c** (dissolved Pb), and **Figure 5.10.a-c** (dissolved Zn). The equations developed by CDPHE (2013) for calculating the hardness-dependent metal benchmarks used in deriving the HQs plotted in these figures are designed to be protective of most aquatic species in CO waters. Hence, the HQs derived from these hardness-adjusted benchmarks tend to be conservative.

An additional set of scatter plots was created specifically for Cd (**Figure 5.6*.a-c**), Cu (**Figure 5.7*.a-c**) and Zn (**Figure 5.10*.a-c**) to assess the potential effects of these three metals on four individual trout species, namely brook trout, brown trout, rainbow trout, and cutthroat trout. *These scatter plots are structurally different from the others* because they do not provide HQs but instead show dissolved metals concentrations (see **Appendix 7.1*, 7.2*, and 7.3***) standardized to a hardness of 50 mg/L using the approach presented in **Appendix 5a**. The purpose for standardizing all of the Cd, Cu, and Zn surface water concentrations to a common hardness of 50 mg/L is to allow for a direct comparison to the chronic toxicity thresholds developed for brook trout, brown trout, rainbow trout, and cutthroat trout as presented in Table 1

of **Appendix 5**. These thresholds are shown by the horizontal lines in the Cd, Cu and Zn scatter plots provided in **Figures 5.6*, 5.7*, and 5.10***, respectively.

Assessment endpoint 2: Maintain a stable and healthy fish community. *Are the metal levels in surface water from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek, between mainstem Cement Creek and mainstem Mineral Creek, and below mainstem Mineral Creek high enough to impair the fish in these waterways?*

The potential for ecological risk to the fish community is assessed as follows.

5.3.1 Measurement endpoint 2A

Compare metal levels measured in surface water samples to chronic surface water benchmarks.

5.3.1.1 Mainstem Mineral Creek

Table 5.20 presents the surface water HQs for the fish community in mainstem Mineral Creek. All surface water samples were collected at one location (M34) by the mouth of the creek.

- **pH**

Figure 5.4.a provides the scatter plots for pH in this EU. The data show that surface water pH can drop as low as around 5.0 during the pre-runoff period, but then stays mostly at or above 6.0 during the runoff and post-runoff period.

- **Metals**

The RME and CTE HQs for Al, Cd, Fe, Ag, and Zn have HQs above 1.0 during all three hydrologic periods. The highest risk in this EU is associated with severe Al exceedances. The other exceedances are relatively minor in comparison. The risk from Ag is highly uncertain because it is based mostly on half of the analytical DLs, as opposed to actual detected concentrations.

The HQ scatterplots for mainstem Mineral Creek show the same general pattern, with the highest risk associated with total Al during all three hydrologic periods.

The concentration scatter plots do not show any risk to brown trout or rainbow trout from Cd or Cu (see **Figures 5.6*.a and 5.7*.a**) and minimal risk to both of these trout species from chronic exposure to Zn during the pre-runoff period (see **Figure 5.10*.a**).

It is concluded that surface water pH of around 5.0 combined with high Al levels during the pre-runoff period can be potentially lethal to aquatic receptors depending on the duration of the low

pH or high Al event. At a minimum, such conditions are expected to cause severe stress to fish during the pre-runoff period.

5.3.1.2 Mainstem Cement Creek

Table 5.21 presents the surface water HQs for aquatic, community-level receptors in mainstem Cement Creek. All surface water samples (except for one obtained at CC49) were collected from CC48, located close to the confluence with the Animas River.

- **pH**

Figure 5.4.a provides the scatter plots for pH in this EU. The data show that pH remained entirely below 6.0 during all sampling events between 2009 and 2014, with pH excursions well below 4.0 during both the pre and post-runoff seasons. Irrespective of the surface water metals concentrations presented below, these pH levels will be acutely lethal to all fish.

- **Metals**

The RME and CTE HQs for Al, Be, Cd, Cu, Fe, Mn, Pb, and Zn exceed 1.0 during all three hydrologic periods. The highest risk in this EU is associated with severe Al exceedances. The other exceedances are relatively minor in comparison, but are still expected to be lethal, particularly for Cd, Cu, and Zn.

The HQ scatterplots for mainstem Mineral Creek show the same general pattern. Total Al shows the highest risk during all three hydrologic periods, with Cd, Cu and Zn also contributing to risk.

The concentration scatter plots show minor risk associated with dissolved Cd to brown trout and rainbow trout (see **Figure 5.6*.a**). The risk to both species increases from exposure to dissolved Cu (see **Figure 5.7*.a**). Dissolved Zn also represents a risk to cutthroat trout, rainbow trout, and brown trout, but not to brook trout (see **Figure 5.10*.a**).

It is concluded that the chemical conditions in the surface water from mainstem Cement Creek cannot support a viable fish community.

5.3.1.3 Animas River

Animas River above mainstem Cement Creek.

Table 5.22 presents the surface water HQs for the fish community in the Animas River above mainstem Cement Creek.

- **pH**

Figure 5.4.a provides the scatter plots for pH in this EU. The data show that pH remained above 6.0 during all sampling events between 2009 and 2014. Hence, pH is not considered a stressor in this reach of the Animas River.

- **Metals**

Al, Cd, Cu, Mn, and Zn have HQs above 1.0 during one or more of the hydrologic periods, although the exceedances are in general relatively minor.

Figures 5.5.a (Al), **5.6.a** (Cd), and **5.10.a** (Zn) suggest the presence of a source of these metals upstream of this EU. The lack of a robust surface water dataset from sampling location A56 ("upstream") precludes determining if the Mayflower Mill, situated just above the confluence of Arrastra Creek with the Animas River between sampling locations A56 and A64, may be a potential source for these three metals, or if the source(s) is/are located further upstream in the watershed.

The concentration scatter plots show minor risk associated with dissolved Cd to brown trout and rainbow trout during the pre-runoff period (see **Figure 5.6*.a**). The risk to both species is minimal from exposure to dissolved Cu (see **Figure 5.7*.a**). Dissolved Zn also represents a risk to cutthroat trout, rainbow trout, and brown trout, but not to brook trout (see **Figure 5.10*.a**).

The chemical conditions in the surface water from the Animas River upstream of mainstem Cement Creek between sampling locations A60 and A68 likely results in toxicity to the fish community, mainly due to Al, Cd, and Zn. Additionally, this potential risk is unrelated to contamination from mainstem Cement Creek which joins the river further downstream of this EU.

Animas River between mainstem Cement Creek and mainstem Mineral Creek

Table 5.23 presents the surface water HQs for the fish community in this short reach of the Animas River. Only two surface water samples were collected from the two sampling locations in October of 2012 (post-runoff period).

- **pH**

Figure 5.4.b provides the scatter plots for pH in this EU. The two data points show that the pH during the post-runoff period is at or below the minimum threshold of 6.0. Hence, pH could be a potential minor stressor in this reach of the Animas River. This acidity reflects input of low-pH surface water from mainstem Cement Creek located at the upstream end of the reach (see **Figure 1.1**). This conclusion is supported by the fact that pH in the Animas River above mainstem Cement Creek is invariably well above 6.0.

- **Metals**

Al, Cd, Cu, Fe, Mn, and Zn have HQs above 1.0 during the post-runoff period, although the exceedances are in general relatively minor, except for Al (**Table 5.23**).

The HQ scatterplots for the Animas River between mainstem Cement Creek and mainstem Mineral Creek show the same general pattern. Total Al shows the highest risk during the post-runoff period (the only period with data), with Cd, Cu and Zn also contributing to risk.

The concentration scatter plots show no risk associated with dissolved Cd or Cu to brown trout and rainbow trout (see **Figures 5.6*.b and 5.7*.b**). Dissolved Zn represents a risk to cutthroat and rainbow trout, but not to brown trout or brook trout (see **Figure 5.10*.b**).

The limited contaminant profile suggests that the surface water chemistry in this reach of the Animas River could cause severe chronic toxicity to fish from a combination of low pH and high Al levels, together with the presence of several other metals.

Animas River below mainstem Mineral Creek

Tables 5.24 to 5.30 present the surface water HQs for aquatic, community-level receptors in the seven EUs of the Animas River below mainstem Mineral Creek. Those EUs were combined for the purpose of this discussion because their risk patterns were quite similar.

- **pH**

Figures 5.4.b and c provide the scatter plots for pH in this reach of the Animas River. Sampling location A72 shows that pH drops to around 5.0 during the pre-runoff period. Surface water samples were collected from sampling locations A73, A75D, and BBridge in April 2014, but pH was not measured in any of these samples. None of the other EUs in this reach were sampled for surface water during the pre-runoff season. Hence, it is unknown how much further downstream the low pH extends prior to snowmelt. This acid pulse most likely originates from both mainstem Cement Creek and mainstem Mineral Creek (see **Figure 5.4.a**), instead of from further upstream on the Animas River. The sparse dataset for the EUs downstream from A72 suggests that pH is not an issue during the runoff and post-runoff periods.

- **Metals**

Al, Cd, Cu, Fe, Mn, and Zn have HQs above 1.0 during one or more of the hydrologic periods, although the exceedances are in general relatively small, except for Al which represents a substantial risk (**Tables 5.24 to 5.30**).

The HQ scatterplots for the Animas River below mainstem Mineral Creek show the same general pattern. Total Al shows the highest risk during all three hydrologic periods, with Cd, Cu and Zn also contributing to risk. Risk is also invariably the highest at sampling location A72.

The concentration scatter plots show no (or minimal) risk associated with dissolved Cd or Cu to brown trout and rainbow trout (see **Figures 5.6*.b,c and 5.7*.b,c**). Dissolved Zn represents some risk to cutthroat and rainbow trout, but not to brown trout or brook trout (see **Figure 5.10*.b,c**).

The limited contaminant profile suggests that the surface water chemistry in this reach of the Animas River could cause severe chronic toxicity to fish during the pre-runoff period from a combination of low pH and high Al levels. The presence of several other metals at lower concentrations might further exacerbate this trend.

Risk conclusion for measurement endpoint 2.A

The prevailing conditions in mainstem Cement Creek are expected to be acutely lethal to fish, mainly due to low pH and high Al levels, coupled with excessive amounts of Cd, Pb, and Zn.

The prevailing conditions in mainstem Mineral Creek appear to be less extreme but will still result in severe stress to fish, mainly due to low pH in the pre-runoff period and high Al levels throughout the year.

The prevailing conditions in the Animas River above mainstem Cement Creek reflect one or more sources of Al, Cd and Zn upstream of this reach, although low pH is not an issue. It appears likely that the prevailing conditions will result in stress to the local fish community in this reach of the river and potential lethality on a seasonal basis.

The prevailing conditions in the Animas River between mainstem Cement Creek and mainstem Mineral Creek can only be assessed based on two surface water samples. This limited dataset suggests that the conditions in this reach of the Animas River reflect input from mainstem Cement Creek and from the Animas River upstream of Cement Creek. Low pH and high Al are expected to be risk drivers to the local fish community, as well as Cd and Zn.

The prevailing conditions in the Animas River below Mineral Creek are difficult to assess properly because only sampling location A72, situated about one mile downstream of the confluence with mainstem Mineral Creek was sampled over a five-year period. The limited data suggest that Al, Cd, and Zn would likely result in chronic stress to the local fish community, even though a possible trend showed lower HQs further downstream. However, this trend could not be confirmed due to the few available data points.

To provide a partial remedy for this data gap, EPA installed “MiniSipper” sampling devices at several locations in the Animas River below mainstem Mineral Creek, specifically A73, A75D,

and BBridge (note: MiniSippers were also installed at locations A56 and A68 in the Animas River above mainstem Cement Creek; however, the devices at locations A72 and A68 were lost during the 2014 spring runoff event). These sampling devices were deployed in mid-April before the spring runoff and retrieved in mid-July after the runoff concluded. On a daily basis, each device collected and stored a five-milliliter integrated surface water sample within a sample coil. Each sample was preserved with 0.25 milliliter nitric acid (stabilizing reagent) to a pH of less than or equal to two and filtered in-situ through a ten micron, ultra-high molecular-weight polyethylene solvent filter. The filtered samples were separated from one another inside the sample coil by a small injected nitrogen gas bubble. The sample coils were returned to the laboratory at the end of the three-month sampling period for analysis of the water samples for dissolved metals and hardness.

The interpretation of the MiniSipper analytical data focuses on Al, Cd, Cu, Pb, and Zn, all of which have aquatic toxicities that depend on hardness (CDPHE, 2013). For the latter four metals, the daily hardness concentrations were used to derive daily hardness-adjusted benchmarks. The metal concentrations measured that day were divided by their hardness-adjusted benchmarks to generate daily HQs. This approach was also used for Al, except that the Al data set did not include total Al concentrations and pH, both of which are required to derive Al benchmarks per the CDPHE (2013) guidance. Instead, the Al HQs were calculated by dividing the daily dissolved Al concentration by the standard benchmark of 87 µg/L provided by CDPHE (2013). All the available daily HQs were then plotted for the five metals over time and across the four sampling locations (i.e., A56, A73, A75D, and BBridge) to help visualize changes in risk to fish at select locations in the Animas River from mid-April 2014 until mid-July 2014.

Note that the MiniSipper data have important limitations, including the potential for "smearing" between adjacent samples in the sample coils, limited QA capabilities, and the need for using a 10 µm versus a 0.4 µm filter to generate the dissolved samples. As a result, the data are only used semi-quantitatively to provide the supporting evidence presented below.

Figure 5.11 summarizes the plots associated with this analysis, which can be interpreted as follows:

- Aluminum:

The Al HQs started increasing towards the middle of May 2014 and exceeded unity (HQ of 1.0) at the end of that month, except for sampling location A73. These HQ exceedances remained below 5.0 and were largely gone by the second half of June 2014. Sampling location A56 showed the highest risk from Al.

- Cadmium

The Cd HQs consistently exceeded 1.0 but stayed largely below 5.0 during the 2014 pre-runoff period at sampling locations A56, A73, and A75D. These HQ exceedances persisted throughout

the runoff period, during which time the Cd HQs at BBridge were also slightly above 1.0. The excess risk from Cd was largely removed by mid-June 2014.

- Copper

Cu was not a risk issue at any of the three MiniSipper sampling locations on the Animas River below mainstem Mineral Creek between April and July 2014. The HQs exceeded 1.0 but stayed below 5.0 at sampling location A56 during the 2014 runoff period.

- Lead

The Pb HQs started increasing towards the middle of May 2014 and were above 1.0 at the end of that month, except for sampling location A73. These HQ exceedances stayed below 5.0, except for sampling location A56, and were largely gone by the second half of June 2014. Sampling location A56 showed the highest risk from Pb.

- Zinc

The pattern for the Zn HQs was similar to that observed for Cd, namely the HQs consistently exceeded 1.0 but stayed largely below 5.0 during the 2014 pre-runoff period at sampling locations A56, A73, and A75D. These HQ exceedances persisted throughout the runoff period, during which time the Zn HQs at BBridge were also slightly above 1.0. The excess risk from Zn was largely gone by mid-June 2014.

The 2014 MiniSipper data mostly reflect the general trends summarized in **Figures 5.5 to 5.10**, namely: (a) the risk to fish increases during the runoff period and then subsides later on in the summer, (b) risk from Cd and Zn is consistently present during the pre-runoff period (except for the BBridge sampling location), and (c) a persistent risk signal is associated with the samples collected at sampling location A56, located upstream of A60 on the Animas River above mainstem Cement Creek. Multi-week exceedances of chronic HQs at the various sampling locations on the Animas River can be expected to have long-term detrimental effects on the local fish populations.

As a final note, the Al HQs summarized in Figure **5.11a** are lower than those provided in **Figure 5.5** for the same sampling locations. The reason is partly because the benchmark calculation methods differed since the MiniSipper Al data represent dissolved Al and lack the pH data needed to select the proper HQ calculation method. Also, the cause behind the apparent Cu, Pb, and Zn spike at sampling location A56 on May 16, 2014 is not known. A large rain event occurred in the general area during this time frame but would not explain the immediate rise and fall observed in the data. The spike may also reflect an unknown sampling artifact associated with the MiniSipper apparatus on that day. Either way, Cd and Al did not spike at the same time, as might have been expected. Regardless, the general trends outlined above are not negated by the presence of this unexplained spike.

5.3.2 Measurement endpoint 2B

Assess survival in juvenile rainbow trout (O. mykiss) exposed for 96 hours in the laboratory to surface water samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

Section 3.6.1 summarizes the results of the acute toxicity tests using juvenile rainbow trout. **Table 3.22** provided the survival data. The toxicity tests were performed using surface water collected during the pre-runoff period (April 2013) and the post-runoff period (October and November 2012). No surface water samples were collected during the runoff period for use in toxicity testing.

Surface water samples collected from mainstem Cement Creek, mainstem Mineral Creek, and sampling location A72 on the Animas River below mainstem Mineral Creek were acutely toxic to juvenile rainbow trout. Sampling location A68 in the Animas River above mainstem Cement Creek was acutely toxic in April 2013 but not in the fall of 2012, strongly suggesting the presence of a seasonal chemical stressor in this reach of the river that is not associated with input from mainstem Cement or Mineral Creeks.

No significant acute toxicity was observed for juvenile rainbow trout exposed to surface water collected from the EUs below sampling location A72. This pattern suggests that the acute toxicity measured in A72 was "diluted out" by the time the river reached sampling location A73, about six miles downstream of the confluence with mainstem Mineral Creek.

5.3.3 Risk Conclusions for assessment endpoint 2 (fish community)

- **Mainstem Cement Creek:**

The chemical conditions in surface water from mainstem Cement Creek are highly toxic to fish, particularly due to low pH and high Al, and to a lesser extent by the presence of Cd, Cu, and Zn. The toxicity tests show that surface water collected from this EU in November (i.e., post-runoff period) was acutely toxic to juvenile rainbow trout (see **Table 3.22**). The preponderance of the evidence suggests that the fish community in mainstem Cement Creek (if present) would experience high stress under current conditions.

- **Mainstem Mineral Creek:**

The chemical conditions in mainstem Mineral Creek appear less severe than in mainstem Cement Creek for the local fish community. However, severe pH drops and high Al levels during the pre-runoff period suggest that fish may experience high stress in the winter, but that survivors could possibly recover during the remainder of the year. The toxicity tests showed that surface water collected from this EU in November (i.e., post-runoff period) was acutely toxic to juvenile rainbow trout (see **Table 3.22**). The preponderance of evidence suggests that the fish community

in mainstem Mineral Creek (if present) would likely experience severe acute stress under current conditions.

- **Animas River above mainstem Cement Creek:**

The chemical conditions in the Animas River above mainstem Cement Creek suggest the presence of one or more sources of metal contamination located further upstream in the watershed. The chemical signature of the surface water suggests that chronic toxicity to the fish community is likely, particularly due to the presence of Al, Cd, and Zn. Low pH, on the other hand, is not an issue in this reach. The presence of significant acute toxicity measured in juvenile rainbow trout exposed to surface water collected in April 2013 from this reach further confirms the results of the chemical analyses. The preponderance of evidence suggests that the fish community in this reach of the Animas River may experience toxic stress during much of the year.

- **Animas River between mainstem Cement Creek and mainstem Mineral Creek**

The amount of chemical information on the quality of the surface water is limited because only two samples were collected, and no acute toxicity testing was performed. The limited amount of data suggests that this reach of the Animas River is likely to be lethal to fish, mostly due to low pH and high levels of Al, with secondary stress caused by Cd and Zn.

- **Animas River below mainstem Mineral Creek**

The chemical signature of the surface water in this reach of the Animas River reflects the major inputs from mainstem Mineral and Cement Creek, and the reach of the Animas River above mainstem Cement Creek. Surface water samples collected from sampling location A72 during the pre- and post-runoff periods were acutely toxic to juvenile rainbow trout. The surface water samples collected during the same two hydrologic periods from the EUs further downstream did not show acute toxicity, suggesting that the acute effects had been "diluted out". However, the preponderance of evidence (including the semi-quantitative MiniSipper datasets summarized in **Figure 5.11**) shows that Al, Cd, and Zn in surface water may exert chronic stress to the fish community all the way to the BBridge EU located about 30 miles downstream from Silverton.

This general conclusion is strongly supported by the results of periodic fisheries surveys performed by the CDOW (2010; see **Appendix 18**). The CDOW electroshocked the Animas River below mainstem Mineral Creek at locations "A-72 USGS" (equivalent to sampling location A72), "Elk Park" (in the vicinity of sampling location A73), and "Teft Spur" (in the vicinity of sampling locations A75D/A75B). The CDOW also sampled the Animas River above mainstem Cement Creek at Howardsville, situated about 4 miles northeast of Silverton. This sampling location, which falls well outside of geographic scope of this BERA EUs but is nonetheless included in this discussion for comparison purposes.

The data consist of fish counts ("fish per mile" organized by trout species) sampled at these four locations in 1992, 1998, 2005, and 2010 (see Table 5 on p. 15 in **Appendix 18**). CDOW returned to Teft Spur on the Animas River in September of 2014 for an additional electroshocking survey (see p. 29 to 32 in **Appendix 19**). The trout density data collected between 1992 and 2014 are summarized for brook trout (**Fig. 5.12.a**), rainbow trout (**Fig. 5.12.b**), and brown trout (**Fig. 5.12.c**). This information is discussed below. Note that the data for cutthroat trout are not plotted because only four specimens were collected at Howardsville in 1992. This trout species has not been observed at any of the four sampling locations since then.

Brook trout (Fig. 5.12.a):

Brook trout are by far the most common of the four trout species collected from the Upper Animas River. The brook trout population in Howardsville was low in 1992 but expanded in subsequent years. As of 2010 (no samples were collected in 2014), the Animas River in Howardsville supports over 1000 brook trout per river mile.

Brook trout have essentially been absent at A72 since 1992. A small but stable brook trout population existed at A73 (Elk Park) between 1992 and 2005 but was eliminated by 2010. No sampling occurred at A73 in 2014 to determine if this situation has changed.

A more robust brook trout population was found at Tefts Spur between 1992 and 2005. By 2010, however, that population had been reduced by around 75%, followed by an additional 30% reduction in 2014.

Rainbow trout (Fig. 5.12.b):

A small rainbow trout population was present in the Animas River at Howardsville in 1992 but has been absent since 1998. No rainbow trout were captured at A72 between 1992 and 2010, or at A73 (Elk Park), except for a handful of fish in 2005. A small rainbow trout population was present at Tefts Spur in 1992 but declined until it had disappeared by 2010. No rainbow trout have been caught at this location since then.

Brown trout (Fig. 5.12.c):

No brown trout have been collected from the Animas River at Howardsville, A72, or A73 (Elk Park) since 1992. A few brown trout had established themselves at Teft Spur by 1998, expanded their population by 2005, but then disappeared by 2010. A small brown trout population was once again present at Teft Spur in 2014.

In conclusion, the available fisheries data shows that the current conditions in the Animas River downstream from the confluence with mainstem Cement and Mineral Creeks have had harmful effects on all trout species, including the more tolerant brook trout. The elimination of brook trout at A73 (Elk Park) between 2005 and 2010, and the strong decline of the brook trout

population at Teft Spur between 2005 and 2014 is particularly striking. **Appendix 18** (p. 16) states that the decline in fish abundance suggests a substantial decline in surface water quality since 2005, which may have been associated with the closure of a water treatment project in 2004 on Cement Creek in the Gladstone area.

5.4 Aquatic invertivorous birds

The risk evaluation for the wildlife receptors generated numerous HQ tables. No-effect and effect HQs were developed for both RME and CTE exposure scenario, resulting in four HQs for ten analytes across seven EUs on the Animas River. Four of the ten "important bioaccumulative compounds" assessed for risk via food chain modeling showed a potential for wildlife risk with at least one CTE no-effect HQ greater than 1.0. Those compounds consisted of Cu, Pb, Se, and Zn.

The data presentation and interpretation outlined below for aquatic invertivorous birds (and the three other wildlife receptor species) was simplified by focusing the discussion only on those four compounds and calculating a geometric mean of the no-effect and effect HQs for both the RME and CTE exposure scenario. A geometric mean was obtained by (a) taking the natural log of a no-effect HQ and its corresponding effect HQ, (b) adding the two logged values, (c) dividing the sum by 2, and (d) taking the anti-log of the result. Those RME and CTE "geomean HQs" were then plotted for each wildlife receptor to simplify the data and help visualize the potential for ecological risk across all the Animas River EUs.

Assessment endpoint 3: Maintain stable and healthy invertivorous bird populations. *Are the metal levels in surface water, sediment, and benthic invertebrates high enough to impair invertivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

The potential for ecological risk to this receptor group is assessed using one measurement endpoint, as follows:

5.4.1 Measurement endpoint 3A

Use metal concentrations measured in sediment and benthic invertebrates in a food chain model to calculate metal-specific EDDs from ingesting surface water, sediment, and benthic invertebrates, and compare these EDDs to avian TRVs.

Tables 5.31 to 5.37 provide the HQs for the American dipper across all of the wildlife EUs. **Figure 5.13.a** summarizes the geometric mean RME and CTE HQs for Cu, Pb, Se, and Zn. The potential risks associated with the four major COPECs are discussed below. The reliability of the findings is considered low because it is based on a single, semi-qualitative Line of Evidence (LOE).

This measure of effect identifies Pb and Cu as major risk drivers to American dipper ingesting surface water, sediment, and aquatic invertebrates from the Animas River at all locations. The highest risk for Pb was identified in A60/A68 (RME geometric mean HQ = 18.7 and CTE geometric mean HQ = 16.2) located in the Animas River reach above mainstem Cement Creek. The highest risk for Cu was identified in A73B (RME geometric mean HQ = 8.4 and CTE geometric mean HQ = 5.1) located in the Animas River near Cascade Creek. Minor risk is also found for Se at A75B in this same location (RME geometric mean HQ = 1.9 and CTE geometric mean HQ = 1.1) and at sampling location A73B in the Animas River near Elk Creek (RME and CTE geometric mean HQs = 1.7). The Zn RME geometric mean HQs were just above 1.0 at two wildlife EUs; namely the Animas River above mainstem Cement Creek (HQ = 1.3) and BBridge (HQ = 1.3). All Zn CTE geometric mean HQs were below 1.0.

The southwestern willow flycatcher, which is listed as an endangered bird species both at the federal and state level, might forage for aquatic insects and breed in the riparian habitats along the Animas River downstream of Silverton. It is not known if this bird is actually present on the Animas River, but this BERA assumes so as a precautionary measure. It was decided that the no effect HQ under a RME scenario would provide a conservative assessment of risk for this protected species. Under that scenario, a potential for risk, primarily from Pb and Cu, but also from Se and Zn is identified both in the Animas River reach above mainstem Cement Creek and at most sampling locations in the Animas River reach below mainstem Cement Creek.

5.5 Aquatic omnivorous birds

Assessment endpoint 4: Maintain stable and healthy omnivorous bird populations. *Are the metal levels in surface water, sediment, benthic invertebrates, and aquatic plants high enough to impair omnivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

The potential for ecological risk to this receptor group was assessed using one measurement endpoint, as follows:

5.5.1 Measurement endpoint 4A

Use metal concentrations measured in sediment samples to estimate metal residues in aquatic plants; use the estimated plant residues and the measured benthic invertebrate residues in a food chain model to calculate metal-specific EDDs from ingesting surface water, sediment, and food, and compare these EDDs to avian TRVs.

The risk to aquatic omnivorous birds, represented by the mallard, is assessed based on the "100% diet" to model females feeding exclusively on benthic invertebrates prior to laying their eggs in the spring, and on the "50%-50% diet" to model both males and females feeding on a mix of plants and benthic invertebrates for the remainder of the year.

Tables 5.38 to 5.44 provide the HQs for the 100% diet, and **Tables 5.45 to 5.51** provide the HQs for the 50%-50% diet. **Figures 5.13.d and 5.13.e** summarize the geometric mean RME and CTE HQs for Cu, Pb, Se, and Zn in the 100% diet and the 50%-50% diet, respectively. The potential risks associated with the four major COPECs are discussed below. The reliability of the findings is considered low because it is based on a single, semi-qualitative LOE.

- 100% benthic invertebrate diet

Of the four major COPECs, Pb and Cu were a minor risk concern to the mallard feeding on a 100% benthic invertebrate diet. Pb RME and CTE geometric mean HQs were 1.3 and 1.2 in the Animas River above mainstem Cement Creek reach. Cu RME and CTE geometric mean HQs at sampling locations A73B and A75B in the Animas River below mainstem Mineral Creek were slightly lower, but still above 1.0. All Se and Zn RME and CTE HQs were less than 1.0; therefore, are not a risk concern for mallard under this exposure scenario.

- 50% benthic invertebrate and 50% aquatic plant diet

Of the four major COPECs, Pb and Cu were a minor risk concern to the mallard feeding on a 50%-50% diet in select wildlife EUs. Risks from Pb exposure were only identified in the Animas above mainstem Cement Creek. In this reach, Pb RME and CTE geometric mean HQs were only slightly lower than those derived for 100% invertebrate diet; 1.3 and 1.1, respectively. Cu RME geometric mean HQs were slight above 1.0 in only two of the six Animas River locations below Mineral Creek; A73B and A75D (**Figure 5.13.e**). All Cu CTE geometric mean HQs were below 1.0 under this exposure scenario. All Se and Zn RME and CTE geometric mean HQs were also below 1.0.

These findings suggest that mallards feeding on either a 100% invertebrate or 50%-50% invertebrate-plant diet are unlikely to be affected by the current conditions in the Animas River at the EUs evaluated in this BERA.

5.6 Piscivorous birds

Assessment endpoint 5: Maintain stable and healthy piscivorous bird populations. *Are the metal levels in surface water, sediment and fish high enough to impair piscivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

The potential for ecological risk to this receptor group was assessed using one measurement endpoint, as follows:

5.6.1 Measurement endpoint 5A

Use metal concentrations measured in sediment samples to estimate metal residues in fish; use food chain modeling to calculate metal-specific EDDs from ingesting surface water, sediment and fish, and compare these EDDs to avian TRVs.

Tables 5.52 to 5.58 provide the HQs for belted kingfisher. **Figure 5.13b** summarizes the geometric mean RME and CTE HQs for Cu, Pb, Se, and Zn. The potential risks associated with the four major COPECs are discussed below. The reliability of the findings is considered low because it is based on a single, semi-qualitative LOE.

This measure of effect identifies Pb as the only risk driver to belted kingfisher ingesting surface water and fish from the Animas River. Risk from Pb was greatest in the reach of the Animas River above mainstem Cement Creek (RME geometric mean HQ = 5.9 and CTE geometric mean HQ = 5.1). Risks steadily declined at each sampling location in a downstream direction to BBridge (**Figure 5.13b**). However, BBridge Pb RME and CTE geometric mean HQ were still slightly above 1.0. All other kingfisher COPECs RME and CTE HQs were below 1.0. These results suggest that the belted kingfisher may be at slight risk from Pb exposure in all the EUs that were evaluated, except for the stretch of the Animas River above Cement Creek where the risk from Pb exposure is low (CTE effect HQ for Pb = 3.6; **Table 5.52**).

5.7 Aquatic herbivorous mammals

Assessment endpoint 6: Maintain stable and healthy herbivorous mammal populations. *Are the metal levels in surface water, sediment, and aquatic plants high enough to impair herbivorous mammals foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

The potential for ecological risk to this receptor group was assessed using one measurement endpoint, as follows:

5.7.1 Measurement endpoint 6A

Use metal concentrations measured in sediment samples to estimate metal residues in aquatic plants; use food chain modeling to calculate metal-specific EDDs from ingesting surface water, sediment, and aquatic plants, and compare these EDDs to mammalian TRVs.

Tables 5.59 to 5.65 provide the exposure estimates and HQs for muskrat. **Figure 5.13.c** summarizes the geometric mean RME and CTE HQs for Cu, Pb, Se, and Zn. The potential risks associated with the four major COPECs are discussed below. The reliability of the findings is considered low because it is based on a single, semi-qualitative LOE.

Of the four major COPECs only Pb and Se are a potential low-level risk concern to the muskrat consuming a 100% aquatic plant diet. Similar to other wildlife receptors, Pb risks were greatest in the Animas River reach above mainstem Cement Creek (**Figure 5.13.c**) with RME and CTE geometric mean HQs equal to 2.5 and 2.2, respectively. Risk from Pb exposure in the Animas River decreased substantially below Mineral Creek sampling locations. Except for one RME geometric mean HQ in A73, all other Pb HQs were below 1.0. Se risks were lower than Pb and followed an opposite spatial trend than that observed for Pb. For example, the lowest Se HQs were derived for the Animas above mainstem Cement Creek reach and greatest at A75B and BBridge; RME geometric mean HQs were 1.1 and 1.0, respectively. No Se CTE HQs were above 1.0 in any sampling locations evaluated. These findings suggest that muskrats or other herbivorous mammals are unlikely to be affected by the current conditions in the Animas River below the Cement Creek confluence.

5.8 General risk conclusions for wildlife receptors

- **Animas River above mainstem Cement Creek**

The greatest risks from Pb exposure were identified in this reach for all avian and mammalian wildlife receptors. All Pb RME and CTE geometric mean HQs were above 1.0 for all four wildlife receptors. The greatest Pb risks were identified for American dipper followed by belted kingfisher and mallard (100% invertebrate diet). Minimal potential risks associated with Cu and Zn exposure were also observed in this reach of the Animas River but only for the American dipper. These results suggest that dipper have the greatest exposure to COPECs of all other avian wildlife receptors.

- **Animas River below mainstem Mineral Creek**

Cu is identified as the major risk driver to the two insectivorous wildlife species, i.e., the American dipper and mallard. Cu exposure risks increased in this reach; namely in A73B and A75B. Benthic invertebrates (diet of insectivorous wildlife) were not collected for tissue residue analysis from the two sampling locations. Hence, the levels of metals in benthic tissues at these two locations were estimated using conservative published sediment-to-benthic invertebrate regression models and uptake factors for use in the food chain model. It is noteworthy that A73B and A75B are the only two sampling locations showing excessive risk from Cu exposure. Given this pattern, it was concluded that the risk to insectivorous wildlife from Cu exposure at these two locations may be biased high and not reflect actual exposure regimes. If these two sampling locations were removed from the evaluation, risk from Cu exposure would follow the general pattern of declining risks from metals exposure from the beginning to the end of this reach.

Pb was also identified as a risk driver to a few wildlife species in this reach. The greatest risks were identified for the American dipper followed by the belted kingfisher. Although risks to these two wildlife species decreased throughout the reach, RME and CTE HQs were still above

1.0 at all Animas River EUs below mainstem Mineral Creek. Exposure to the remaining COPECs were of little to no concern to any of the other wildlife receptors.

The increased risk of metals exposure in the American dipper versus the other avian species was driven almost entirely by the higher food and sediment ingestion rates of this species compared to the two other bird species (see **Table 4.36**). As such, the American dipper appears to be a suitably sensitive wildlife receptor for future risk evaluations on this river system. In addition, this species also serves as a surrogate for the southwestern willow flycatcher, a listed species of passerine insectivore listed for San Juan County, CO, which may or may not be present in the riparian habitat of the Animas River above or below Silverton.

5.9 Uncertainty Analysis

Uncertainty is inherent in any ecological risk assessment due to incomplete or inadequate knowledge about a number of key input parameters. This lack of knowledge is usually addressed by making exposure and toxicity estimates using the limited available data, or by making conservative assumptions based on guidance and best professional judgment when no reliable data are available. The major uncertainties associated with this BERA are discussed below.

5.9.1 Community-level receptors

- It is unclear if mainstem Cement Creek or Mineral Creek upstream of the confluence with South Fork Mineral Creek supported aquatic life before mining activities started in their watersheds in the 19th century (Church *et al*., 1999). If this observation is correct, then any impairment may not reflect negatively on current conditions in those two waterways. This situation represents a serious uncertainty, which would have to be considered as part of any future risk management decision-making.

- Except for Al and Fe, the surface water exposures evaluated in this BERA are based on dissolved metal concentrations, which represent the toxicologically "active" fraction of the total metals. Basing the surface water exposures on this fraction is not overly conservative and does not generate much uncertainty.

- Twenty sediment samples were collected from the reach of the Animas River above mainstem Cement Creek between A60 and A68. The data from these samples were pooled into a single, large dataset representative of that EU. The sediment datasets collected from the EUs on the Animas River below mainstem Mineral Creek were uniformly small (n = 3 to 5) which was not always enough to calculate representative EPCs using ProUCL. Hence, some uncertainty is associated with the risk conclusions derived from these smaller sediment datasets.

- Risk to community-level receptors was assessed using the HQ method. The HQs were not summed to calculate a Hazard Index (HI), because a HI assumes that HQs are additive. It

is not anticipated that all of the inorganic COPECs evaluated in this BERA would exert their toxic effects on one and the same organ, which is a basic requirement for calculating HIs. On the other hand, it is possible that some of the COPECs may in fact exert additive toxicity, in which case the HQ approach would underestimate certain risks. This observation applies equally to the wildlife evaluation.

- Be and Ag in surface water were retained as COPECs for community-level aquatic receptors even though these two analytes are not present above their DL in most of the EUs. The HQs represent half of the highest DL divided by the chronic benchmark. The HQ exceedances are particularly striking for Ag (see **Tables 3.5, 3.6, and 3.8**). It is not known if Be and Ag represent a realistic but unquantifiable concern for this BERA. This lack of information represents an uncertainty, which may need to be addressed as part of the risk management process.

- Only one benthic species (the amphipod *H. azteca*) was used for the sediment toxicity tests. Even though this species is considered sensitive to contamination, including metals, it is not known how much more or less sensitive it is compared to the benthic invertebrate species typically found in the Animas River upstream and downstream of Silverton (particularly the EPT species). At a minimum, the fact that the toxicity endpoints responded significantly at all sampling locations in the ten-day sediment toxicity test compared to the laboratory sediment control sample shows that the test organisms were sensitive to the chemical conditions found in the field-collected sediment samples. As a result, the uncertainty about species sensitivity is small.

- Juvenile rainbow trout were used in the surface water toxicity tests. This species is directly relevant to the fish populations found in the Animas River. Rainbow trout (and particularly juvenile life stages) are considered quite sensitive to the presence of metals and low pH in surface water. Hence, the uncertainty associated with their response to the acute exposures in the laboratory is minimal. However, the test did not assess toxicity from chronic exposures typically experienced by fish populations in the Animas River. The lack of an acute response in juvenile rainbow trout at sampling locations A73, A73B, A75B, and BBridge does not imply that a toxic response would not be present under longer-term exposures in the laboratory. This data gap would have represented a large uncertainty by itself but is negated by the results of the 2010 and 2014 fisheries surveys performed by the CDOW that show sharp declines or complete extirpation of trout populations in the Animas River below mainstem Mineral Creek. These findings were further supported by the MiniSipper data that show the presence of multi-week chronic toxicity for several metals in surface water before and during the snowmelt period. As a result of these two supporting lines of evidence, the uncertainty associated with the lack of chronic toxicity to juvenile rainbow trout exposed to surface water samples collected from the lower reaches of the Animas River is considered minimal.

- All the trout species in the Animas River bury their eggs in gravelly substrate during spawning. These eggs remain in the gravel for several months until they hatch. The sac fry stay in the substrate for several more weeks until they have resorbed their yolk sac, after which the juveniles emerge into the overlying surface water. Hence, the embryo-larval stages of trout are fully exposed to metals in pore water for six plus months (note: the surface water benchmarks are derived from toxicity tests on hatched fish, not eggs). This BERA used the pore water HQs only to assess the risk to the benthic invertebrate community. This particular assessment was not performed for the sac fry, however, because the other three lines of evidence already showed unacceptable risk to the fish community. Note that the risk from pore water exposure to trout sac fry is identical to the benthic invertebrates because these two aquatic community-level receptor groups are evaluated using the same set of surface water screening benchmarks. Hence, the risk from pore water exposure to trout sac fry in the Animas River is provided in **Tables 5.13 to 5.18**.

- The benthic invertebrate risk derived from analytical chemistry data is based only on metal concentrations measured in sediment and pore water. The substrate of the Animas River and its two major tributaries in the area of Silverton consists mostly of gravel, cobble, and boulders. It is therefore reasonable to expect that the benthic invertebrates present on and within this substrate will also be exposed, at least in part, to metals present in the overlying surface water. The surface water exposure pathway was not explicitly evaluated for the benthic invertebrate community in this BERA but would be a factor based on the risks to fish as determined from surface water chemistry data. This assessment was not performed, however, because the other four lines of evidence already show unacceptable risk to the benthic invertebrate community. Note that the risk from surface water exposure to benthic invertebrates is identical as that for fish because both of these aquatic community-level receptor groups are evaluated using the same set of surface water screening benchmarks. Hence, the risk of surface water exposure to the benthic invertebrate community is provided in **Tables 5.20 to 5.30**.

5.9.2 Wildlife receptors

- The exposure modeling used published Biota-to-Sediment Accumulation Factors (BSAFs) or regression equations, instead of field-collected tissue samples to estimate COPEC levels in fish and plants (and benthic invertebrates, but only at sampling location A73B and A75B from which tissue samples were not available). The evidence presented in this report suggests that the literature-derived values for benthic invertebrates may be poor predictors of site-specific contaminant uptake and tissue levels, resulting in uncertainty. Hence the risk from Cu to the American dipper and mallard at sampling locations A73B and A75B is considered hypothetical and probably overly conservative. Additionally, the soil-to-plant regression models and uptake factors were derived from terrestrial studies because no studies have been published to estimate sediment-to-plant contaminant uptake. It is not known if or how metal uptake in plants differs between soil

and sediment, resulting in unquantifiable uncertainty about actual risk to the omnivorous birds and the herbivorous mammals feeding on aquatic plants.

- Benthic invertebrates were collected for residue analysis in September 2014. These samples provide measured (versus estimated) tissue data for use in the food chain models for the American dipper and the mallard. It is not known how much or if metal levels fluctuate in benthic tissue throughout the year or across years in the Animas River. Also, with only a single sample to work from, the RME and CTE concentrations derived from the benthic invertebrate samples for use in the EDD calculations are identical to each other. The small benthic invertebrate tissue residue dataset represents an uncertainty, but it appears unlikely that additional benthic residue sampling events in the future would greatly change the current wildlife risks.

- The exposure modeling assumes that the Animas River reach above mainstem Cement Creek between sampling location A60 and A68 equals a wildlife receptor's entire home range and forage range (i.e., area use factor (AUF) = 1.0). This assumption is not unrealistic, given that this reach covers about two miles of river habitat, and therefore results in limited uncertainty.

- Forty surface water samples were collected from the reach of the Animas River above mainstem Cement Creek. Twenty-five of those samples were collected at sampling location A68. But even though this data set is assumed to represent the entire EU, it focuses on one specific location. The impact on the risk conclusions, however, is expected to be minimal. A review of the surface water chemistry data obtained from the six sampling locations in this EU shows that the metal concentrations are quite similar to each other. As such, it appears unlikely that the current surface water dataset for the Animas River above mainstem Cement Creek generated unrepresentative EPCs.

- The exposure modeling included sediment ingestion. The substrate composition of the Animas River at and below Silverton appears to include large fractions of coarse sand, gravel, pebble, and small cobble, instead of the fine sands and silts expected to be accidentally ingested by wildlife receptors during feeding. The actual incidental sediment ingestion may be substantially lower than assumed in the food chain models, which would slightly decrease the calculated HQs.

- The characterization of exposure assumes that enough aquatic invertebrates, fish, and aquatic plants are present in the two Animas River reaches to feed the four wildlife receptor populations evaluated in this BERA. This assumption is speculative in light of the presence of aquatic toxicity to fish and benthic invertebrates identified in the surface water and sediment. Instead, the evidence shows that these two receptor groups are impacted and therefore may not be available in the quantities needed to support viable wildlife receptor populations as assumed in the food chain models. If so, then the

estimated exposures, and the resulting risks to wildlife, may be more hypothetical (and higher) than real.

- The COPEC tissue residues in fish were derived from the COPEC levels measured in sediment samples. This approach assumes that the entire mass of COPECs present in fish originates from the sediment. The relatively high levels of metals detected in Animas River surface water make it likely that fish also accumulated COPECs via bioconcentration through the gills. This additional pathway would have increased tissue residue levels but is not accounted for in the exposure modeling. Therefore, it is possible that the EDDs for the belted kingfisher may have been somewhat underestimated.

- The effects assessment for the wildlife receptors used published no-effect and effect TRVs to measure COPEC toxicity. The assessment endpoints focus on preserving populations, whereas TRVs are derived from data on individuals of a test species. Extrapolating individual effects to higher levels of ecological organization is inherently uncertain, particularly because these extrapolations are applied across non-related species (e.g., chicken to belted kingfisher, or mouse to muskrat). The degree of uncertainty with this approach is unknown.

- The wildlife TRVs apply to all birds or mammals. This means that the same COPEC-specific TRVs were used for the American dipper, mallard, and belted kingfisher. It is unknown how much more, or less, sensitive these three receptors species might be compared to the test species employed to generate the TRVs used in this BERA. Using "one-size-fits-all" TRVs creates much uncertainty about the actual toxicity of a COPEC to the target wildlife receptor. However, the TRV-derivation process is conservative by design, such that it appears more likely that the wildlife risks are overestimated rather than underestimated.

- The consistent use of conservative assumptions (such as assuming 100% of contaminant bioavailability in food items, assuming feeding in a habitat which may lack food items, relying on TRVs derived from toxicity tests using soluble or other highly bioavailable fractions of the test chemical, and using conservative "one size fits all" TRVs) most likely overestimated risk to the wildlife receptors evaluated in this BERA. As a result, the actual risk to wildlife receptors may be substantially lower than reported in this BERA.

6.0 SUMMARY AND CONCLUSIONS

6.1 Introduction

The Animas River flows through the town of Silverton in San Juan County, CO. This waterway is affected by water, which has come in contact with mineralized material, either naturally or as a result of mining activities, such as through the creation of mine adits. The affected water originates in the upper reaches of two major tributaries of the Animas River in this area, namely Cement Creek and Mineral Creek, and from other tributaries of the Animas River further upstream of Silverton. Some of the tributaries contain high levels of metals and acidity which are carried downstream to the Animas River. This evaluation did not attempt to separate natural contamination from past mining-related contamination but assessed the total risk from all sources combined.

The surface water data represent dozens of samples collected from all the EUs between May 2009 and September 2014. The sediment data set was substantially smaller and consisted of analytical data collected from those same waterways during five sampling events between May 2012 and September 2014. The pore water data set represented two sampling events on the Animas River and mainstem Mineral Creek in April 2014 and September 2014. The benthic invertebrate tissue data set came from one sample-collection event in September 2014. The data were reviewed to identify assessment endpoints and measures of effect, and to develop a CSM, which showed the movement of contaminants from the sources to the receptors.

The effects evaluation used chronic surface water benchmarks (hardness-adjusted, if necessary) for the surface water and pore water samples, plus no-effect and effect sediment benchmarks, to quantify risk to benthic invertebrates and fish exposed to surface water, pore water and sediment. No-effect and effect TRVs for birds and mammals were used to assess the toxicity of metals taken up via ingestion by wildlife receptors. Additionally, surface water and sediment toxicity tests were performed in the laboratory on samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above Cement Creek and below Mineral Creek to measure effects to benthic invertebrates (the amphipod *H. azteca*) and juvenile rainbow trout (*O. mykiss*).

Mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River were treated as separate EUs to derive RME and CTE EPCs for use in the baseline evaluation. To fine tune the exposure to aquatic community-level receptors, the surface water data were further split into three hydrologic periods, namely the pre-runoff period (February to April), runoff period (May and June), and the post-runoff period (July to November).

The EPC calculation method varied depending on the EUs, as follows:

- *Animas River above mainstem Cement Creek*: the surface water, sediment, and pore water analytical data were combined into three separate datasets to calculate COPEC-specific RME and CTE EPCs across the sampling locations.

- *Animas River between Cement and Mineral Creeks*: only two surface water analytical data were available from the two sampling locations in this reach of the river. Therefore, wildlife receptors were not evaluated because sediment analytical data were required to estimate the tissue residue levels in the food items evaluated in the food chain models. The surface water analytical data were summarized by sampling location for calculating COPEC-specific RME and CTE EPCs to evaluate the fish and benthic invertebrate community.

- *Animas River below mainstem Mineral Creek*: up to several miles separate the various EUs in this lower reach of the river. As a result, this BERA assumed that wildlife receptors would not be exposed across the entire reach. Instead, the surface water, sediment, and pore water analytical data were summarized by sampling location to calculate COPEC-specific RME and CTE EPCs for use in food chain modeling and to assess exposure to the benthic invertebrate and the fish community.

- *Mainstem Cement Creek*: this BERA did not evaluate wildlife receptors foraging in this EU because the SLERA showed that current chemical conditions in this waterway are too degraded to provide forage for wildlife. The surface water and sediment data from the two sampling locations at the mouth of the creek were used to calculate COPEC-specific RME and CTE EPCs to evaluate risk to the fish and benthic invertebrate community.

- *Mainstem Mineral Creek*: this BERA did not evaluate wildlife receptors foraging in this EU because current chemical conditions in this waterway are too degraded to provide enough forage for wildlife. The surface water and sediment data from the sampling location at the mouth of the creek were used to calculate COPEC-specific RME and CTE EPCs to evaluate risk to the fish and benthic invertebrate community.

Exposure to the four wildlife receptor species foraging in the reaches of the Animas River above mainstem Cement Creek and below mainstem Mineral Creek was quantified using a food chain model which calculated RME and CTE EDDs based on ingesting surface water, sediment, and food items. The food items consisted of benthic invertebrates, fish, and aquatic plants, depending on the target wildlife species. The contaminant levels in the benthic invertebrates were based on measured values (except at sampling locations A73B and A75B), whereas the contaminant levels in fish and plants were estimated by multiplying the sediment RME and CTE COPEC levels by published COPEC-specific sediment-to-biota accumulation factors or by using published regression equations.

Risk was quantified using the HQ method, which compares measured exposures (i.e., RME and CTE surface water, sediment, and pore water EPCs) or estimated exposures (RME and CTE wildlife EDDs) to chronic surface water benchmarks, and no-effect and effect sediment benchmarks and wildlife TRVs.

A COPEC-specific HQ was then calculated using the following general equation:

HQ = EPC or EDD/benchmark or TRV

Where:

HQ	=	Hazard Quotient (unitless)
EPC	=	RME and CTE Exposure Point Concentration (µg/L or mg/Kg)
EDD	=	RME and CTE Estimated Daily Dose (mg/kg bw-day)
Benchmark	=	chronic surface water benchmarks or sediment no effect and effect benchmarks (µg/L or mg/kg, respectively)
TRV	=	no effect and effect wildlife Toxicity Reference Value (mg/Kg bw-day)

HQs below 1.0 were used to eliminate COPECs with assurance that they did not pose a risk. HQs at or above 1.0 identified a potential for ecological risk under the exposure and toxicity assumptions used in this evaluation. The risk characterization used the terms low risk (one or more CTE effect HQs >1.0 but <5.0), moderate risk (one or more CTE effect HQs >5.0 but <10.0), or high risk (one or more CTE effect HQs >10.0) to discuss risk even though it is understood that risk does not increase in a linear fashion with increasing HQs.

Besides assessing the potential impacts associated with RME and CTE exposures, the risk characterization for fish and benthic invertebrates also viewed each surface water and sediment sample as an individual exposure event in time. HQs were calculated for all available surface water and sediment samples and were used to form "scatter plots" by sampling station and hydrologic period (i.e., pre-runoff, runoff, and post-runoff). Those plots were then used to identify patterns of risk across the waterways and hydrologic periods.

Finally, toxicity data from benthic invertebrates and fish exposed in the laboratory to field-collected surface water and sediment samples were evaluated statistically to determine which of the observed responses were significantly different from laboratory control samples. Benthic community data collected in September 2014 were graphically analyzed and compared to historic data collected from the same sampling locations in the past. Data from past fish surveys were also reviewed.

Uncertainty was inherent in this BERA because many assumptions needed to be made in order to proceed with the investigation. These assumptions affected all aspects of the assessment including the CSM, the effects analysis, the exposure analysis, and the risk characterization. The

uncertainty analysis identified and discussed the major assumptions made in this BERA. It also provided a short description to determine if the assumptions were likely to have overestimated or underestimated the potential for ecological risk. The end result was a balanced overview of uncertainty to help risk managers understand the full extent of potential ecological risk to receptors living or feeding in mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above, across from, and below Silverton.

6.2 Risk conclusions for benthic invertebrates

Taken together, the four independent measurement endpoints (i.e., comparison of bulk sediment chemistry to sediment benchmarks, comparison of field-collected pore water chemistry to surface water benchmarks, sediment toxicity tests, and recent plus past benthic community survey results) show a strong potential for risk to the benthic invertebrate community in various sections of the Animas River, as well as in mainstem Cement and Mineral creeks.

The sediment HQ evaluation and sediment toxicity test results do not provide a consistent picture. The sediment HQ analysis identifies sediment samples CC49 and M34 as the least impacted by metals, whereas sediment samples A75B, BBridge, and the Animas River upstream of Cement Creek are the most impacted by metals. This pattern is contrary to the outcome of the sediment toxicity test, which shows the highest toxicity at CC49 and M34 and lower (relative) toxicity in the Animas River above mainstem Cement Creek, plus A75B and BBridge.

6.3 Risk conclusions for fish

- **Mainstem Cement Creek:**

The chemical conditions in surface water from mainstem Cement Creek were highly toxic to fish, particularly due to low pH and high Al, and to a lesser extent by the presence of Cd, Cu, and Zn. The toxicity tests showed that surface water collected from this EU in November 2012 (i.e., post-runoff period) was acutely toxic to juvenile rainbow trout. The preponderance of evidence suggested that the fish community in mainstem Cement Creek (if present) would experience lethal stress under current conditions.

- **Mainstem Mineral Creek:**

The chemical conditions in surface water from mainstem Mineral Creek appeared less severe than in mainstem Cement Creek for the local fish community. However, serious pH drops during the pre-runoff period coupled with high Al levels during the pre-runoff and post-runoff periods suggested that fish may experience high stress in the winter, summer, and fall, but that survivors could possibly recover during the rest of the year (spring). The toxicity tests showed surface water collected from this EU in November 2012 (i.e., post-runoff period) and April 2013 (pre-runoff period) was acutely toxic to juvenile rainbow trout. The preponderance of evidence

suggested that the fish community in mainstem Mineral Creek (if present) would likely experience high stress under current conditions.

- **Animas River above mainstem Cement Creek:**

The chemical conditions in surface water from this reach of the Animas River between A60 and A68 indicated the presence of one or more sources of metal contamination located further upstream in the watershed. The chemical signature of the surface water suggested that chronic toxicity to the fish community was possible, particularly due to the presence of Al, Cd, and Zn. Low pH, on the other hand, was not an issue in this reach. The presence of significant acute toxicity measured in juvenile rainbow trout exposed to surface water from this reach further confirms the results of the chemical analyses. The preponderance of evidence suggested that the fish community in this reach of the Animas River is stressed during much of the year. This conclusion was supported by the fact that daily surface water samples collected between April and July 2014 using "MiniSipper" sampling devices positioned at location A56 (upstream of A60) showed the presence of potentially severe chronic toxicity associated with dissolved Al, Cd, Cu, Pb, and Zn during the pre-runoff and runoff periods.

- **Animas River between mainstem Cement Creek and mainstem Mineral Creek**

Little chemical information on the quality of the surface water was available because only two samples were collected, and no acute toxicity testing was performed. The limited amount of data suggested that this reach of the Animas River was likely to be lethal to fish, mostly due to low pH and high levels of Al, with secondary stress caused by Cd and Zn.

- **Animas River below mainstem Mineral Creek**

The chemical signature of the surface water in this reach of the Animas River reflected the major inputs from mainstem Mineral and Cement Creek, and the reach of the Animas River above mainstem Cement Creek. Surface water samples collected from sampling location A72 during the pre and post-runoff periods were acutely toxic to juvenile rainbow trout. Surface water samples collected during the same two hydrologic periods from the EUs further downstream did not show acute toxicity, suggesting that the effect had been "diluted out". However, the preponderance of evidence shows that Al, Cd, and Zn in surface water may exert chronic effects on the fish community to at least the BBridge EU located about 30 miles downstream from Silverton. This conclusion was supported by two additional lines of evidence:

  - Daily surface water samples collected between April and July 2014 using "MiniSipper" sampling devices positioned at locations A73, A75D and BBridge showed the presence of low-grade but multi-week chronic toxicity associated with dissolved Al, Cd, and Zn during the pre-runoff and runoff periods.

- A fisheries survey performed by the CDOW in 2010 on the Animas River in the vicinity of sampling locations A72, A73, and A75D/A75B showed a severe decline of the trout populations at all three locations between 2005 and 2010. The CDOW ascribed this collapse to a drastic reduction in surface water quality apparently associated with the discontinuance of a water treatment project in the Gladstone area on Cement Creek upgradient from Silverton. A 2014 follow-up fisheries survey by the CDOW in the vicinity of sampling location A75D/A75B showed that the trout population had continued to decline to very low numbers.

6.4 Risk conclusions for wildlife receptors

- **Animas River above mainstem Cement Creek**

A potential for high-level risk to American dipper from Pb exposure was identified in this reach. The American dipper was used as a surrogate species to perform an assessment of risk to the southwestern willow flycatcher, a federally and state-listed bird species. Evaluation of the surrogate species suggests that the flycatcher may be at risk from foraging in the Animas River above mainstem Cement Creek between sampling location A60 and A68. This conclusion was based on a single line of evidence (food chain exposure modeling) and conservative exposure and effects assumptions. Low-level Pb risks were also identified in the three other wildlife receptors; namely the belted kingfisher, mallard, and muskrat. Of these receptors, the kingfisher was determined to be most at risk in this reach with a CTE effect HQ of 4.2. Low-level Cu risks were also identified for American dipper with CTE HQs ranging from 1.7 to 1.9.

- **Animas River below mainstem Mineral Creek**

Wildlife risks were evaluated at six sampling locations in this approximate 30-mile reach. All of these sampling locations were on the Animas River, downgradient from the Cement Creek confluence. Risks associated with Pb exposure showed a large decline throughout this reach for every wildlife receptor. However, the CTE effect HQs for the American dipper were still elevated and ranged from 3.9 just below Cement Creek (A73) to 2.2 in the most downriver, BBridge sampling location. The same trend occurred for the belted kingfisher, except that the risks were substantially lower than for the American dipper. Unlike Pb, the risks to insectivorous wildlife from Cu exposure increased marginally in this reach; specifically, at locations A73B and A75B. Benthic invertebrates (i.e., representing the diet of insectivorous wildlife) were not collected for tissue residue analysis from sampling locations A73B and A75B. Hence, the levels of metals in benthic tissues at these two locations were estimated using conservative published sediment-to-benthic invertebrate regression models and uptake factors for use in the food chain model. It is noteworthy that the only two sampling locations with excessive risk from Cu are A73B and A75B. Given this pattern, it was concluded that the elevated risk to insectivorous wildlife from Cu exposure at these two sampling locations was likely biased high and may not reflect actual exposure regimes. Exposure to the remaining COPECs were of little to no concern to any of the other wildlife receptors.

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Figures



Figure 1.1
Sampling Locations on the Animas River Upstream and Across from Silverton, CO

Sample Locations

Mine Locations

Rivers and Streams

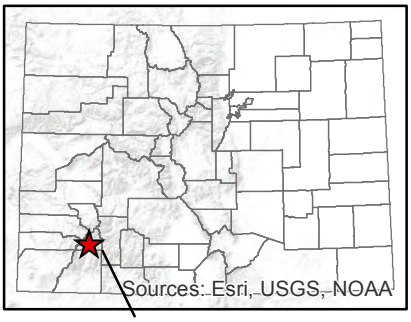
Date: January 30, 2014

0 1,000 2,000 Feet

Data Sources:
Sample Locations: U.S. EPA Region 8 (2013)
Mine Locations: U.S. EPA and ESAT (2012)
Rivers and Streams: CDOW 1:24k (2004)
Image: Microsoft Bing web service (2014)
Coordinate System/Projection:
UTM Zone 13 North, NAD 83, Meters

N

Colorado



Area Enlarged

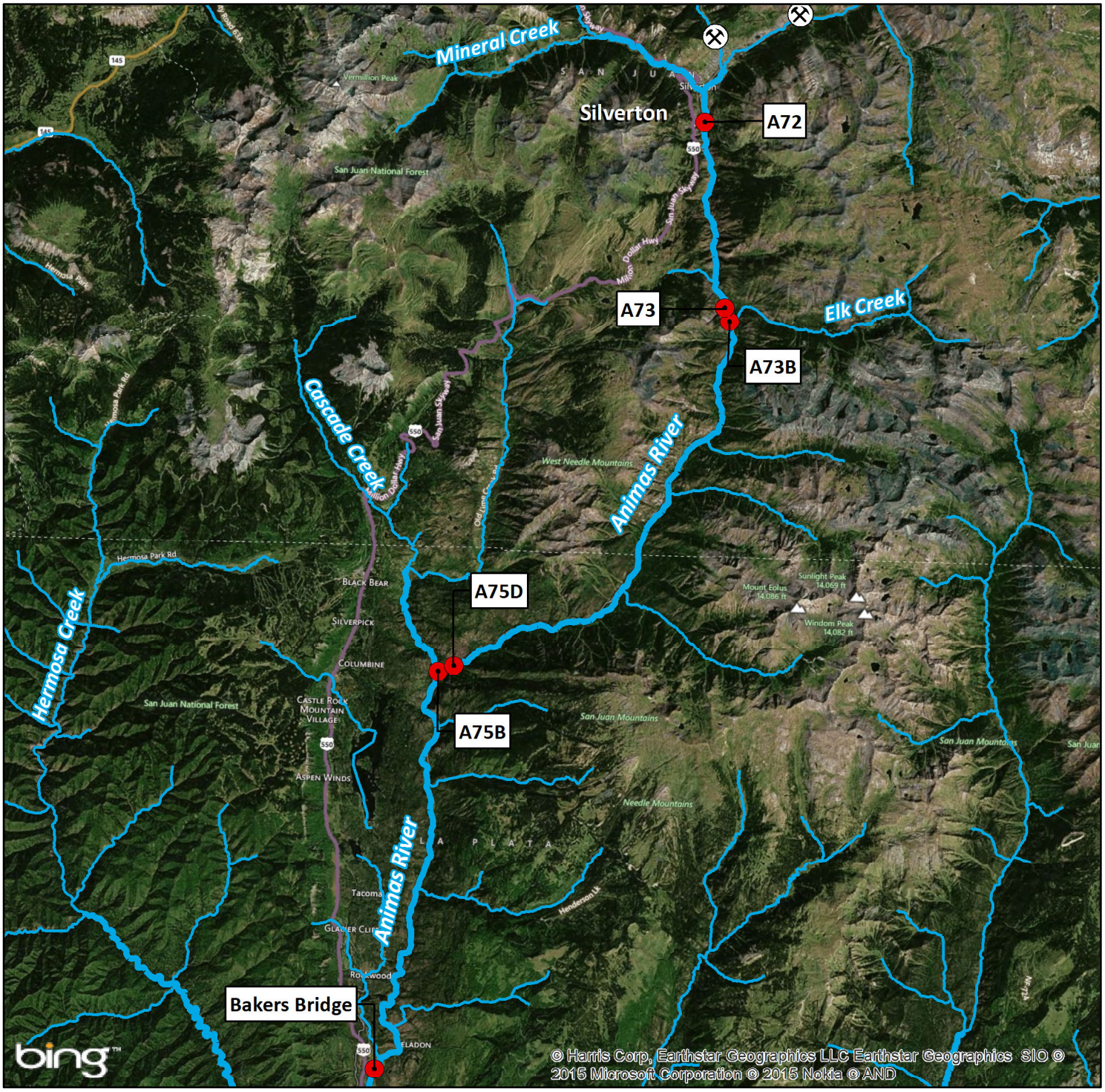


Figure 1.2

Sampling Locations on the Animas River Downstream from Silverton, CO

Sample Locations

Mine Locations

Rivers and Streams

Date: January 30, 2014

0 1.5 3 Miles

N

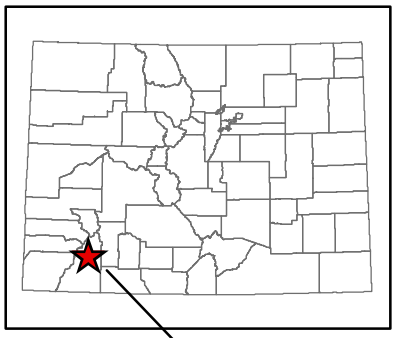
Data Sources:

Sample Locations: U.S. EPA Region 8 (2013);
Mine Locations: U.S. EPA and ESAT (2012);
Rivers and Streams: CDOW (2004);
Image: Microsoft Bing web service (2014).

Coordinate System/Projection:

UTM Zone 13 North, NAD 83, Meters

Colorado



Area Enlarged

FIGURE 2.1

Conceptual site model for the aquatic habitats and receptors evaluated in the BERA

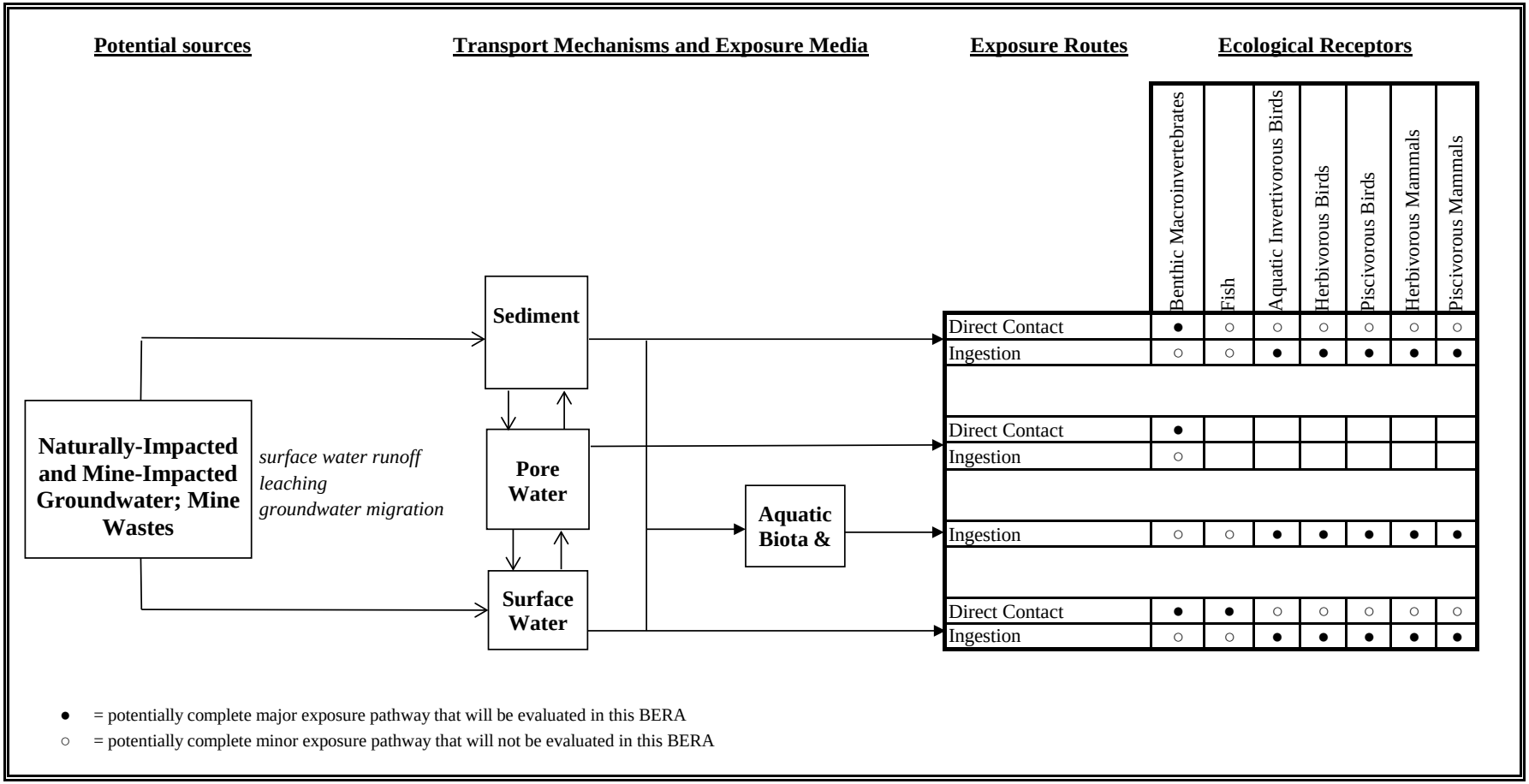


Figure 3.1: Summary of select benthic invertebrate community data collected in September-October 2014 from the Animas River, main stem Cement Creek, and main stem Mineral Creek

Figure 3.1a: Multi-Metric Index (MMI) scores for the benthic invertebrate community in the Animas River, mainstem Cement Cr. & mainstem Mineral Cr. (Sep. 2014)

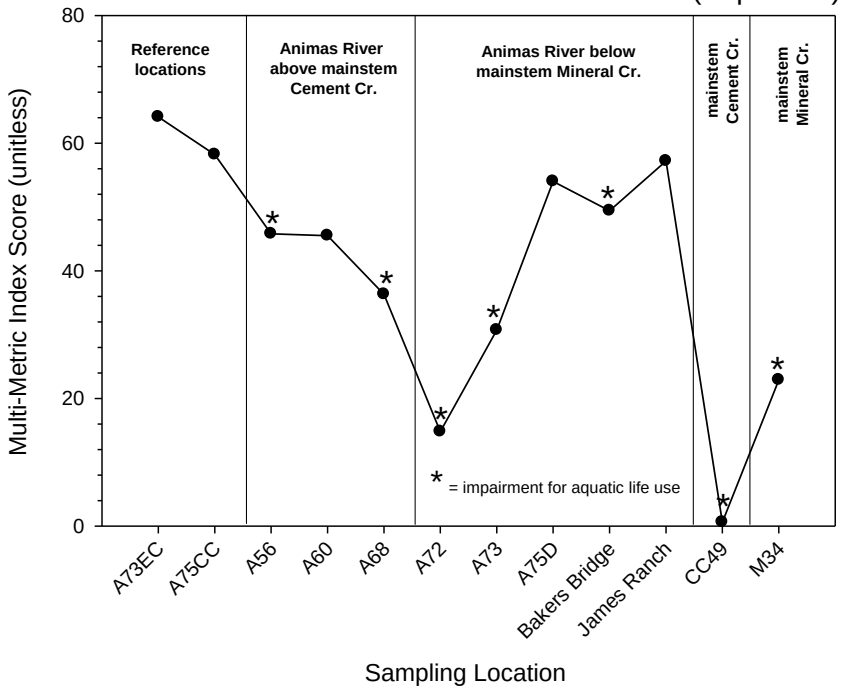


Figure 3.1b: # of taxa, # of intolerant taxa and # of EPT taxa for the benthic invertebrate community in the Animas River, mainstem Cement Cr. & mainstem Mineral Cr. (Sep. 2014)

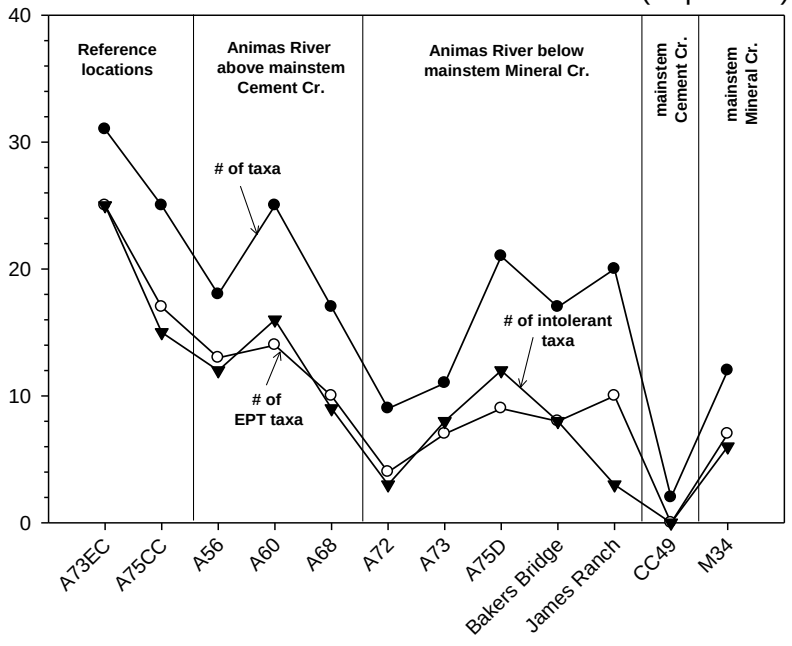


Figure 3.1 (cont'd): Summary of select benthic invertebrate community data collected in September-October 2014 from the Animas River, main stem Cement Creek, and main stem Mineral Creek

Figure 3.1c: Shannon-Weaver Diversity Index for the benthic invertebrate community in the Animas River, mainstem Cement Cr. & mainstem Mineral Cr. (Sep. 2014)

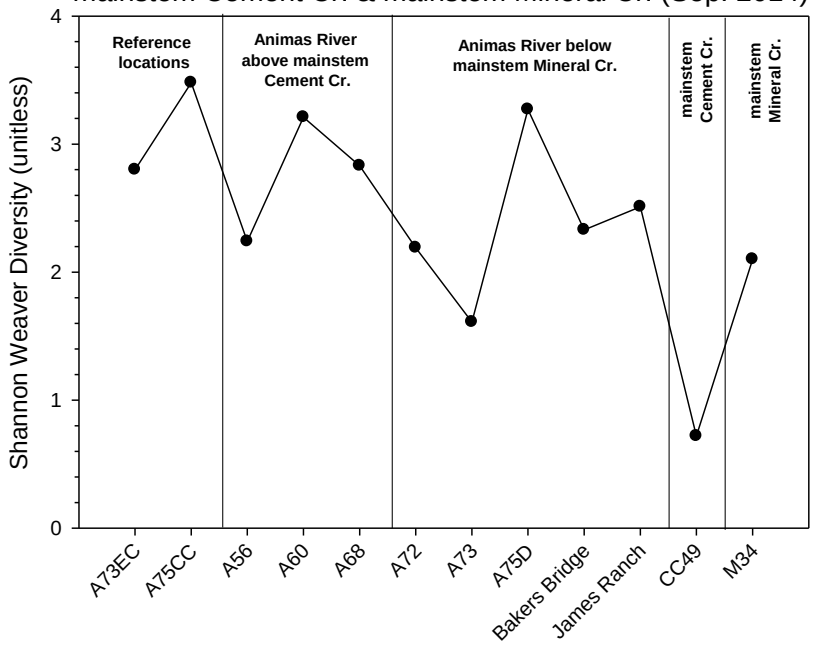


Figure 3.1d: The Hilsendorf Biotic Index for the benthic invertebrate community in the Animas River, mainstem Cement Cr. & mainstem Mineral Cr. (Sep. 2014)

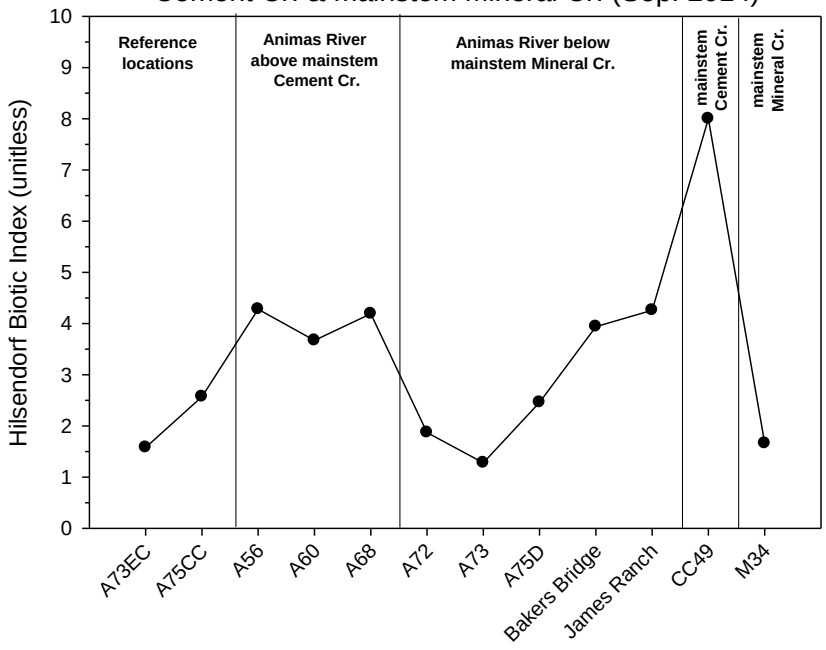


Figure 3.1 (cont'd): Summary of select benthic invertebrate community data collected in September-October 2014 from the Animas River, main stem Cement Creek, and main stem Mineral Creek

Figure 3.1e: EPT Index, Ephemerata abundance, and %EPT for the benthic invertebrate community in the Animas River, mainstem Cement Cr. & mainstem Mineral Cr. (Sep. 2014)

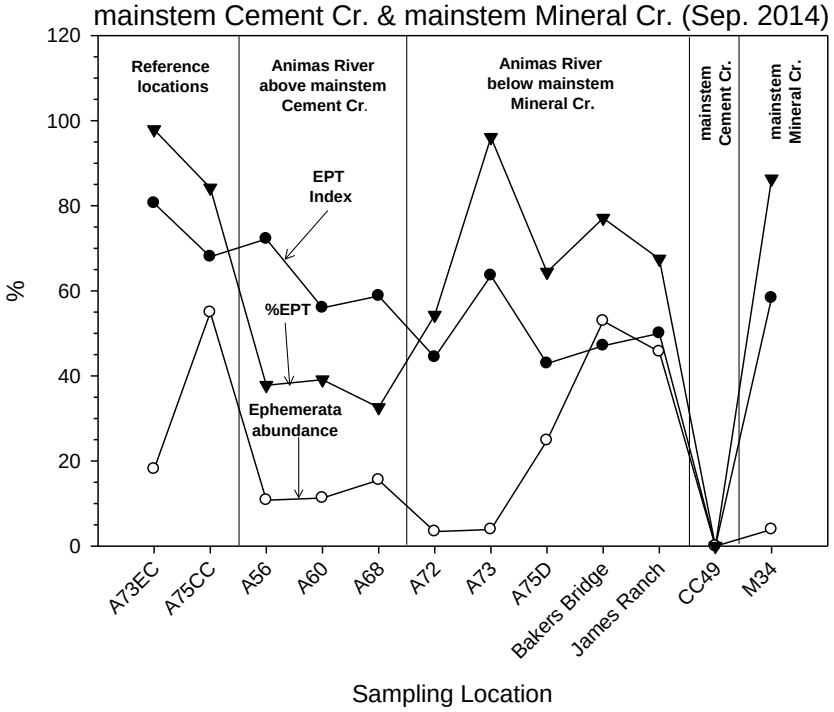


Figure 3.1f: Filterers, scrapers, and clingers in the benthic community in the Animas River, mainstem Cement Creek, and mainsten Mineral Creek (Sep. 2014)

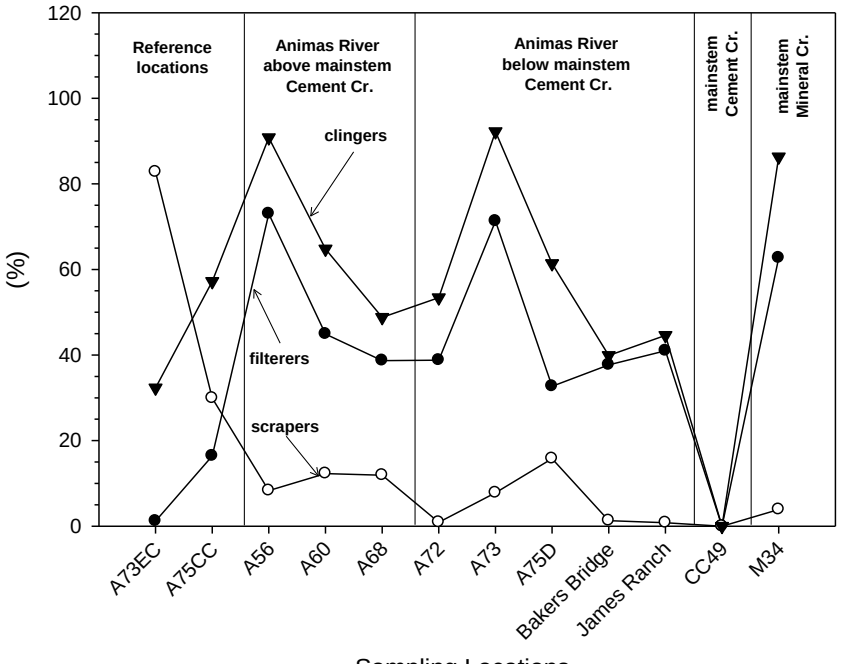


Figure 5.1: Geometric mean no effect and effect HQs for the benthic invertebrate community exposed to sediment in the Animas River above Cement Creek and below Mineral Creek

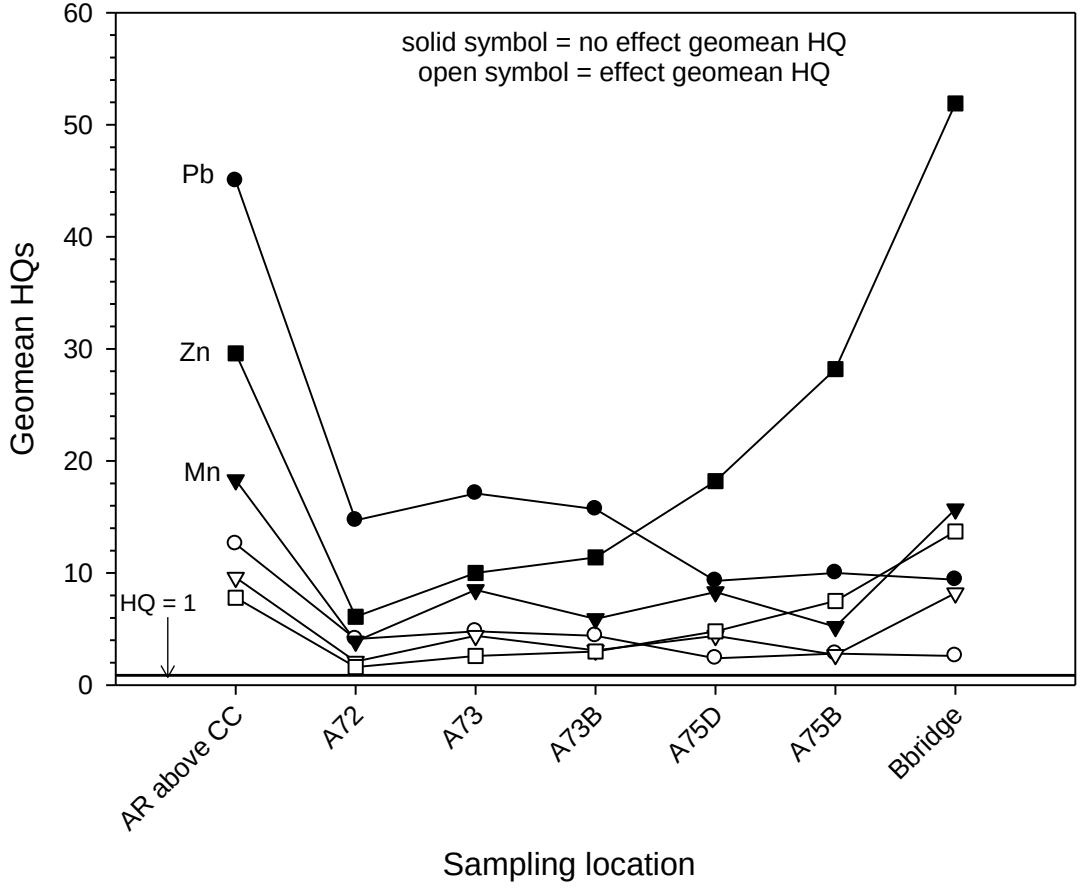


Figure 5.2: Sample-specific no effect and effect HQs for select metals in sediment collected from the Animas River, mainstem Cement Creek and mainstem Mineral Creek

Figure 5.2a: No effect and effect HQs for Al in sediment samples collected from the Animas River, mainstem Cement Creek and mainstem Mineral Creek

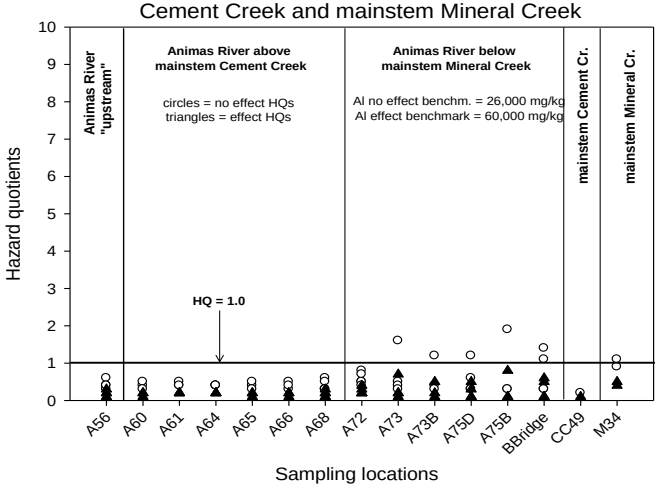


Figure 5.2b: No effect and effect HQs for As in sediment samples collected from the Animas River, mainstem Cement Creek and mainstem Mineral Creek

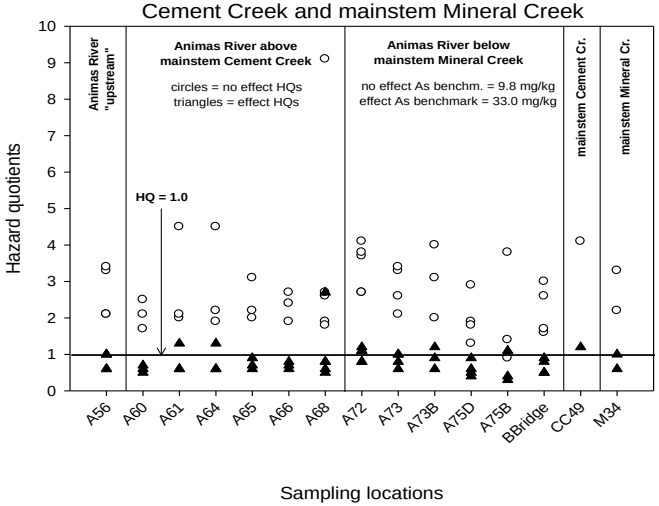


Figure 5.2c: No effect and effect HQs for Cd in sediment samples collected from the Animas River, mainstem Cement Creek and mainstem Mineral Creek

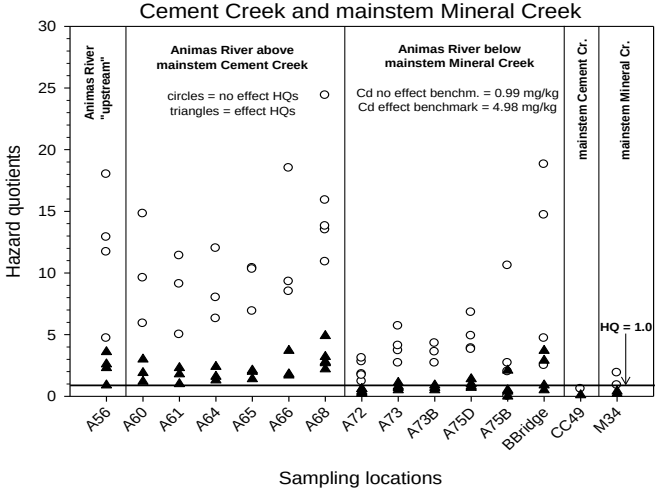


Figure 5.2d: No effect and effect HQs for Cu in sediment samples collected from the Animas River, mainstem Cement Creek and mainstem Mineral Creek

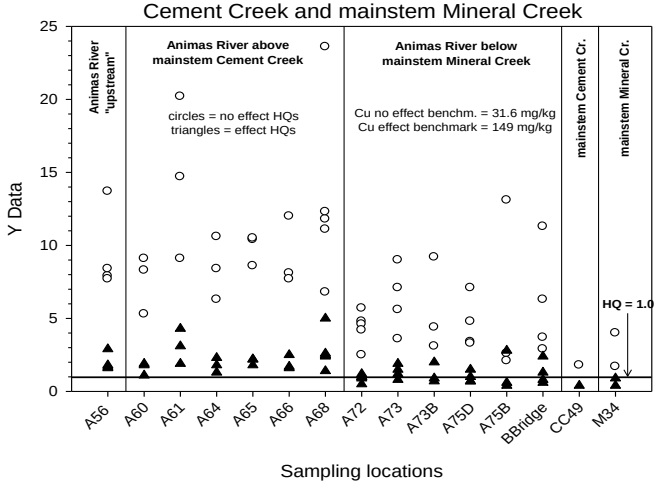


Figure 5.2 (cont'd): Sample-specific no effect and effect HQs for select metals in sediment collected from the Animas River, mainstem Cement Creek and mainstem Mineral Creek

Figure 5.2e: No effect and effect HQs for Pb in sediment samples collected from the Animas River, mainstem Cement Creek and mainstem Mineral Creek

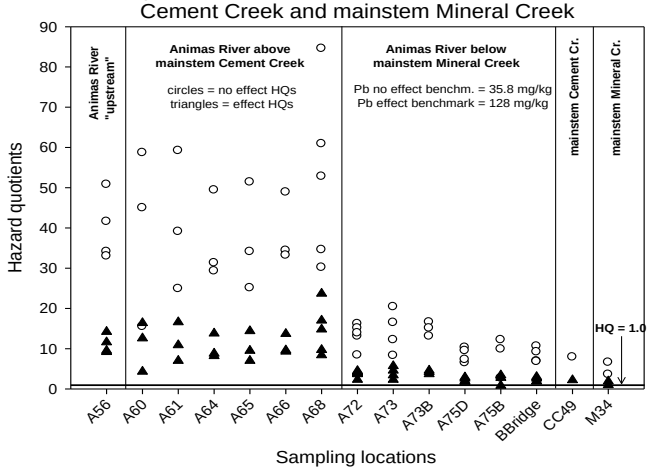


Figure 5.2f: No effect and effect HQs for Mn in sediment samples collected from the Animas River, mainstem Cement Creek and mainstem Mineral Creek

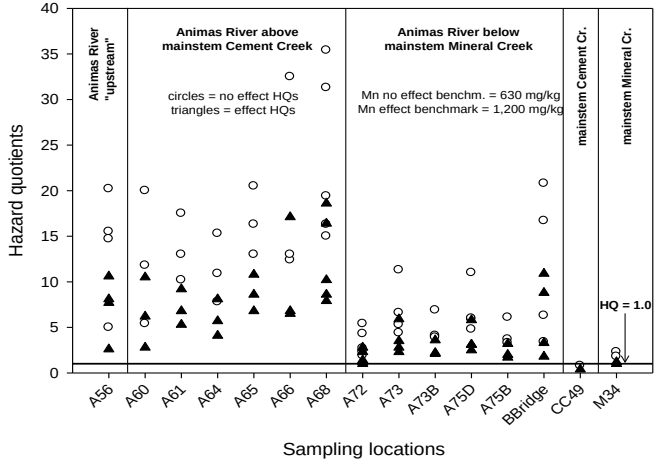


Figure 5.2g: No effect and effect HQs for Ag in sediment samples collected from the Animas River, mainstem Cement Creek and mainstem Mineral Creek

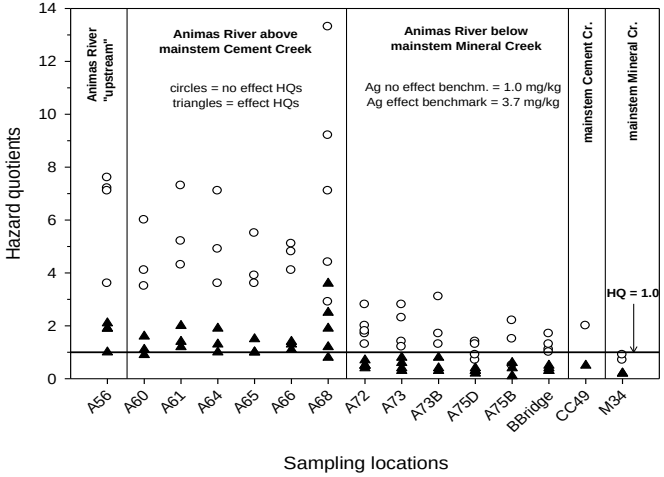


Figure 5.2h: No effect and effect HQs for Zn in sediment samples collected from the Animas River, mainstem Cement Creek and mainstem Mineral Creek

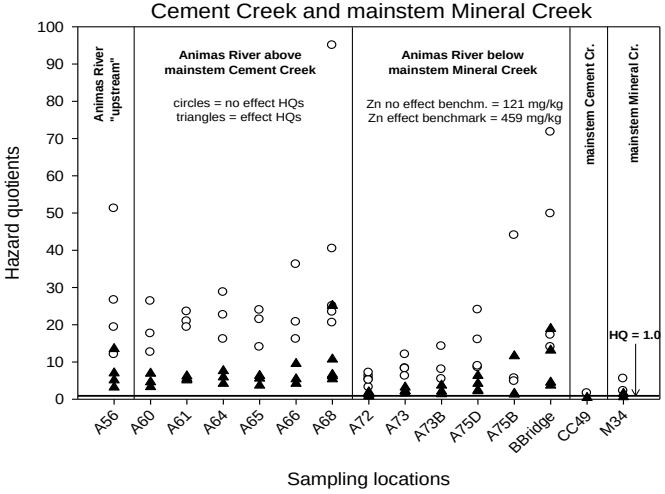


Figure 5.3: Multi-Metric Index Scores (1992-2014)

Figure 5.3a: MMI scores over time for sampling locations on the Animas River below mainstem Mineral Creek and at the two reference locations

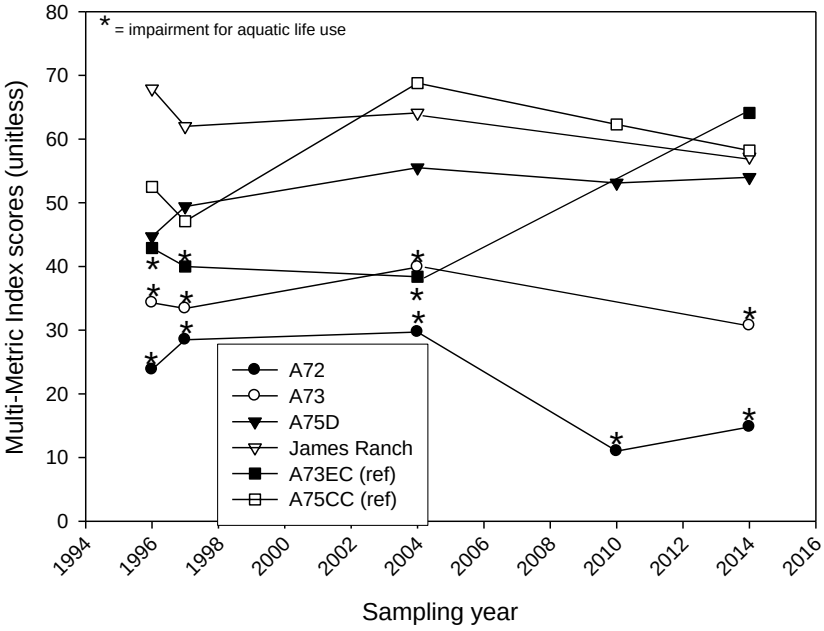


Figure 5.3b: MMI scores over time for sampling location A68 above mainstem Cement Creek, in mainstem Mineral Creek and at the two reference locations

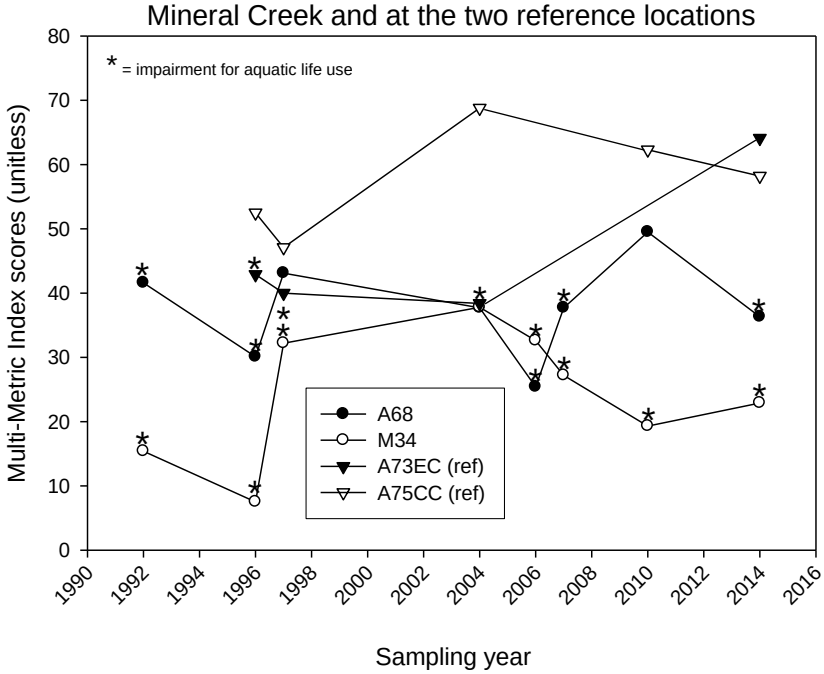


Figure 5.4: Scatter plots of pH in surface water

Figure 5.4.a: pH in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60-A68)

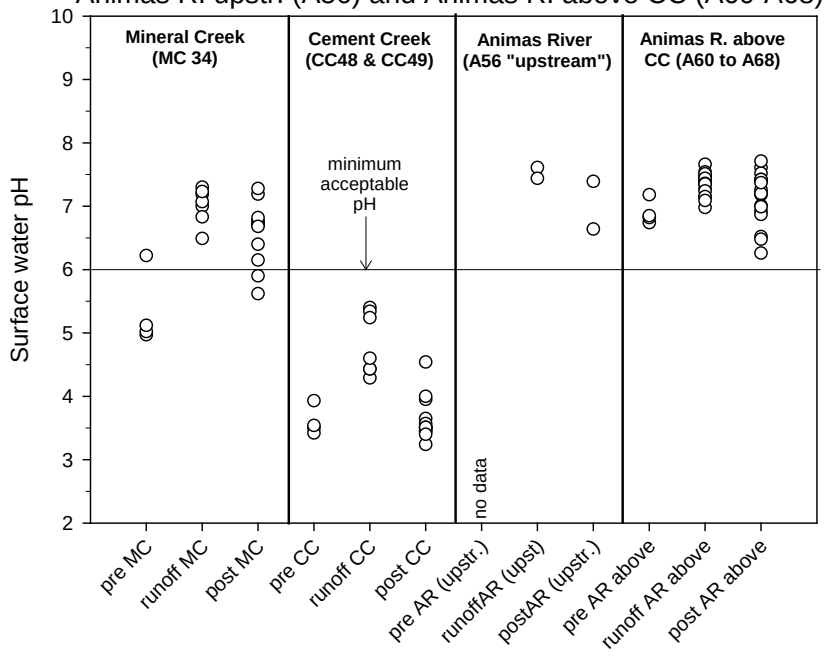


Figure 5.4.b: pH in pre-runoff, runoff, and post-runoff surface water samples from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)

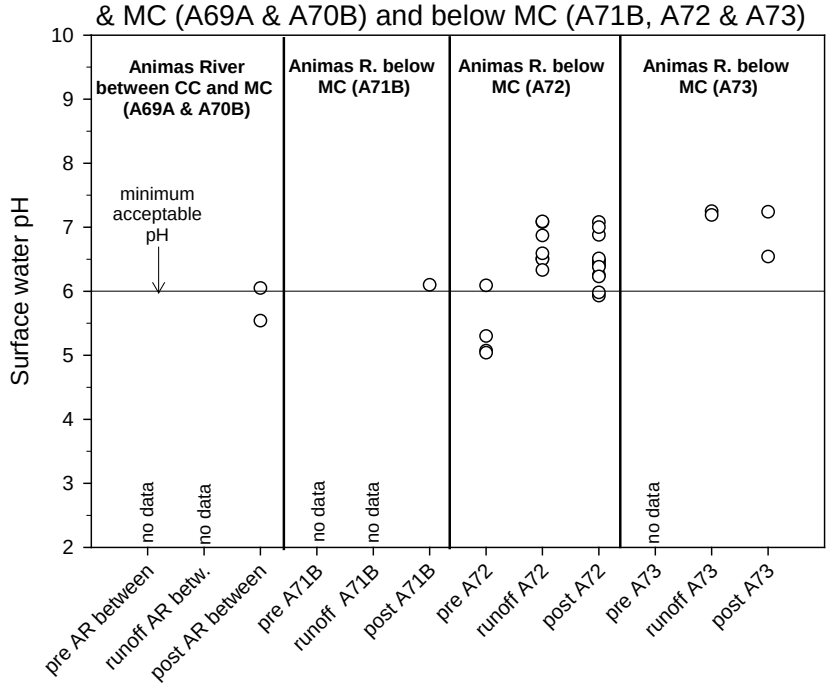


Figure 5.4 (cont'd): Scatter plots of pH in surface water

Figure 5.4.c: pH in pre-runoff, runoff, and post-runoff surface water samples from the Animas River below Mineral Creek (A73B, A75D, A75B, and Bakers Bridge)

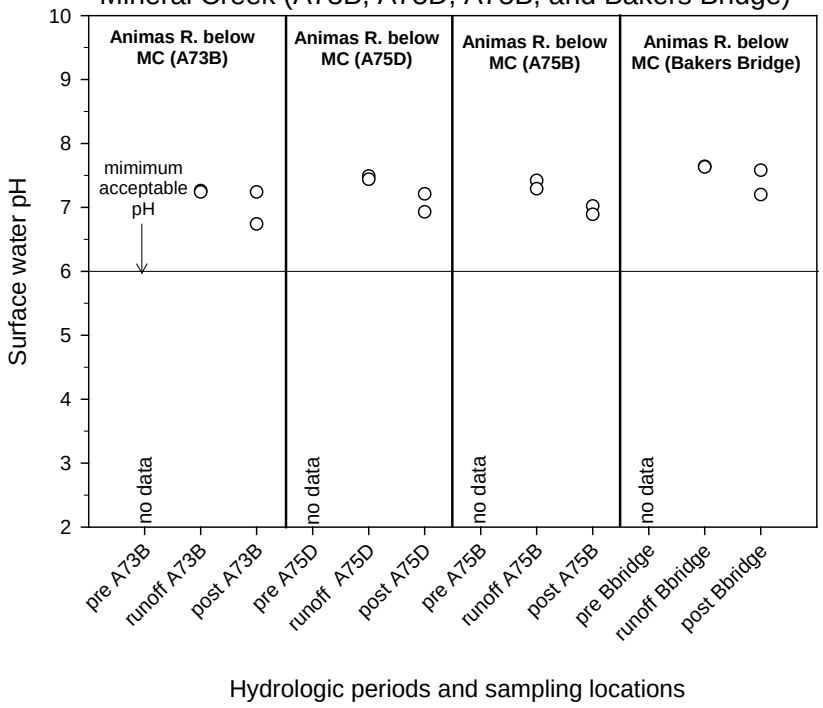


Figure 5.5: Scatter plots of total Al chronic HQs in surface water

Figure 5.5.a: Total Al HQs in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60-A68)

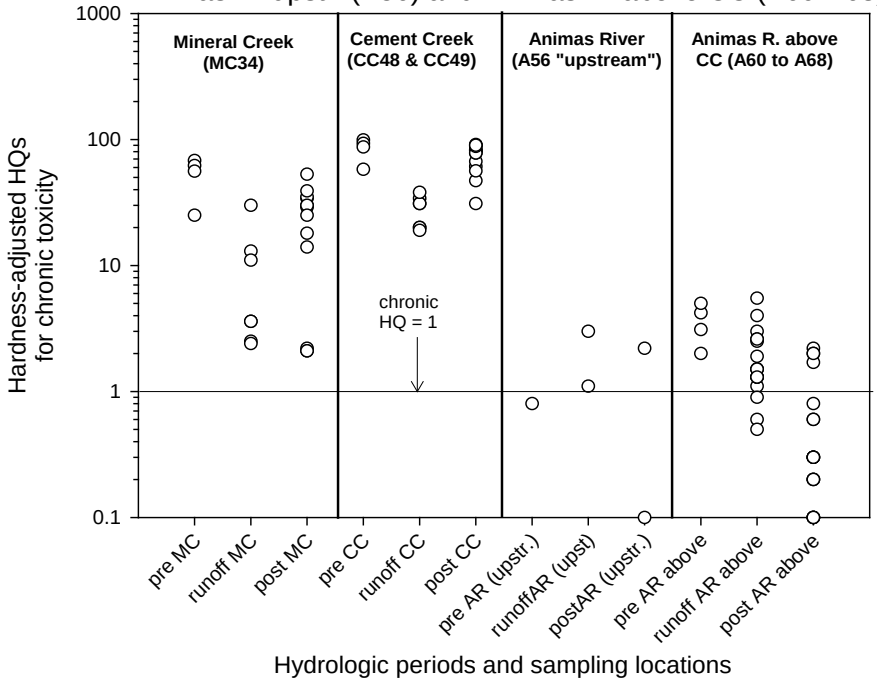


Figure 5.5.b: Total Al HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)

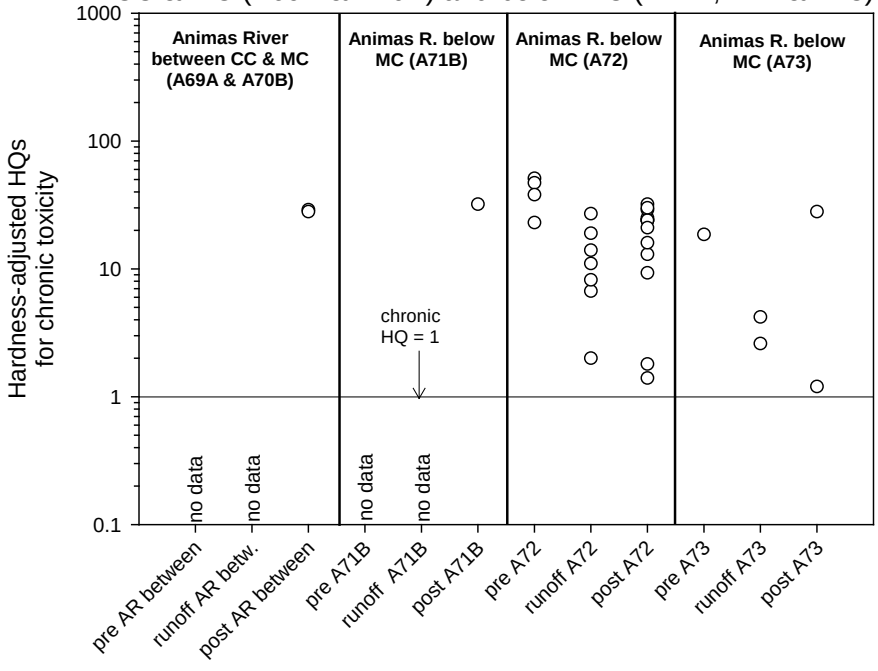


Figure 5.5 (cont'd): Scatter plots of total Al chronic HQs in surface water

Figure 5.5.c: Total Al HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River below MC at locations A73B, A75D, A75B, and Bakers Bridge

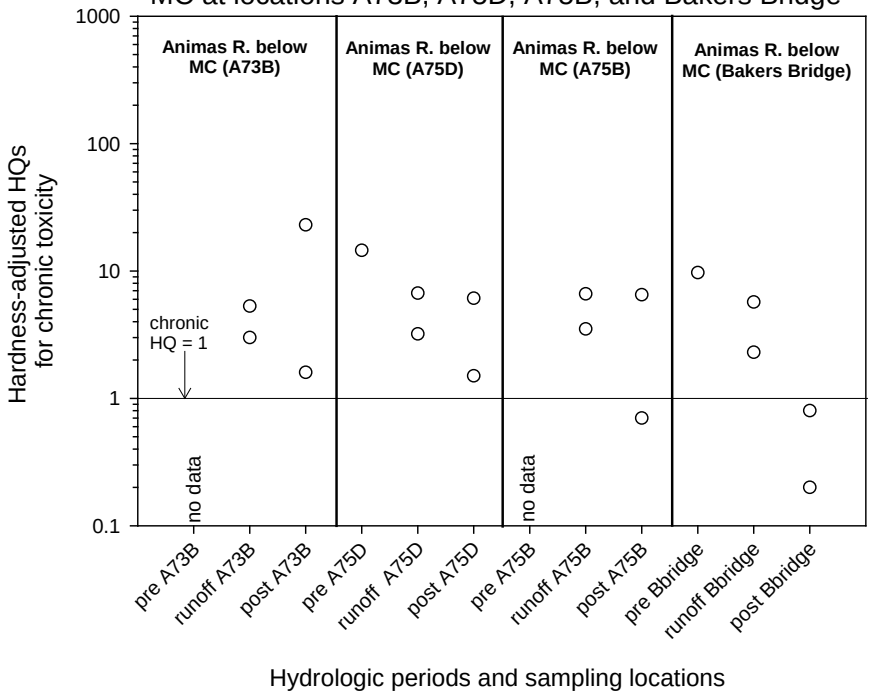


Figure 5.6: Scatter plots of dissolved Cd chronic HQs in surface water

Figure 5.6.a: Dissolved Cd HQs in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)

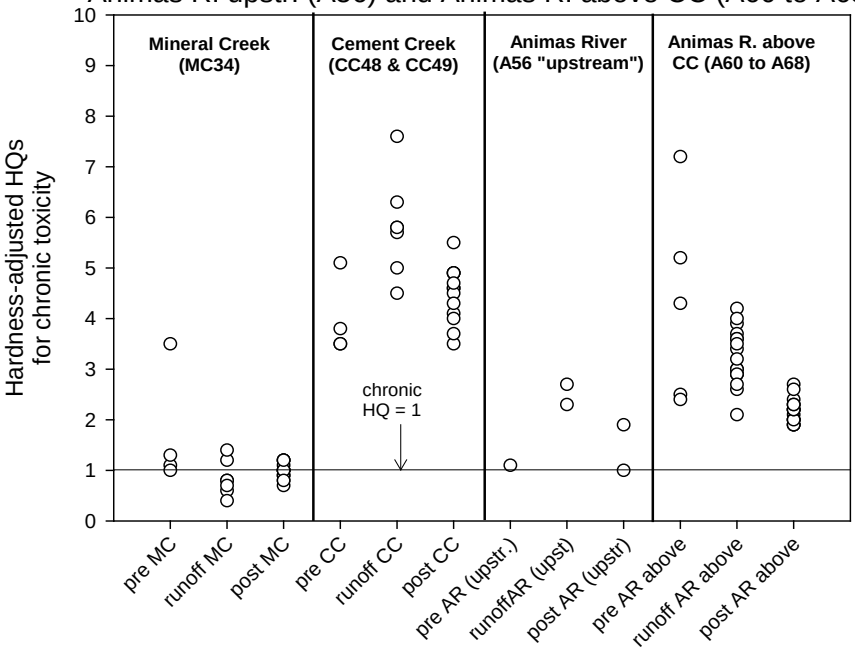


Figure 5.6.b: Dissolved Cd in pre-runoff, runoff, and post-runoff surface water samples from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)

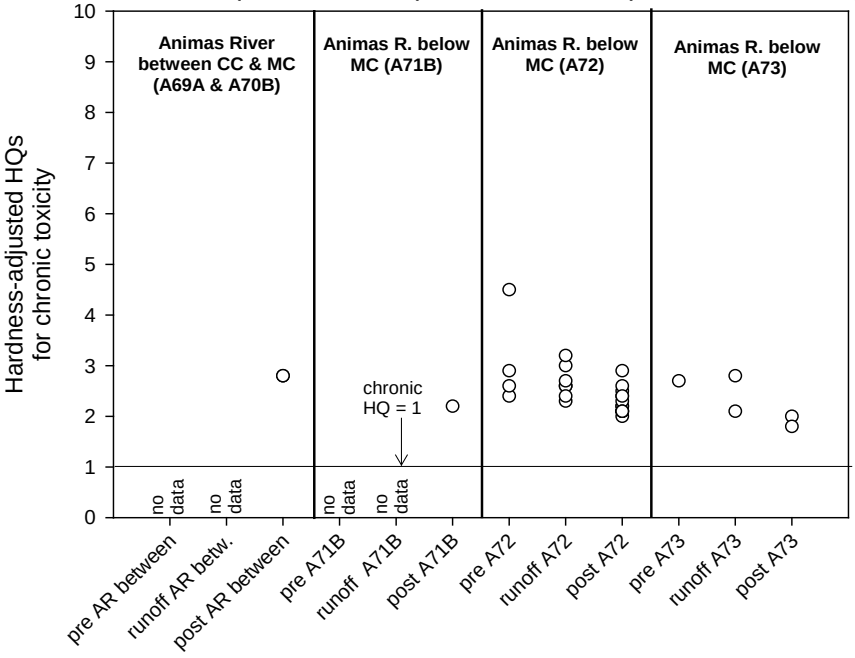


Figure 5.6 (cont'd): Scatter plots of dissolved Cd chronic HQs in surface

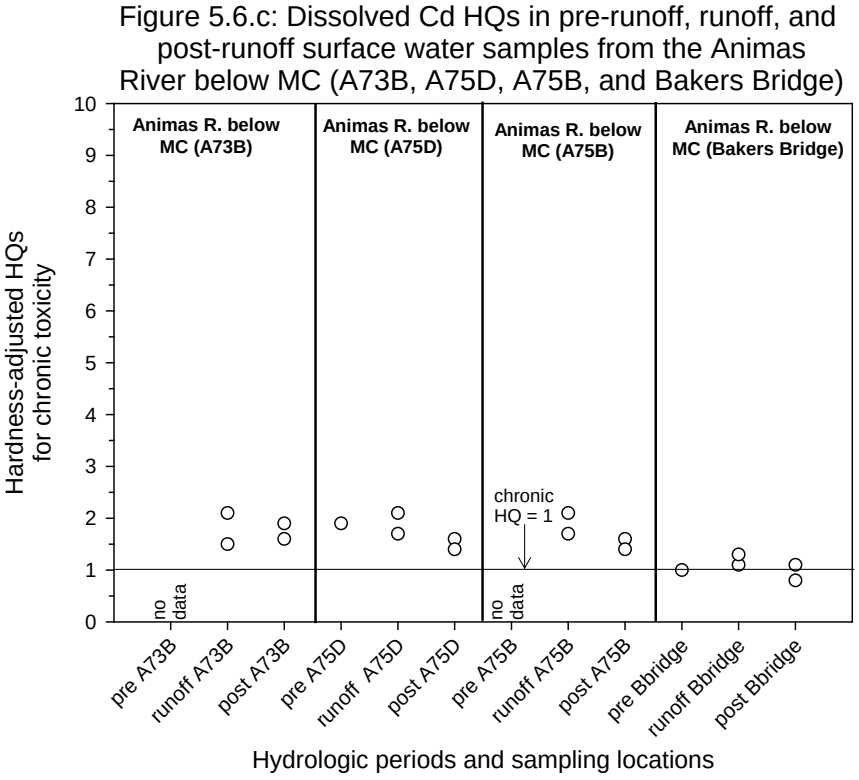
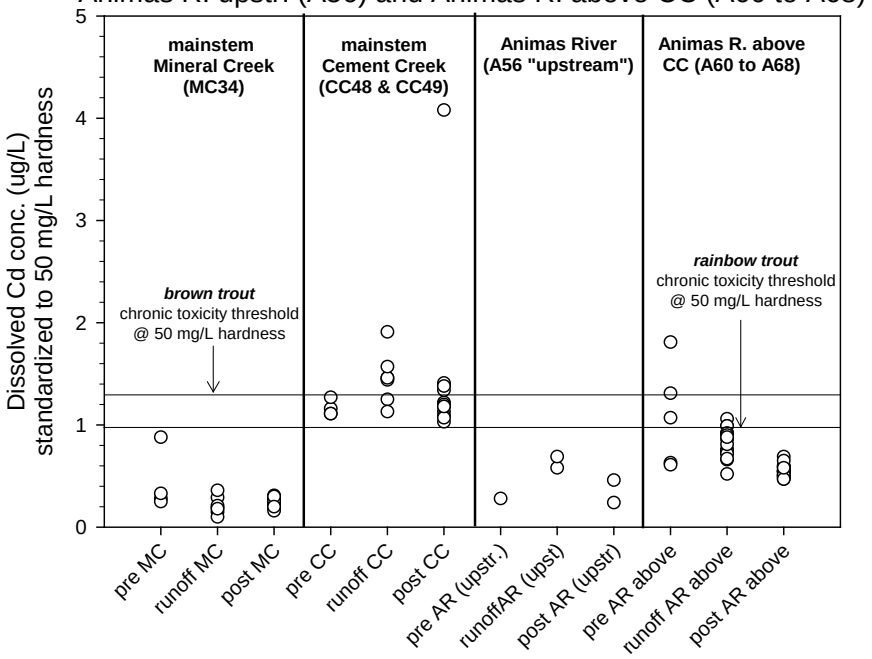


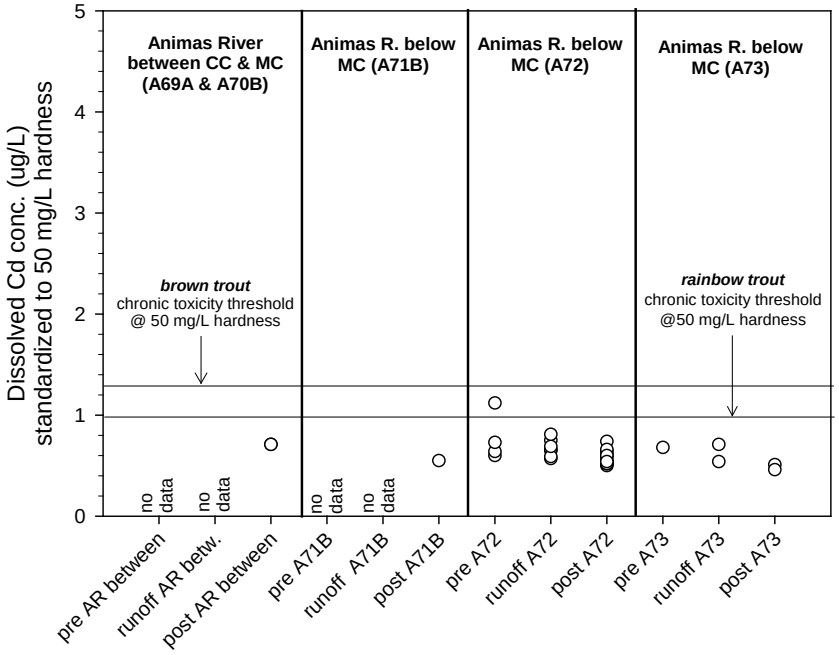
Figure 5.6*: Scatter plots of dissolved Cd concentrations adjusted to a hardness of 50 mg/L

Figure 5.6*.a: [Cd] @ 50 mg/L hardness in pre-runoff, runoff, and post-runoff surface water from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)



Hydrologic periods and sampling locations

Figure 5.6*.b: [Cd] @ 50 mg/L hardness in pre-runoff, runoff, and post-runoff surface water from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)



Hydrologic periods and sampling locations

Figure 5.6* (cont'd): Scatter plots of dissolved Cd concentrations adjusted to a hardness of 50 mg/L

Figure 5.6*.c: [Cd] @ 50 mg/L hardness in pre-runoff, runoff, and post-runoff surface water from the Animas River below MC (A73B, A75D, A75B, and Bakers Bridge)

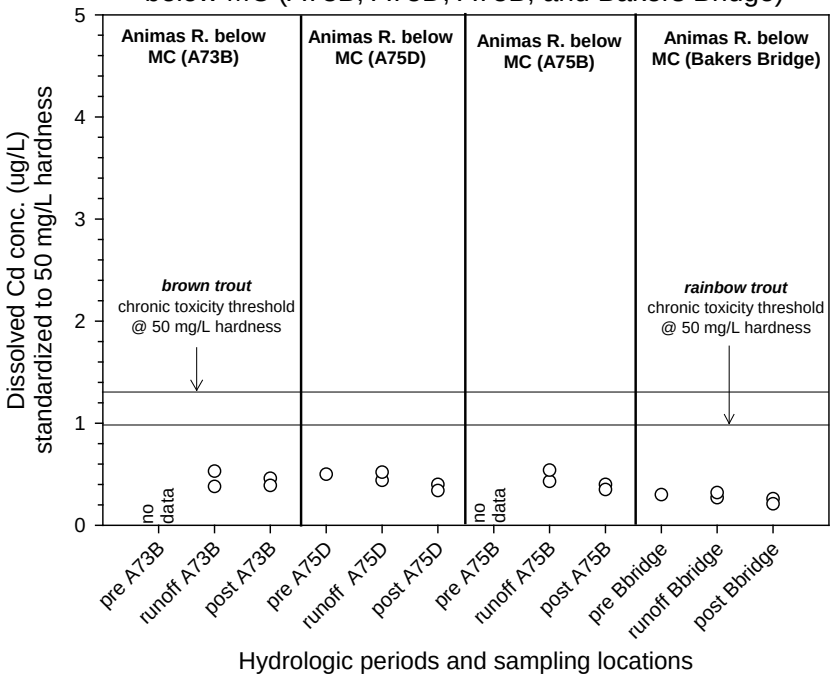


Figure 5.7: Scatter plots of dissolved Cu chronic HQs in surface water

Figure 5.7.a: Dissolved Cu HQs in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)

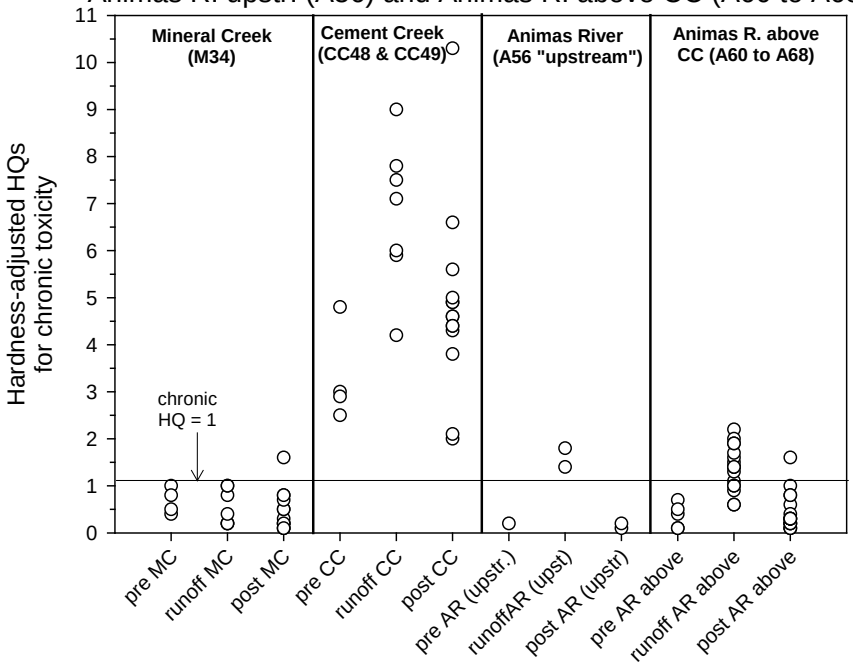


Figure 5.7.b: Dissolved Cu HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)

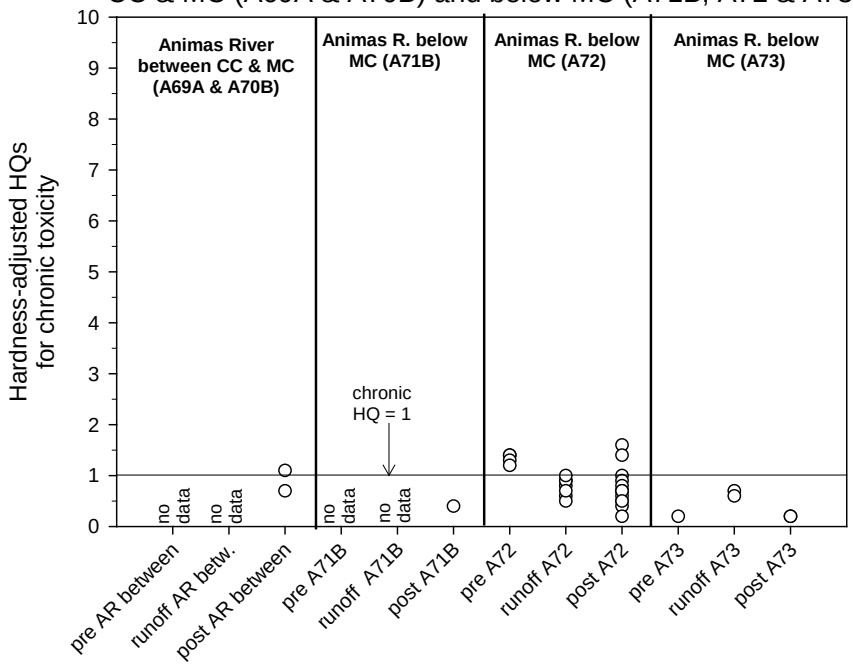


Figure 5.7 (cont.d): Scatter plots of dissolved Cu chronic HQs in surface

Figure 5.7.c: Dissolved Cu HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River below MC (A73B, A75D, A75B, and Bakers Bridge)

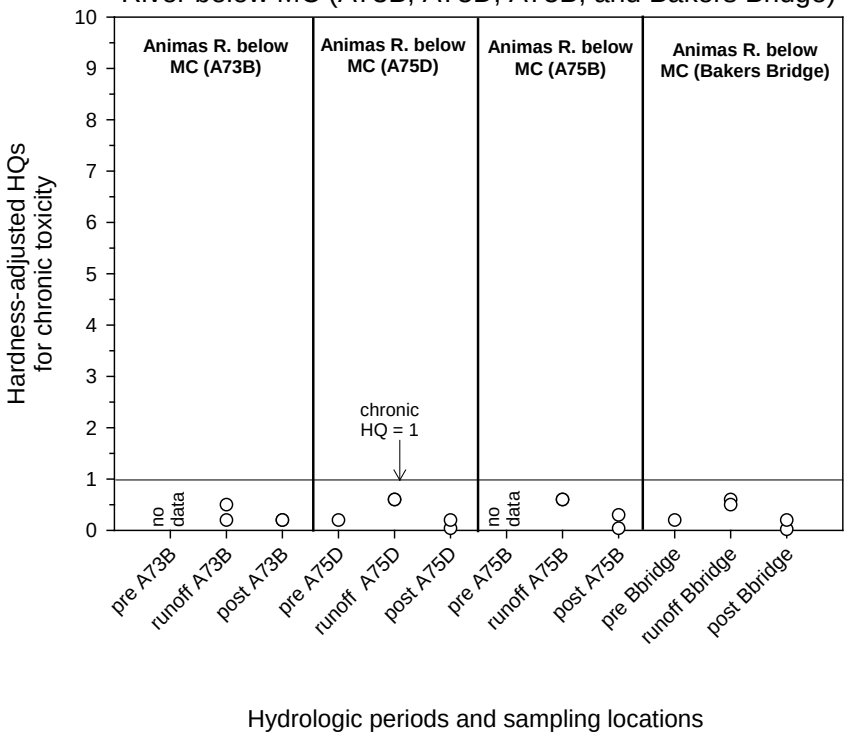


Figure 5.7*: Scatter plots of dissolved Cu concentrations adjusted to a hardness of 50 mg/L

Figure 5.7*.a: [Cu] @ 50 mg/L hardness in pre-runoff, runoff, and post- runoff surface water from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)

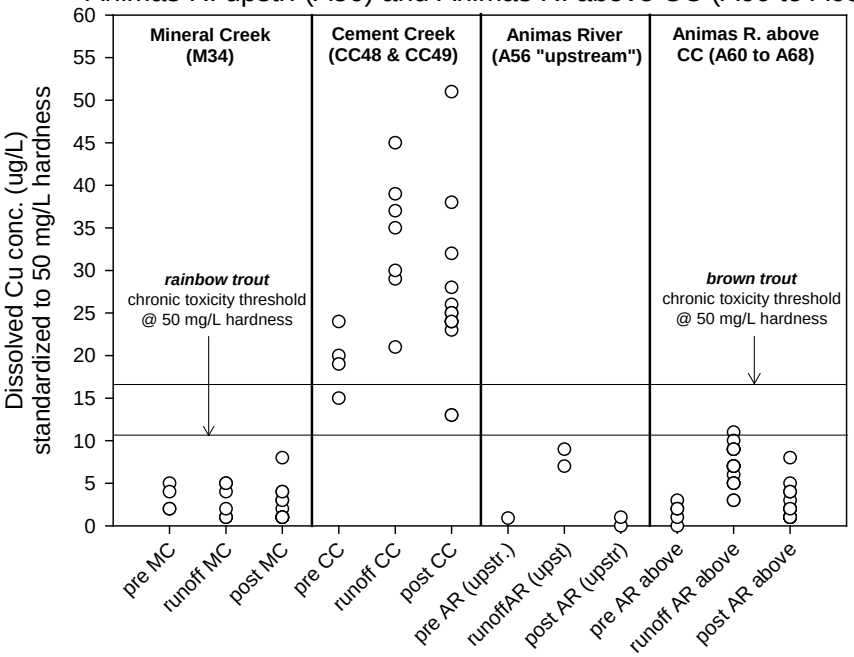


Figure 5.7*.b: [Cu] @ 50 mg/L hardness in pre-runoff, runoff, and post-runoff surface water from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)

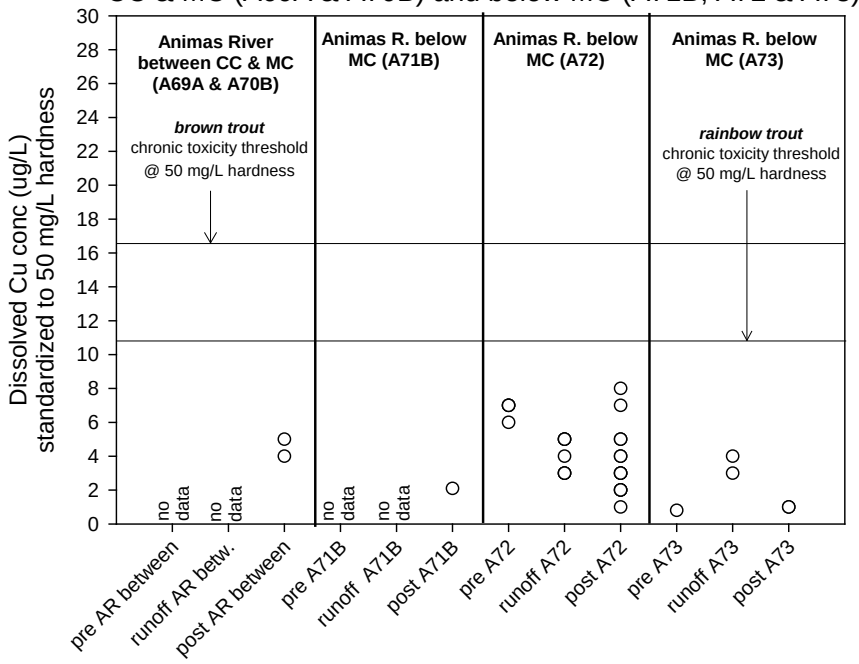


Figure 5.7* (cont'd): Scatter plots of dissolved Cu concentrations adjusted to a hardness of 50

Figure 5.7*.c: [Cu] @ 50 mg/L hardness in pre-runoff, runoff, and post-runoff surface water from the Animas River below MC (A73B, A75D, A75B, and Bakers Bridge)

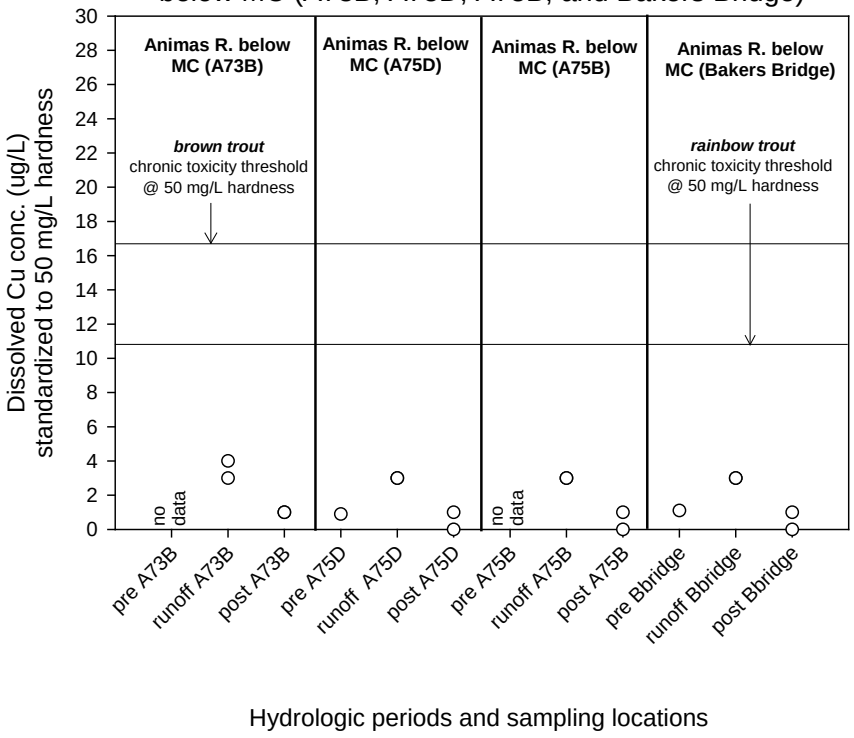


Figure 5.8: Scatter plots of dissolved Mn chronic HQs in surface water

Figure 5.8.a: Dissolved Mn HQs in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)

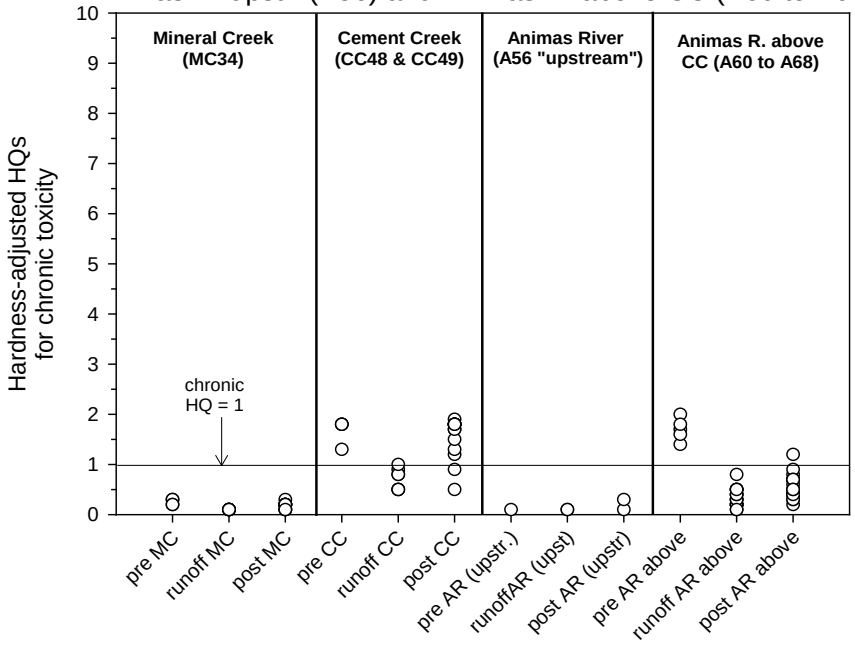


Figure 5.8.b: Dissolved Mn HQs in pre-runof, runoff, and post-runoff surface water samples from the Animas River between CC and MC (A69A & A70B) and below MC (A71B, A72 & A73)

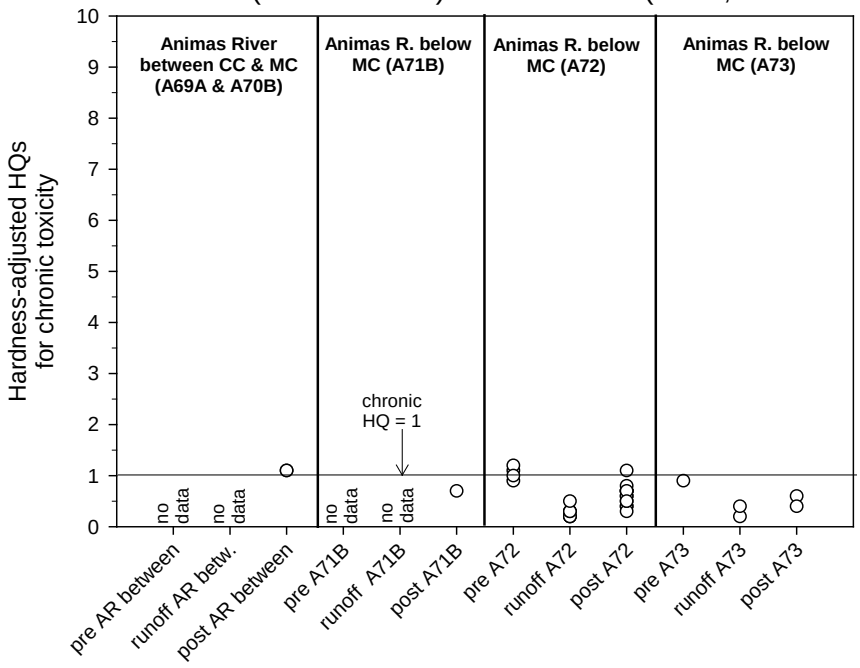


Figure 5.8 (cont'd): Scatter plots of dissolved Mn chronic HQs in surface

Figure 5.8.c: Dissolved Mn HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River below MC (A73B, A75D, A75B, and Bakers Bridge)

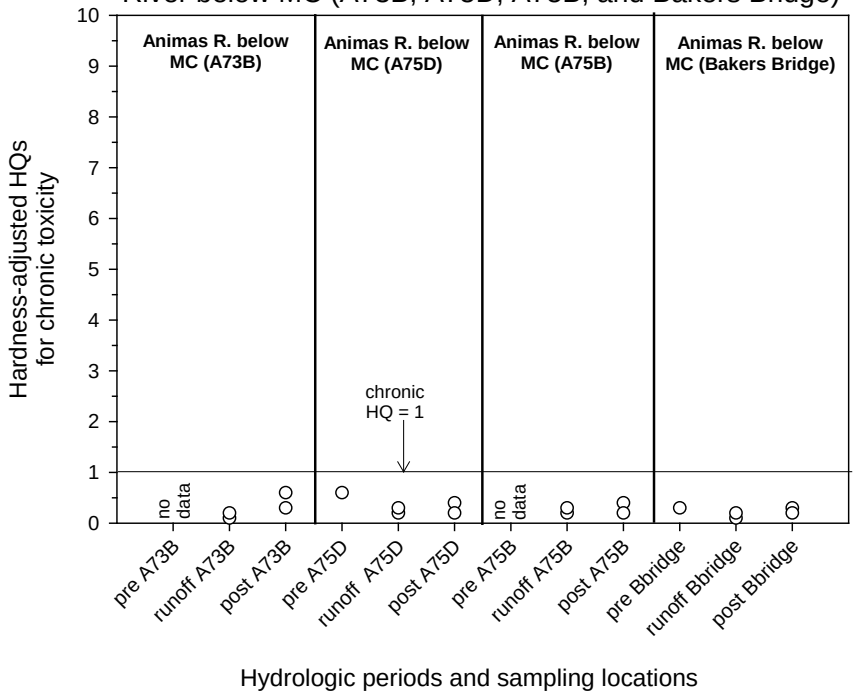


Figure 5.9: Scatter plots of dissolved Pb chronic HQs in surface water

Figure 5.9.a: Dissolved Pb HQs in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)

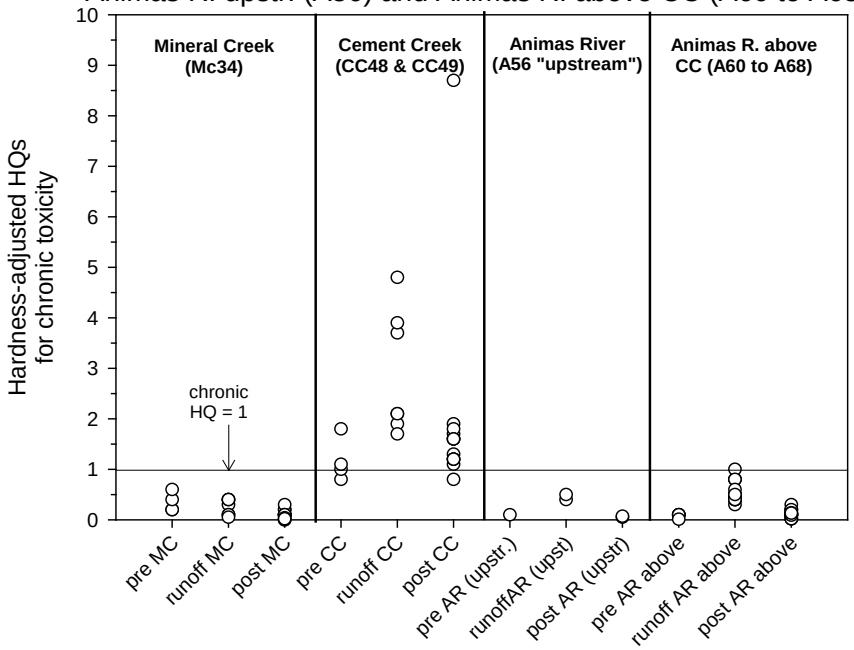


Figure 5.9.b: Dissolved Pb HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River between CC and MC (A69A & A70B) and below MC (A71B, A72 & A73)

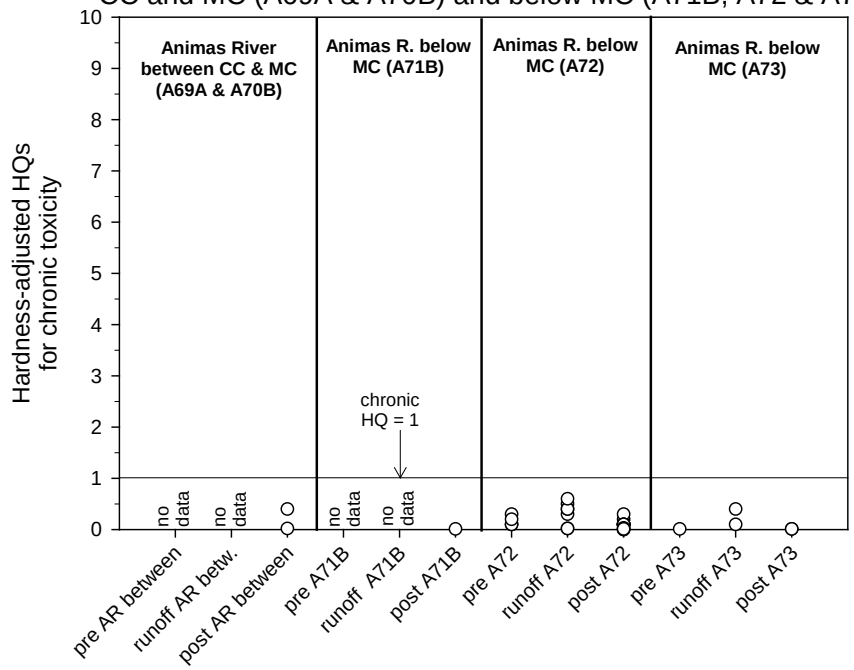


Figure 5.9 (cont'd): Scatter plots of dissolved Pb chronic HQs in surface

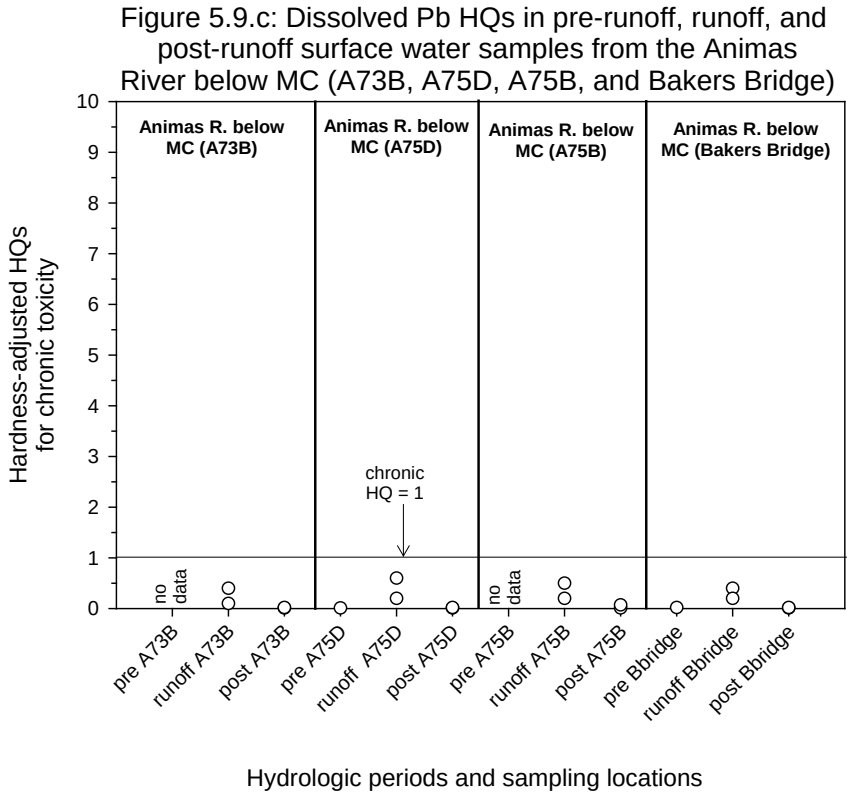


Figure 5.10: Scatter plots of dissolved Zn chronic HQs in surface water

Figure 5.10.a: Dissolved Zn HQs in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)

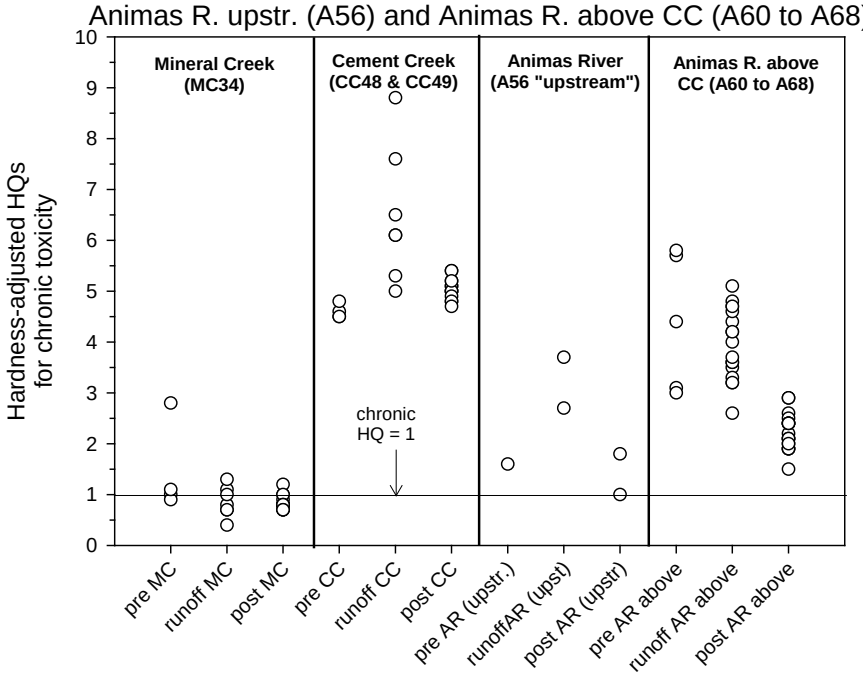


Figure 5.10.b: Dissolved Zn HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)

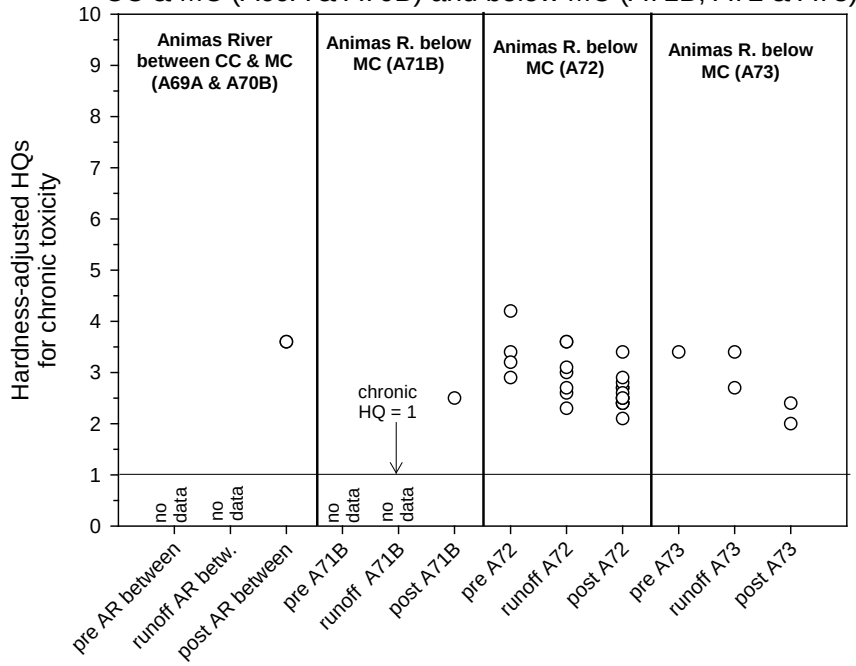


Figure 5.10 (cont'd): Scatter plots of dissolved Zn chronic HQs in surface

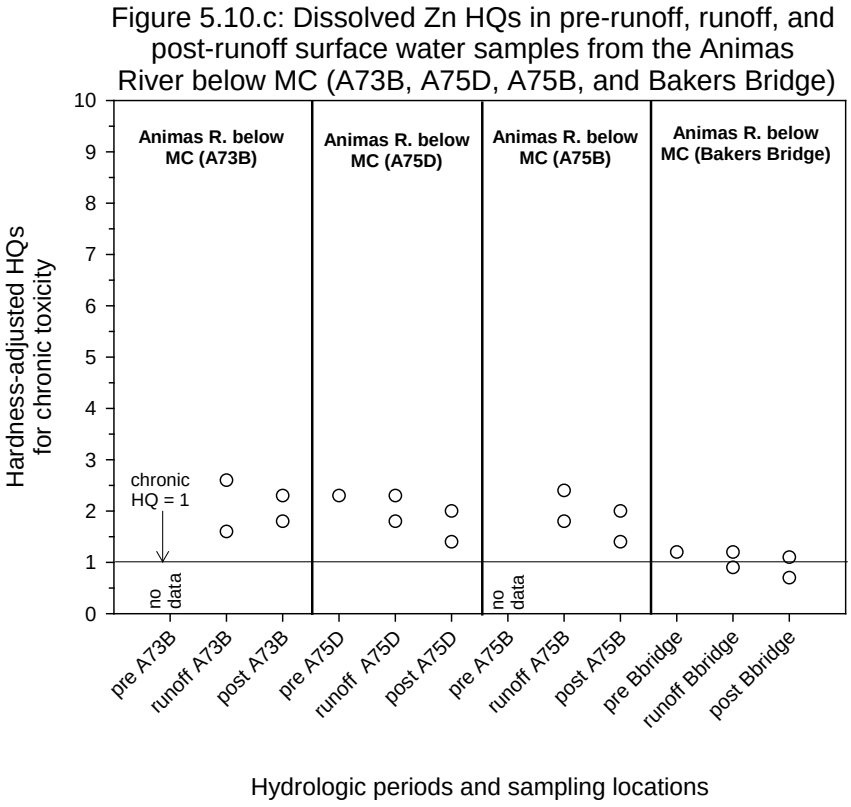
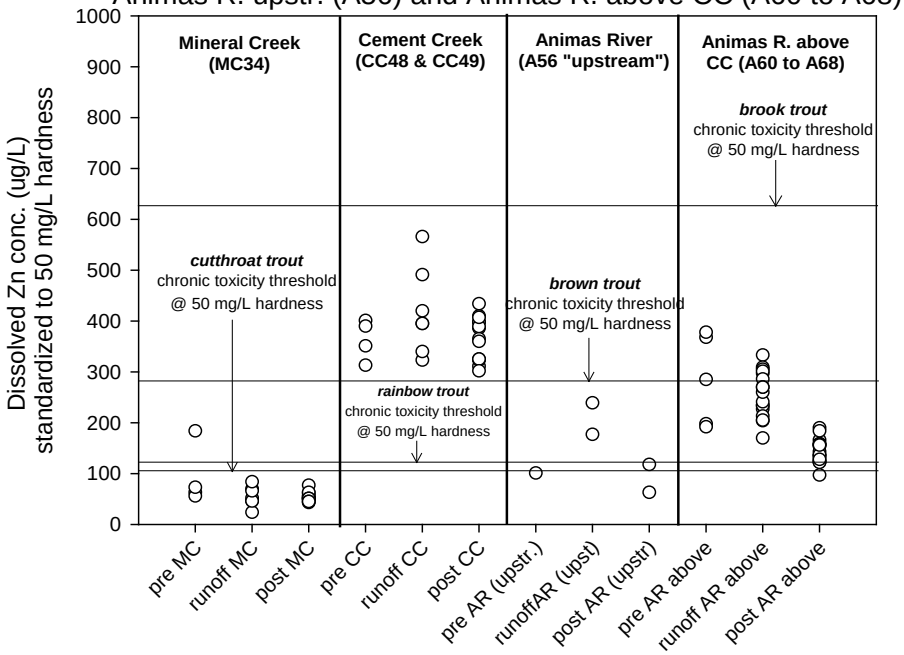


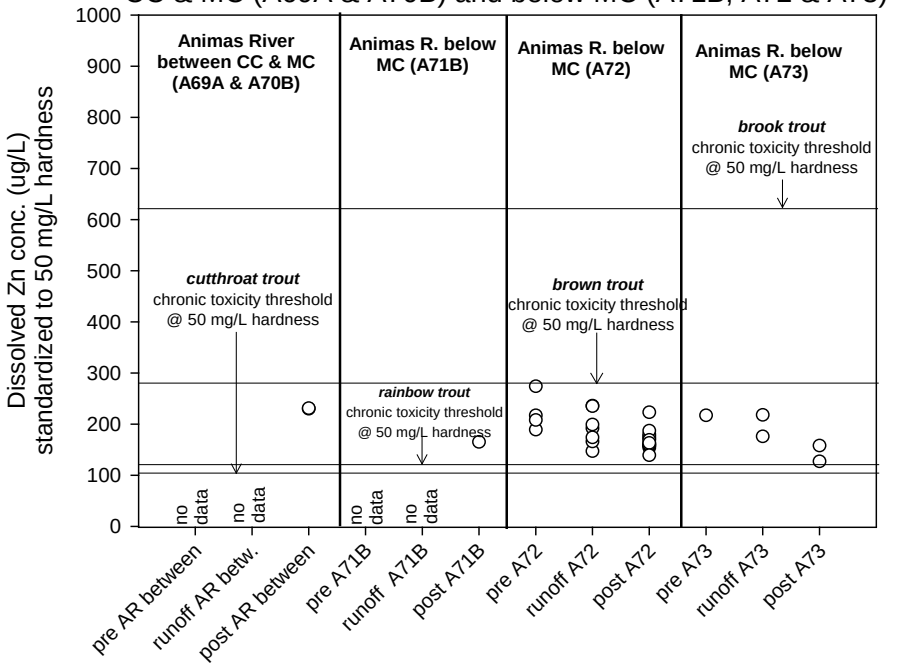
Figure 5.10*: Scatter plots of dissolved Zn concentrations adjusted to a hardness of 50 mg/L

Figure 5.10*.a: [Zn] @ 50 mg/L hardness in pre-runoff, runoff, and post-runoff surface water from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)



Hydrologic periods and sampling locations

Figure 5.10*.b: [Zn] @ 50 mg/L hardness in pre-runoff, runoff, and post-runoff surface water from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)



Hydrologic periods and sampling locations

Figure 5.10* (cont'd): Scatter plots of dissolved Zn concentrations adjusted to a hardness of 50 mg/L

Figure 5.10*.c: [Zn] @ 50 mg/L hardness in pre-runoff, runoff, and post-runoff surface water from the Animas River below MC (A73B, A75D, A75B, and Bakers Bridge)

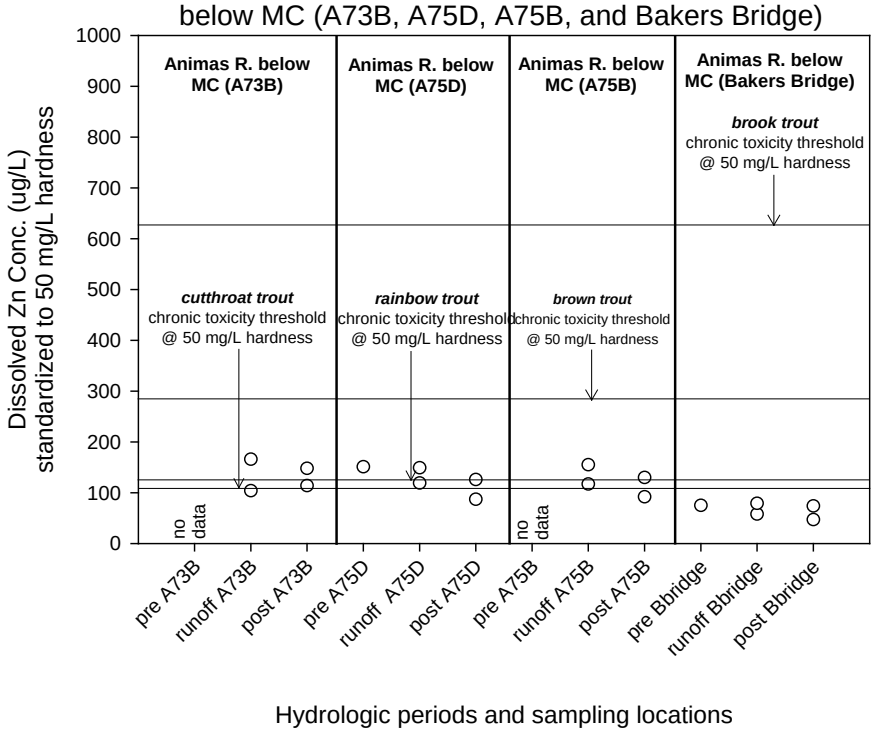


Figure 5.11: Scatter plots of dissolved metals chronic HQs in surface water samples collected using MiniSipper sampling devices in 2014

Figure 5.11a: Chronic HQs for dissolved Al in surface water collected in 2014 from the Animas River using MiniSipper samplers at locations A56, A73, A75D and Bakers Bridge

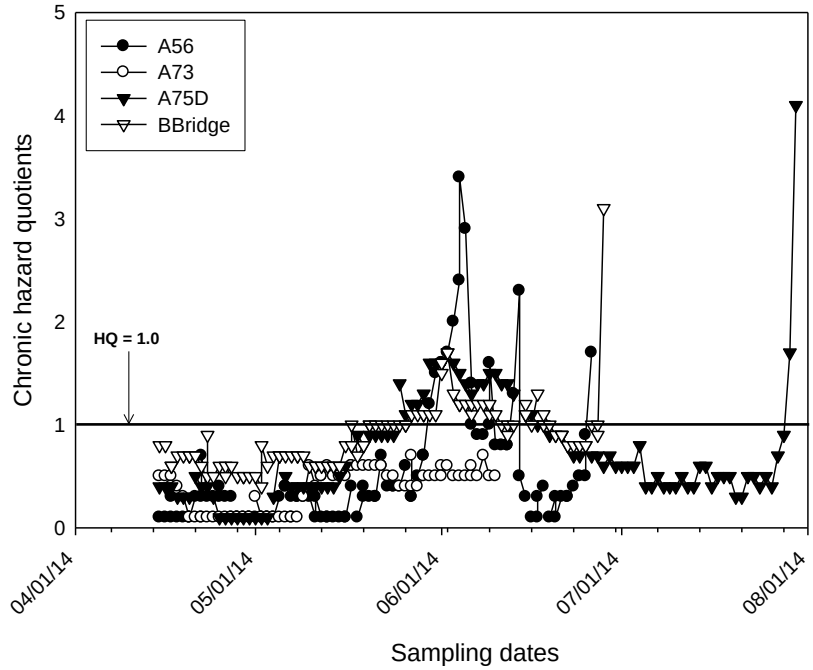


Figure 5.11b: Chronic HQs for dissolved Cd in surface water collected in 2014 from the Animas River using MiniSipper samplers at locations A56, A73, A75D and Bakers Bridge

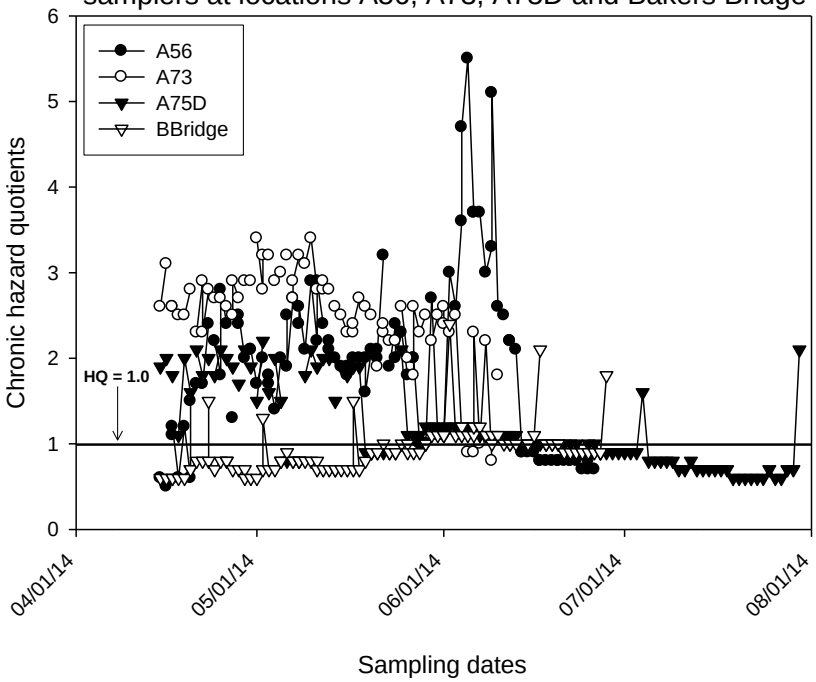


Figure 5.11 (cont'd): Scatter plots of dissolved metals chronic HQs in surface water samples collected using MiniSipper sampling devices in 2014

Figure 5.11c: Chronic HQs for dissolved Cu in surface water collected in 2014 from the Animas River using MiniSipper samplers at locations A56, A73, A75D and Bakers Bridge

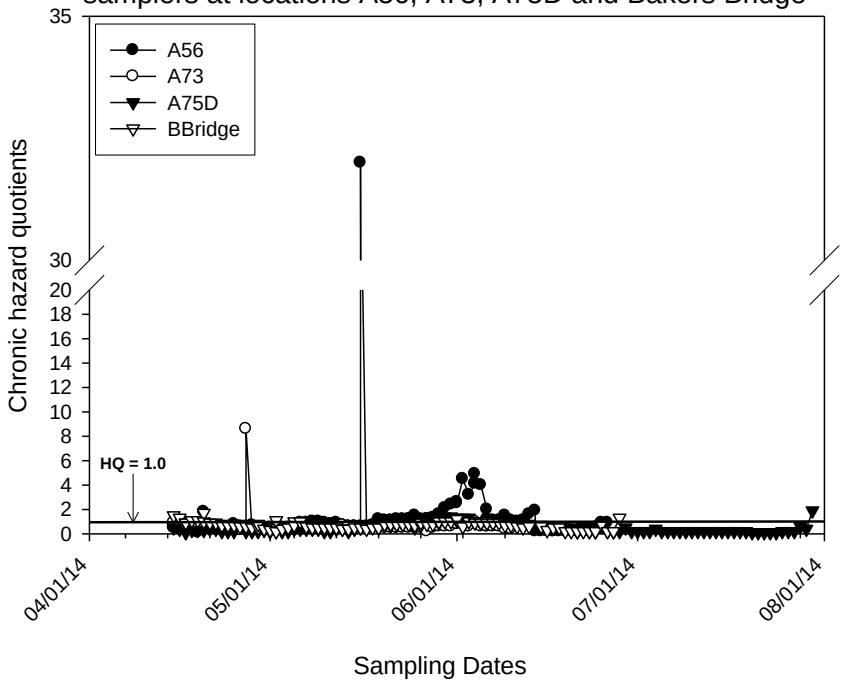


Figure 5.11d: Chronic HQs for dissolved Pb in surface water collected in 2014 from the Animas River using MiniSipper samplers at locations A56, A73, A75D and Bakers Bridge

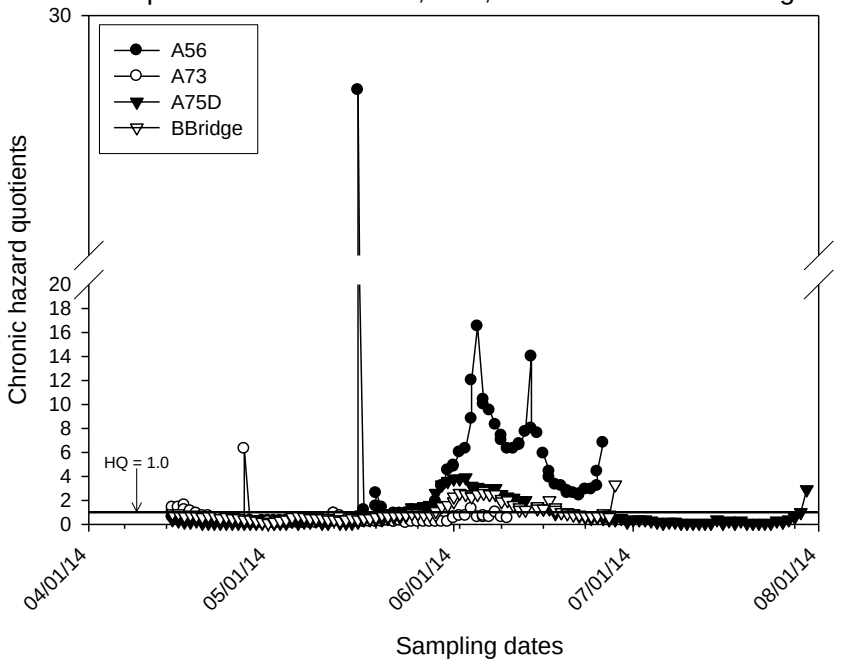


Figure 5.11 (cont'd): Scatter plots of dissolved metals chronic HQs in surface water samples collected using MiniSipper sampling devices in 2014

Figure 5.11e: Chronic HQs for dissolved Zn in surface water collected from the Animas River in 2014 using MiniSipper samplers at locations A56, A73, A75D and Bakers Bridge

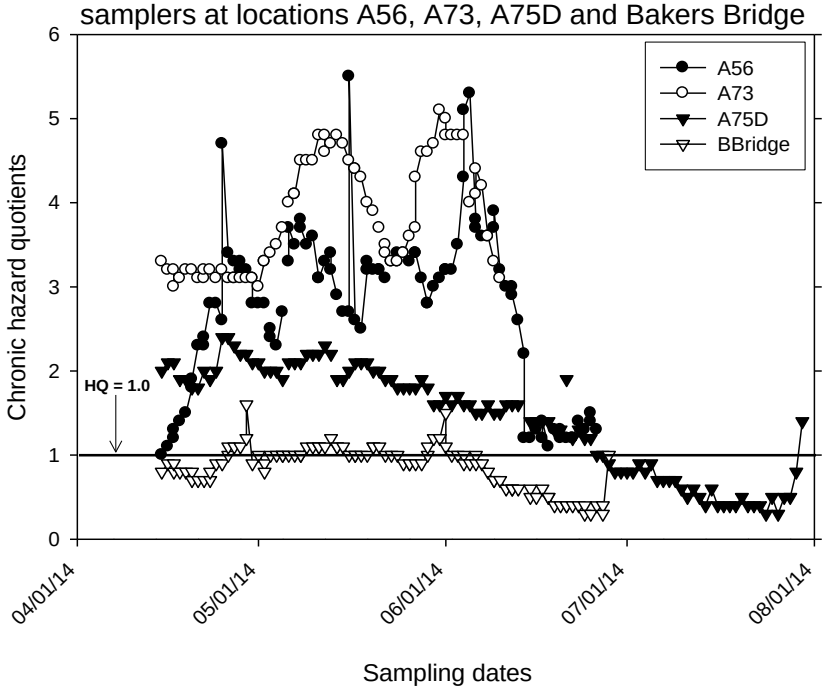


Figure 5.12: Trout densities over time at four locations on the Animas River

Figure 5.12.a: Brook trout densities (fish/mile) at four sampling locations on the Upper Animas River between 1992 and 2014

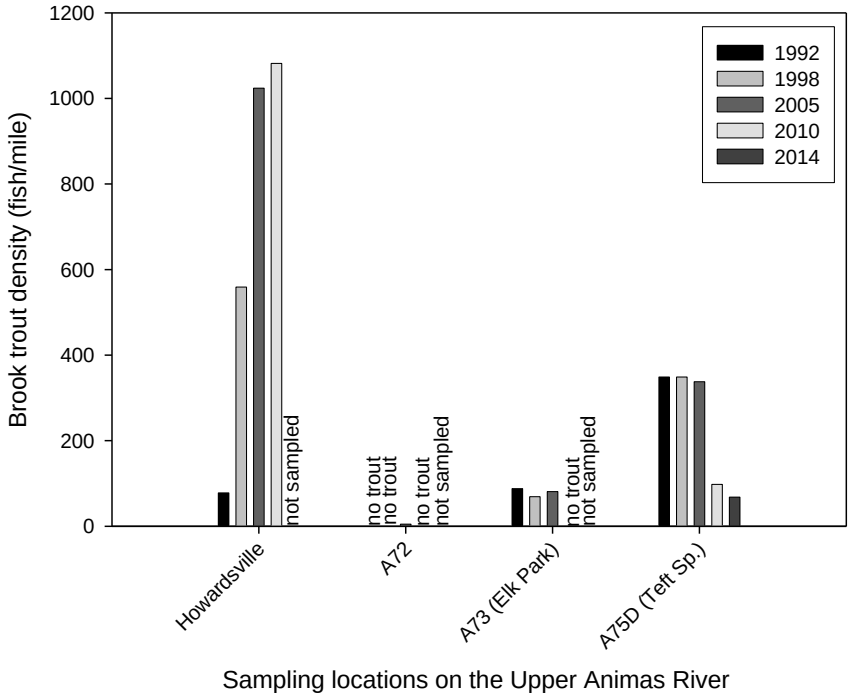


Figure 5.12.b: Rainbow trout densities (fish/mile) at four sampling locations on the Upper Animas River between 1992 and 2014

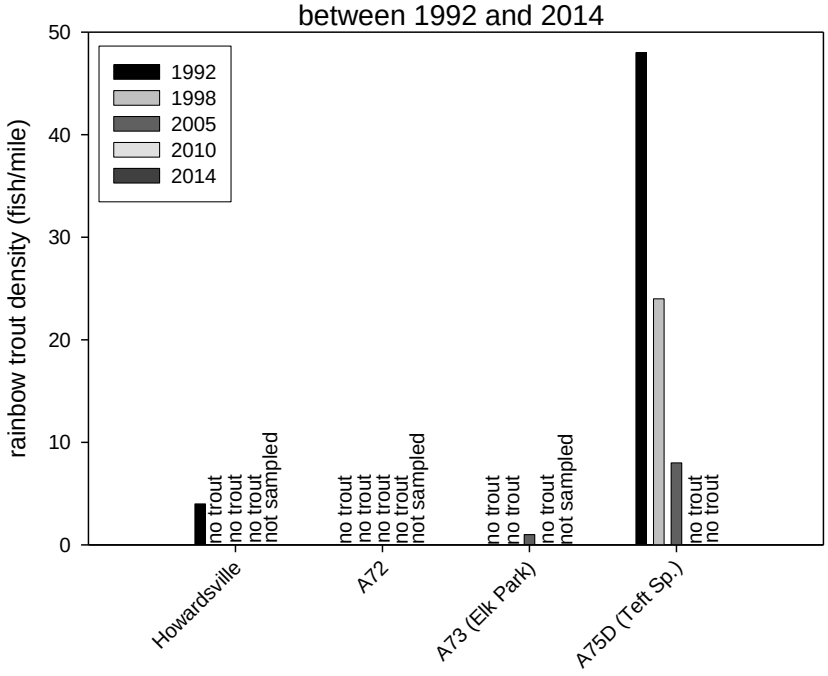


Figure 5.12 (cont'd): Trout densities over time at four locations on the Animas River

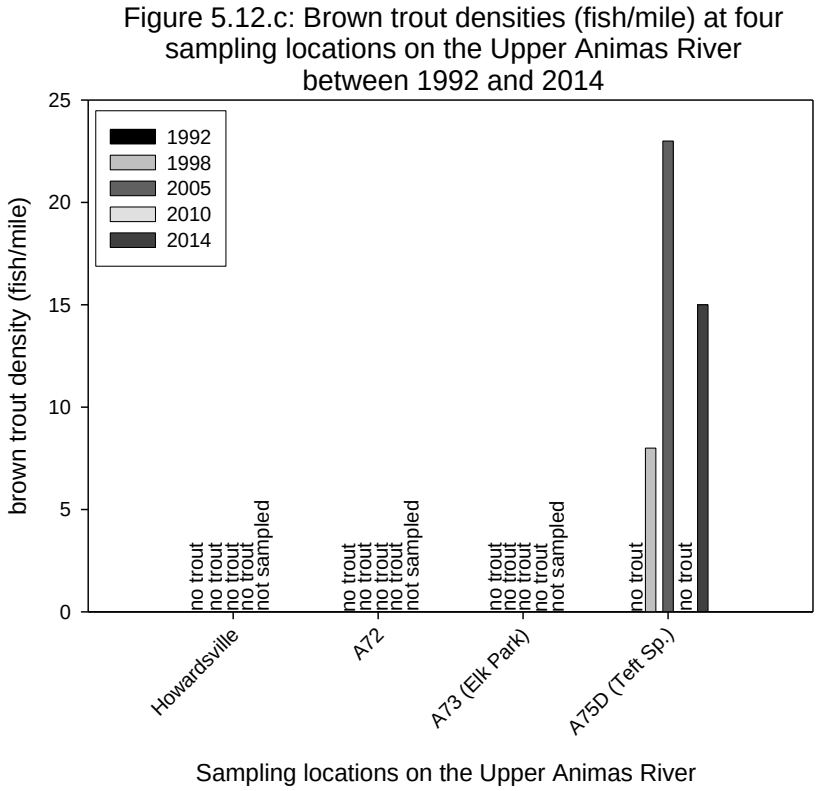


Figure 5.13: Geometric mean RME and CTE HQs for the four wildlife receptors evaluated using food chain modeling

Figure 5.13.a Geometric mean Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) Hazard Quotients (HQs) for the American dipper feeding in the Animas River above Cement Creek and below Mineral Creek

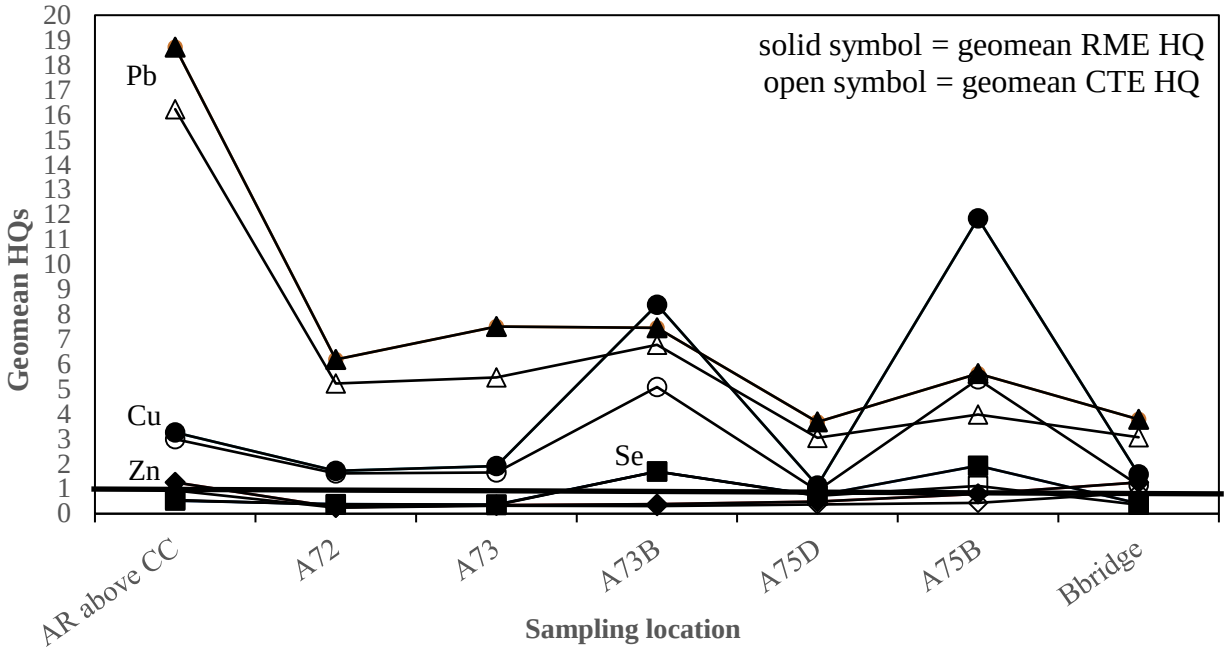


Figure 5.13.b Geometric mean Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) Hazard Quotients (HQs) for the belted kingfisher feeding in the Animas River above Cement Creek and below Mineral Creek

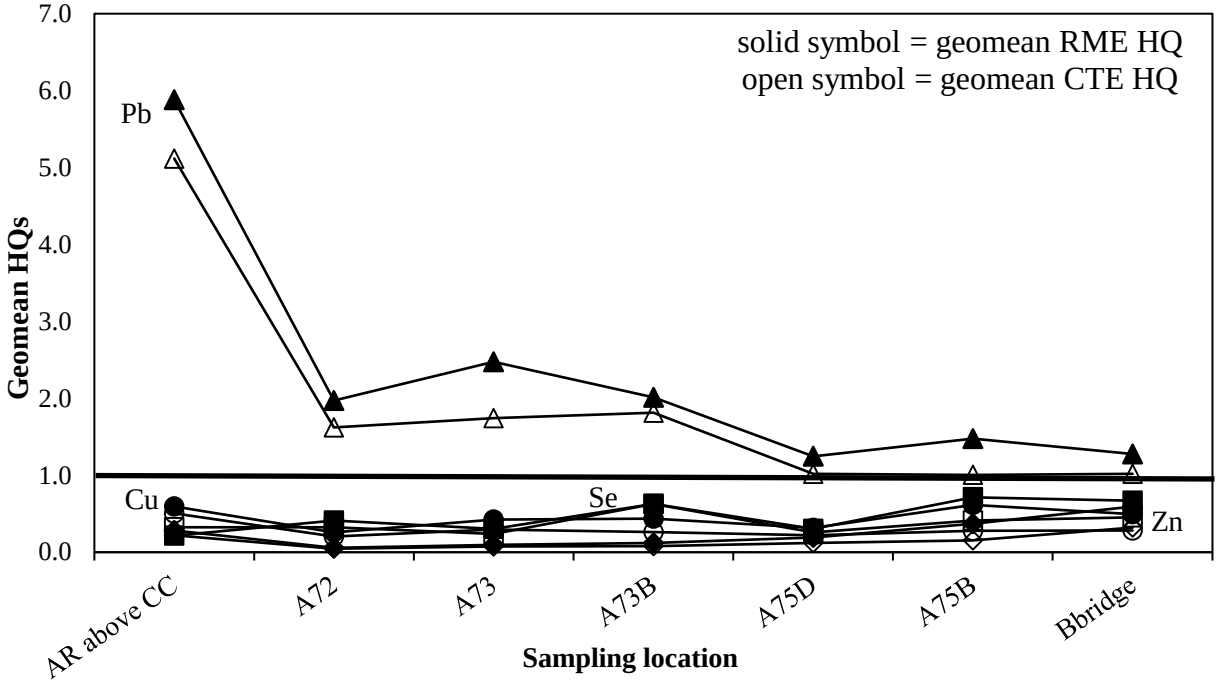


Figure 5.13 (cont'd): Geometric mean RME and CTE HQs for the four wildlife receptors evaluated using food chain modeling

Figure 5.13.c Geometric mean Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) Hazard Quotients (HQs) for the muskrat feeding in the Animas River above Cement Creek and below Mineral Creek

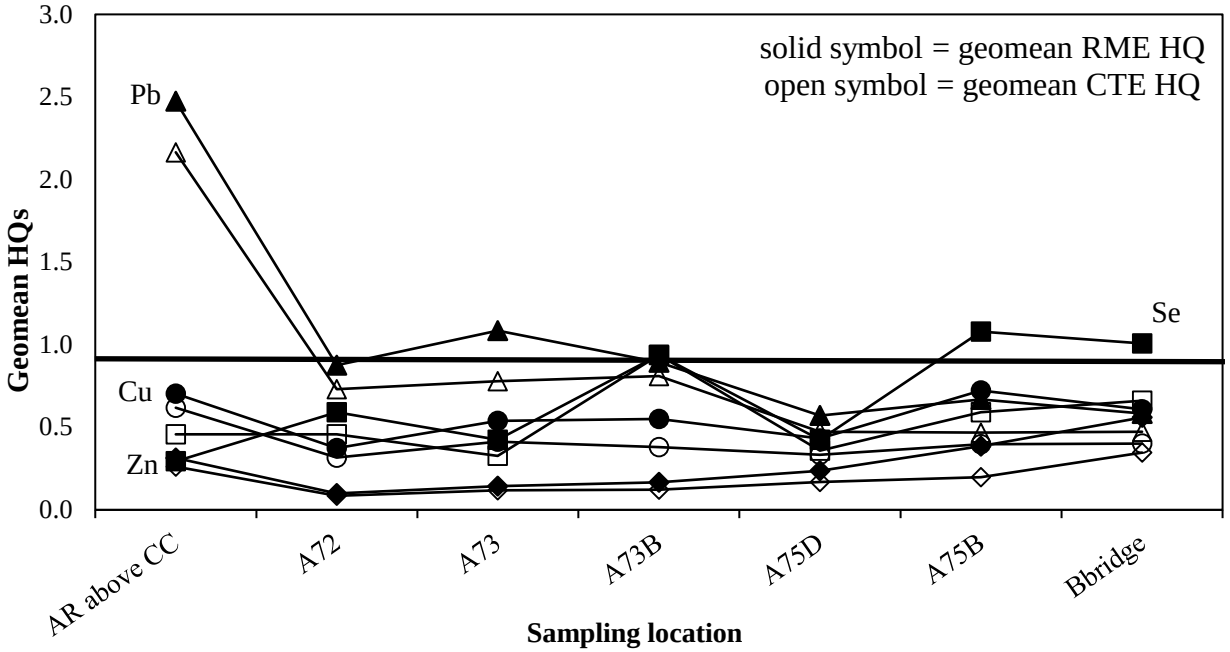


Figure 5.13.d Geometric mean Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) Hazard Quotients (HQs) for the mallard feeding on 100% benthic invertebrate diet in the Animas River above Cement Cr. and below Mineral Cr.

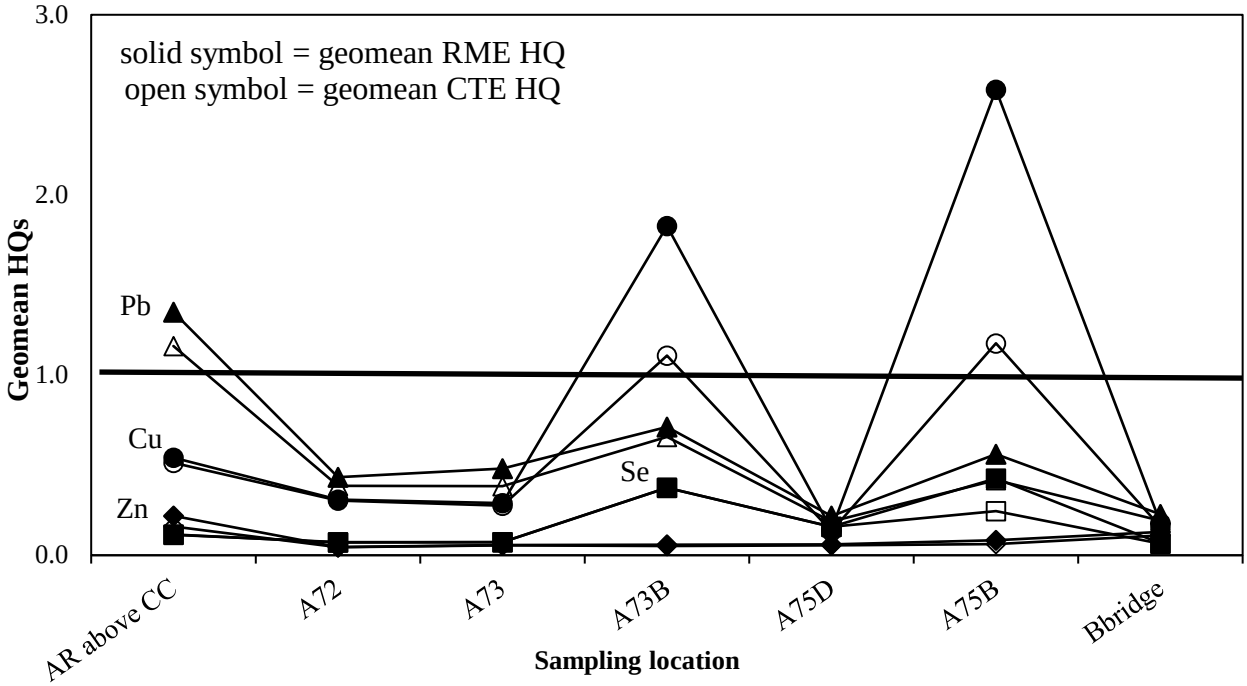
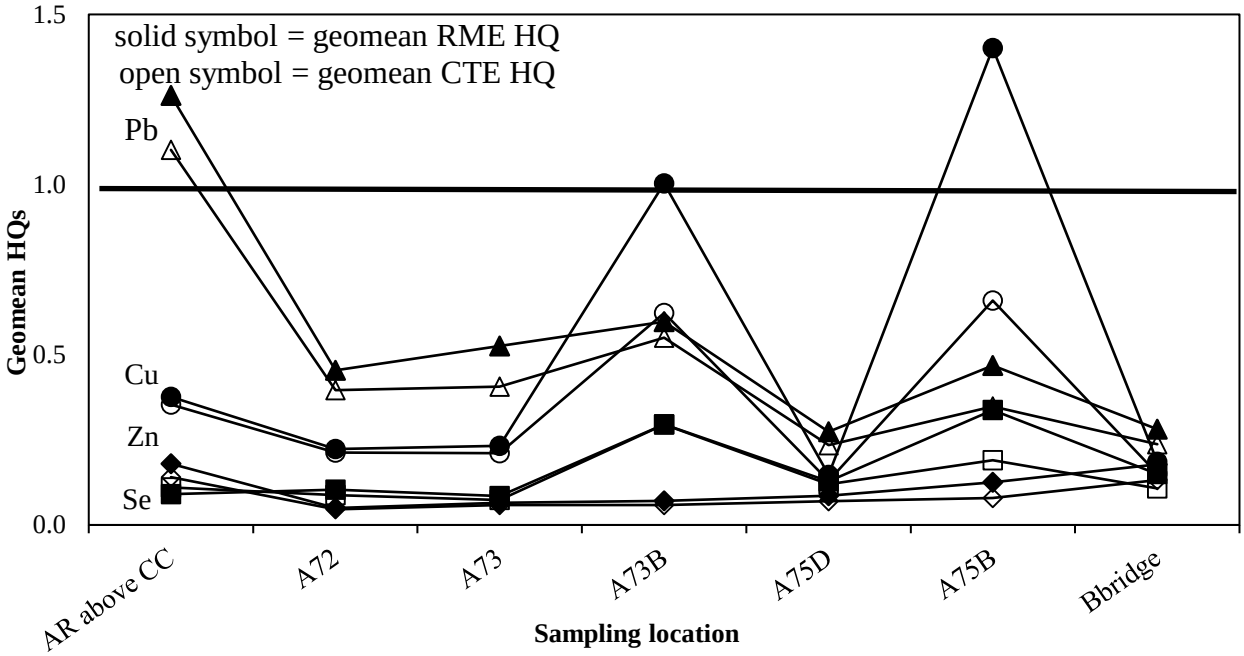


Figure 5.13 (cont'd): Geometric mean RME and CTE HQs for the four wildlife receptors evaluated using food chain modeling

Figure 5.13.e Geometric mean Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) Hazard Quotients (HQs) for the mallard (50%-50% diet) feeding in the Animas River above Cement Creek and below Mineral Creek



Tables

Table 2.1
Summary of the 2009-2014 surface water sampling efforts at select locations in the Upper Animas River, Cement Creek, and Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

		Animas River																		
		Above mainstem Cement Creek							Between Cement & Mineral Creeks		Below mainstem Mineral Creek							Mainstem Cement Creek		Mainstem Mineral Creek
	Sample Date	A56[a]	A60	A61	A64	A65	A66	A68	A69A	A70B	A71B	A72	A73	A73B	A75D	A75B	Bbridge	CC48	CC49	M34
pre-runoff period	Feb-10							√				√						√		√
	Mar-10							√				√						√		√
	Apr-10							√				√						√		√
	Mar-11							√				√						√		√
	Apr-14	√						√					√		√		√			
runoff period	May-09							√				√						√		√
	Jun-09							√				√						√		√
	Jun-10							√				√						√		√
	Jun-11							√				√						√		√
	May-12							√				√						√		√
	May-13	√	√	√	√	√	√	√				√	√	√	√	√	√	√		√
	May-14	√	√	√	√	√	√	√				√	√	√	√	√	√	√		√
post-runoff period	Jul-09							√				√						√		√
	Aug-09							√				√						√		√
	Sep-09							√				√						√		√
	Nov-09							√				√						√		√
	Jul-10							√				√						√		√
	Sep-10							√				√						√		√
	Nov-10							√				√						√		√
	Jul-11							√				√						√		√
	Aug-11							√				√						√		√
	Sep-11							√				√						√		√
	Oct-11							√				√						√		√
	Oct-12	√						√	√	√	√	√	√	√	√	√	√	√	√	√
	Sep-14	√	√	√	√	√	√	√				√	√	√	√	√	√	√		√

[a] "upstream" location

prepared by: SJP (2/3/15)
reviewed by: EC (3/12/15)

Table 2.2
Summary of the 2009-2014 sediment sampling efforts at select locations in the Upper Animas River, Cement Creek, and Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

		Animas River																		
		Above mainstem Cement Creek							Between Cement & Mineral Creeks		Below mainstem Mineral Creek							Mainstem Cement Creek		Mainstem Mineral Creek
	Sample Date	A56[a]	A60	A61	A64	A65	A66	A68	A69A	A70B	A71B	A72	A73	A73B	A75D	A75B	Bbridge	CC48	CC49	M34
pre-runoff period	Feb-10																			
	Mar-10																			
	Apr-10																			
	Mar-11																			
	Apr-14	√	√	√	√	√	√	√				√	√		√		√			
runoff period	May-09																			
	Jun-09																			
	Jun-10																			
	Jun-11																			
	May-12							√				√								
	May-13	√	√	√	√	√	√	√				√	√	√	√	√	√			
	Jun-14																			
post-runoff period	Jul-09																			
	Aug-09																			
	Sep-09																			
	Nov-09																			
	Jul-10																			
	Sep-10																			
	Nov-10																			
	Jul-11																			
	Aug-11																			
	Sep-11																			
	Oct-11																			
	Oct-12	√						√				√	√	√	√	√	√		√	√
	Sep-14	√	√	√	√	√	√	√				√	√	√	√	√	√			√

[a] "upstream" location

prepared by: SJP (2/3/15)
reviewed by: EC (3/12/15)

Table 2.3
Summary of the 2009-2014 sediment pore water sampling efforts at select locations in the Upper Animas River, Cement Creek, and Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

		Animas River																		
		Above mainstem Cement Creek							Between Cement & Mineral Creeks		Below mainstem Mineral Creek							Mainstem Cement Creek		Mainstem Mineral Creek
	Sample Date	A56[a]	A60	A61	A64	A65	A66	A68	A69A	A70B	A71B	A72	A73	A73B	A75D	A75B	Bbridge	CC48	CC49	M34
pre-runoff period	Feb-10																			
	Mar-10																			
	Apr-10																			
	Mar-11																			
	Apr-14	√	√	√	√	√	√	√				√	√		√		√			
runoff period	May-09																			
	Jun-09																			
	Jun-10																			
	Jun-11																			
	May-12																			
	May-13																			
	May-14																			
post-runoff period	Jul-09																			
	Aug-09																			
	Sep-09																			
	Nov-09																			
	Jul-10																			
	Sep-10																			
	Nov-10																			
	Jul-11																			
	Aug-11																			
	Sep-11																			
	Oct-11																			
	Oct-12																			
	Sep-14	√	√	√		√	√	√				√	√	√	√		√			√

[a] "upstream" location

prepared by: SJP (2/3/15)
reviewed by: EC (3/12/15)

Table 3.1
Surface water chronic benchmarks and sediment no effect and effect benchmarks
Baseline Ecological Risk Assessment
Upper Animas River Mining District

metals	surface water		sediment							
	chronic benchmarks (µg/L)		no effect benchmarks (mg/kg)				effect benchmarks (mg/kg)			
	CDPHE (2013)	Buchman (2008)	MacDonald *et al*. (2000)	Ingersoll *et al*. (1996)	Long *et al*. (1995)	Thompson *et al*., 2005	MacDonald *et al*. (2000)	Ingersoll *et al*. (1996)	Long *et al*. (1995)	Thompson *et al*., 2005
pH	6.5	--	--	--	--	--	--	--	--	--
Aluminum	87 or $e^{(1.3695[\ln(\text{hardness})]-0.1158)}$, depending on pH and hardness	87	--	26,000	--	--	--	60,000	--	--
Arsenic	150	190	9.8	11	8.2	9.3	33	48	70	56
Beryllium	NA	0.66	--	--	--	--	--	--	--	--
Cadmium	(1.101672-[ln(hardness) x(0.041838)] x $e^{0.7998[\ln(\text{hardness})]-4.4451}$ (trout)	0.25	0.99	0.58	1.2	--	4.98	3.2	9.6	--
Chromium	$e^{(0.819[\ln(\text{hardness})]+0.5340)}$	74	43.4	36	81	36.7	111	120	370	69.2
Copper	$e^{(0.8545[\ln(\text{hardness})]-1.7428)}$	9	31.6	28	34	12	149	100	270	200
Iron	1,000	1,000	--	190,000	--	--	--	250,000	--	--
Lead	(1.46203-[(ln(hardness) x (0.145712)]) x $e^{(1.273[\ln(\text{hardness})]-4.705)}$	3	35.8	37	46.7	27.7	128	82	218	380
Manganese	$e^{(0.3331[\ln(\text{hardness})]+5.8743)}$	80	--	630	--	--	--	1,200	--	--
Mercury	0.01	0.77	0.18	--	0.15	--	1.06	--	0.71	--
Nickel	$e^{(0.846[\ln(\text{hardness})]+0.0554)}$	52	22.7	20	20.9	21	48.6	33	51.6	170
Selenium	4.6	5.0 total	--	--	--	0.9	--	--	--	4.7
Silver	$e^{(1.72[\ln(\text{hardness})]-10.51)}$(trout)	0.36	--	--	1.0	--	--	--	3.7	--
Zinc	0.986 x $e^{(0.9094[\ln(\text{hardness})]+0.6235)}$	120	121	98	150	--	459	540	410	--

shading identifies the benchmarks retained for use in the BERA
NA = not available

Sources:

Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.
Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.
Ingersoll, C.G. *et al*. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. J. Great Lakes Res. 22:602-623.
Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
Thompson, P.A., J. Kurias, and S. Mihok. 2005. Derivation and use of sediment guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monit. Assess. 110:71-85.

prepared by: SJP (12/3/13)
reviewed by: EC (3/12/15)

Table 3.2
No-effect and effect TRVs for birds
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte*	No-effect TRVs		Effect TRVs	
	EcoSSL TRVs[a]	1996 toxicological benchmarks for wildlife[b]	Los Alamos National Laboratory[c]	1996 toxicological benchmarks for wildlife[b]
Arsenic	2.24	5.14	22.4	12.8
Cadmium	1.47	1.45	14.7	20
Chromium III	2.66	1.0	26.6	5.0
Copper	4.05	47	12.1	61.7
Lead	1.63	1.13	3.26	11.3
Mercury (inorganic)	--	0.45	--	0.9
Nickel	6.71	77.4	67.1	107
Selenium	0.29	0.5	0.579	1.0
Silver	2.02	--	20.2	--
Zinc	66.1	14.5	661	131

* Only those analytes identified as "important bioaccumulatice compounds" in Table 4-2 of EPA (2000) are included in this table.

Footnotes:

All units are mg/kg bw-day

Shading identifies the TRVs selected for use in the BERA

[a] EPA EcoSSL reports (http://www.epa.gov/ecotox/ecossl), as follows:

EPA, 2005a. Ecological soil screening levels for **arsenic**. Interim final. OSWER Directive 9285.7-62.

EPA, 2005b. Ecological soil screening levels for **cadmium**. Interim final. OSWER Directive 9285.7-65.

EPA, 2008. Ecological soil screening levels for **chromium**. Interim final. OSWER Directive 9285.7-66.

EPA, 2007a. Ecological soil screening levels for **copper**. Interim final. OSWER Directive 9285.7-68.

EPA, 2005c. Ecological soil screening levels for **lead**. Interim final. OSWER Directive 9285.7-70.

EPA, 2007b. Ecological soil screening levels for **nickel**. Interim final. OSWER Directive 9285.7-76.

EPA, 2007c. Ecological soil screening levels for **selenium**. Interim final. OSWER Directive 9285.7-72.

EPA, 2006. Ecological soil screening levels for **silver**. Interim final. OSWER Directive 9285.7-77.

EPA, 2007d. Ecological soil screening levels for **zinc**. Interim final. OSWER Directive 9285.7-73.

[b] Sample *et al.* , 1996, Toxicological Benchmarks for Wildlife: 1996 Revision, ES/ER/TM-86/R3, http://www.esd.ornl.gov/programs/ecorisk/documents/tm86r3.pdf (values are the toxicities measured in the test species)

[c] Los Alamos National Laboratory. 2016. Ecological screening levels. ECORISK Database. Available at: https://lanl.gov/environment/protection/eco-risk-assessment.php

-- not available

EcoSSL – ecological soil screening level

TRV – toxicity reference value

prepared by: SJP (12/4/13)

reviewed by: EC (3/12/15)

Table 3.3
No-effect and effect TRVs for mammals
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte*	No-effect TRVs		Effect TRVs	
	EcoSSL TRVs[a]	1996 toxicological benchmarks for wildlife[b]	Los Alamos National Laboratory[c]	1996 toxicological benchmarks for wildlife[b]
Arsenic	1.04	0.126	1.66	1.26
Cadmium	0.77	1.0	7.7	10.0
Chromium III	2.4	2737[d]	24	--
Copper	5.6	11.7	9.34	15.4
Lead	4.7	8.0	9	80
Mercury (inorganic)	--	1.0	14.1	--
Nickel	1.7	40	3.4	80
Selenium	0.14	0.2	0.214	0.33
Silver	6.02	--	60.2	--
Zinc	75.4	160	754	320

* Only those analytes identified as "important bioaccumulatice compounds" in Table 4-2 of EPA (2000) are included in this attachment.

Footnotes:

All units are in mg/kg bw-day

Shading identifies TRVs selected for use in the BERA

[a] USEPA EcoSSL reports (http://www.epa.gov/ecotox/ecossl), as follows:

EPA, 2005a. Ecological soil screening levels for **arsenic**. Interim final. OSWER Directive 9285.7-62.

EPA, 2005b. Ecological soil screening levels for **cadmium**. Interim final. OSWER Directive 9285.7-65.

EPA, 2008. Ecological soil screening levels for **chromium**. Interim final. OSWER Directive 9285.7-66.

EPA, 2007a. Ecological soil screening levels for **copper**. Interim final. OSWER Directive 9285.7-68.

EPA, 2005c. Ecological soil screening levels for **lead**. Interim final. OSWER Directive 9285.7-70.

EPA, 2007b. Ecological soil screening levels for **nickel**. Interim final. OSWER Directive 9285.7-76.

EPA, 2007c. Ecological soil screening levels for **selenium**. Interim final. OSWER Directive 9285.7-72.

EPA, 2006. Ecological soil screening levels for **silver**. Interim final. OSWER Directive 9285.7-77.

EPA, 2007d. Ecological soil screening levels for **zinc**. Interim final. OSWER Directive 9285.7-73.

[b] Sample *et al* ., 1996, Toxicological Benchmarks for Wildlife: 1996 Revision, ES/ER/TM-86/R3, http://www.esd.ornl.gov/programs/ecorisk/documents/tm86r3.pdf (values are the toxicities measured in the test species)

[c] Los Alamos National Laboratory. 2016. Ecological screening levels. ECORISK Database. Available at: https://lanl.gov/environment/protection/eco-risk-assessment.php

[d] The no effect TRV for CrIII is as reported in the reference

-- not available

EcoSSL – ecological soil screening level

TRV – toxicity reference value

prepared by: SJP (12/4/13)

reviewed by: EC (3/12/15)

Table 3.4
Selection of surface water COPECs for community-level receptors in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Compound	Frequency of Detection	Minimum Detect (µg/L)	Flag	Maximum Detect (µg/L)[a]	Flag	Location of Maximum Detect[*]	Conc. used for Screening[b]	Benchmark (ug/L)[c,**]	Hardness (mg/L)[d]	Hardness-Adjusted Benchmark (ug/L)[e]	Bench-mark Source	Hazard Quotient[f]	COPEC?	Reason Code
pH	24/24	4.97		7.30		M34	4.97	6.50	--	--	1	**>1[g]**	**yes**	a
Aluminum	24/24	563		5950		M34	5950	87	--	--	1	**68.4**	**yes**	a
Arsenic	0/24	--		2.0	U	M34	2.0	150	--	--	1	<1	no	b
Beryllium	0/24	--		5.0	U	M34	5.0	0.66	--	--	2	**7.6**	**yes**	a
Cadmium	22/24	0.2		2.0		M34	2.0	--	150	0.58	1	**3.4**	**yes**	a
Chromium	0/24	--		2.5	U	M34	2.5	--	49	41	1	<1	no	b
Copper	12/24	1.5		16.2		M34	12.3	--	150	13.0	1	<1	no	a
Iron	24/24	754		8290		M34	8290	1,000	--	--	1	**8.3**	**yes**	a
Lead	6/24	0.1	J	4.2		M34	4.2	--	247	6.6	1	<1	no	b
Manganese	24/24	84.9		634		M34	592	--	238	2202	1	<1	no	b
Nickel	8/24	0.5	J	5.3		M34	2.0	--	49	28	1	<1	no	b
Selenium	0/24	--		1.3	U	M34	1.3	4.6	--	--	1	<1	no	b
Silver	2/24	0.5		0.6		M34	0.6	--	309	0.520	1	**1.2**	**yes**	a
Zinc	23/24	48.1		499		M34	499	--	150	175	1	**2.8**	**yes**	a

Notes:
Dissolved analytical data were used for all metals except aluminum and iron where total metals data were used.

[*] For pH, the location shown is the one with the lowest-measured pH

[**] The pH benchmark is unitless

[a] These values represent the maximum detected concentrations, or half the maximum detection limit for a non-detected analyte (except for pH which represents the lowest reported value) measured between May 2009 and September 2014 in mainstem Mineral Creek.

[b] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the maximum concentration

[c] These benchmarks are not sensitive to surface water hardness

[d] This hardness was associated with the detected analyte concentration that resulted in the highest HQ measured between May 2009 and September 2014 in mainstem Mineral Creek

[e] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[f] the hazard quotient is calculated by dividing a screening concentration by its benchmark

[g] pH values are logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:
a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark
b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:
1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.
2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration,

Table 3.5
Selection of surface water COPECs for community-level receptors in mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Compound	Frequency of Detection	Minimum Detect (µg/L)	Flag	Maximum Detect (µg/L)[a]	Flag	Location of Maximum Detect[*]	Conc. used for Screening[b]	Benchmark (ug/L)[c,**]	Hardness (mg/L)[d]	Hardness-Adjusted Benchmark (ug/L)[e]	Bench-mark Source	Hazard Quotient[f]	COPEC?	Reason Code
pH	25/25	3.24		5.40		CC48	3.24	6.50	--	--	1	**>1**[g]	**yes**	a
Aluminum	25/25	1610		8610		CC48	8610	87	--	--	1	**99.0**	**yes**	a
Arsenic	0/25	--		2.0	U	CC48	2.0	150	--	--	1	<1	no	b
Beryllium	9/25	1.1		1.3		CC48	1.3	0.66	--	--	2	**2.0**	**yes**	a
Cadmium	25/25	2.0		7.00		CC48	5.1	--	67	0.31	1	**16.4**	**yes**	a
Chromium	0/25	--		5.0	U	CC48	2.5	--	67	53	1	<1	no	b
Copper	25/25	55.6		221		CC48	65.3	--	67	6.4	1	**10.3**	**yes**	a
Iron	25/25	3610		21700		CC48	21700	1000	--	--	1	**21.7**	**yes**	a
Lead	25/25	4.2		21.4		CC48	14.2	--	67	1.6	1	**8.9**	**yes**	a
Manganese	25/25	710		5300		CC49	5270	--	495	2618[h]	1	**2.0**	**yes**	a
Nickel	22/25	2.2		19.4		CC48	5.9	--	67	37	1	<1	no	b
Selenium	1/25	3.2	J	3.2	J	CC48	3.2	4.6	--	--	1	<1	no	b
Silver	0/25	--		2.5	U	CC48	1.25	--	67	0.04	1	**31.3**	**yes**	a
Zinc	25/25	394		2890		CC48	1310	--	126	150	1	**8.7**	**yes**	a

Notes:
Dissolved analytical data were used for all metals except aluminum and iron where total metals data were used.

[*] For pH, the location shown is the one with the lowest-measured pH

[**] The pH benchmark is unitless

[a] These values represent the maximum detected concentrations, or half the maximum detection limit for a non-detected analyte (except for pH which represents the lowest reported value) measured between May 2009 and September 2014 in mainstem Cement Creek.

[b] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the maximum concentration

[c] These benchmarks are not sensitive to surface water hardness

[d] This hardness was associated with the detected analyte concentration that resulted in the highest HQ measured between May 2009 and September 2014 in mainstem Cement Creek

[e] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[f] The hazard quotient is calculated by dividing a screening concentration by its benchmark

[g] pH values are logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

[h] Sample hardness was greater than the 400 mg/L limit for use in deriving hardness-based criteria. Therefore, the hardness-based benchmark was derived using a hardness value of 400 mg/L

Reason codes:
a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark
b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:
1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.
2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration,

Table 3.6
Selection of SW COPECs for community-level receptors in the Animas River above Mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Compound	Frequency of Detection	Minimum Detect (µg/L)	Flag	Maximum Detect (µg/L)[a]	Flag	Location of Maximum Detect[*]	Conc. used for Screening[b]	Benchmark (ug/L)[c,**]	Hardness (mg/L)[d]	Hardness-Adjusted Benchmark (ug/L)[e]	Bench-mark Source	Hazard Quotient[f]	COPEC?	Reason Code
pH	39/39	6.26		7.71		A68	6.26	6.50	--	--	1	<1[g]	no	b
Aluminum	35/40	101		1010		A68	1010	--	49	184	1	**5.5**	**yes**	a
Arsenic	0/40	--		2.0	U	multiple	2.0	150	--	--	1	<1	no	b
Beryllium	0/40	--		1.0	U	multiple	1.0	0.66	--	--	2	**1.5**	**yes**	a
Cadmium	40/40	0.7		4.1		A68	4.1	--	148	0.57	1	**7.2**	**yes**	a
Chromium	0/40	--		2.5	U	A68	2.5	--	50	42	1	<1	no	b
Copper	24/40	2.7		16.5		A61	16.5	--	80	7.4	1	**2.2**	**yes**	a
Iron	31/40	111	J	1100		A68	1100	1000	--	--	1	**1.1**	**yes**	a
Lead	20/40	0.1	J	1.5		A66	1.5	--	64	1.5	1	**1.0**	**yes**	a
Manganese	40/40	153		3730		A68	3730	--	148	1880	1	**2.0**	**yes**	a
Nickel	0/40	--		2.0	U	A68	2.0	--	50	29	1	<1	no	b
Selenium	0/40	--		0.5	U	multiple	0.5	4.6	--	--	1	<1	no	b
Silver	0/40	--		0.25	U	multiple	0.25	--	49	0.02	1	**11.4**	**yes**	a
Zinc	40/40	237		1030		A68	1030		151	176	1	**5.8**	**yes**	a

Notes:
Dissolved analytical data were used for all metals except aluminum and iron where total metals data were used.

[*] For pH, the location shown is the one with the lowest-measured pH

[**] The pH benchmark is unitless

[a] These values represent the maximum detected concentrations, or half the maximum detection limit for a non-detected analyte (except for pH which represents the lowest reported value) measured between May 2009 and September 2014 in the Animas River above mainstem Cement Creek

[b] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the maximum concentration

[c] These benchmarks are not sensitive to surface water hardness

[d] This hardness was associated with the analyte concentration that resulted in the highest HQ measured between May 2009 and September 2014 in the Animas River above mainstem Cement Creek

[e] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[f] The hazard quotient is calculated by dividing a screening concentration by its benchmark

[g] pH values are logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:
a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark
b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:
1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.
2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration,

prepared by: SJP (1/27/14) reviewed by: RI (2/10/14)
updated by: BB (2/17/15) reviewed by: EC (2/18/15)

Table 3.7
Selection of surface water COPECs for community-level receptors in the Animas River between mainstem Cement Creek and mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Compound	Frequency of Detection	Minimum Detect (µg/L)	Flag	Maximum Detect (µg/L)[a]	Flag	Location of Maximum Detect[*]	Conc. used for Screening[b]	Benchmark (ug/L)[c,**]	Hardness (mg/L)[d]	Hardness-Adjusted Benchmark (ug/L)[e]	Bench-mark Source	Hazard Quotient[f]	COPEC?	Reason Code
pH	2/2	5.54		6.05		A69A	5.54	6.50	--	--	1	**>1**[g]	**yes**	a
Aluminum	2/2	2460	D	2520	D	A69A	2520	87	--	--	1	**29.0**	**yes**	a
Arsenic	0/2	--		0.25	U	multiple	0.25	150	--	--	1	<1	no	b
Beryllium	0/2	--		1.0	U	multiple	1.0	0.66	--	--	2	**1.5**	**yes**	a
Cadmium	2/2	2.7		2.7		multiple	2.7	--	295	0.95	1	**2.8**	**yes**	a
Chromium	0/2	--		0.5	U	multiple	0.5	--	295	180	1	<1	no	b
Copper	2/2	16.3		24.8		A70B	24.8	--	295	23.0	1	**1.1**	**yes**	a
Iron	2/2	4890	D	5100	D	A69A	5100	1000	--	--	1	**5.1**	**yes**	a
Lead	2/2	0.2	J	3.0		A70B	3.0	--	295	8.0	1	<1	no	b
Manganese	2/2	2540		2590		A69A	2540	--	295	2365	1	**1.1**	**yes**	a
Nickel	2/2	4.8		5.2		A70B	5.2		295	130	1	<1	no	b
Selenium	0/2	--		0.25	U	multiple	0.25	4.6	--	--	1	<1	no	b
Silver	0/2	--		0.25	U	multiple	0.25	--	295	0.48	1	<1	no	b
Zinc	2/2	1160		1160		multiple	1160	--	295	324	1	**3.6**	**yes**	a

Notes:
Dissolved analytical data were used for all metals except aluminum and iron where total metals data were used.

[*] For pH, the location shown is the one with the lowest-measured pH

[**] The pH benchmark is unitless

[a] These values represent the maximum detected concentrations, or half the maximum detection limit for a non-detected analyte (except for pH which represents the lowest reported value) measured between May 2009 and September 2014 in the Animas River between mainstem Cement Creek and mainstem Mineral Creek

[b] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the maximum concentration

[c] These benchmarks are not sensitive to surface water hardness

[d] This hardness was associated with the analyte concentration that resulted in the highest HQ measured between May 2009 and September 2014 in the Animas River between mainstem Cement Creek and mainstem Mineral Creek

[e] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[f] The hazard quotient is calculated by dividing a screening concentration by its benchmark

[g] pH values are logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:
a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark
b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:
1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.
2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration,

Table 3.8
Selection of surface water COPECs for community-level receptors in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Compound	Frequency of Detection	Minimum Detect (µg/L)	Flag	Maximum Detect (µg/L)[a]	Flag	Location of Maximum Detect[*]	Conc. used for Screening[b]	Benchmark (ug/L)[c,**]	Hardness (mg/L)[d]	Hardness-Adjusted Benchmark (ug/L)[e]	Bench-mark Source	Hazard Quotient[f]	COPEC?	Reason Code
pH	45/45	5.04		7.64		A72	5.04	6.50	--	--	1	**>1[g]**	**yes**	a
Aluminum	48/48	234	JD	4440		A72	4440	87	--	--	1	**51.0**	**yes**	a
Arsenic	0/48	--		2.0	U	multiple	2.0	150	--	--	1	<1	no	b
Beryllium	0/48	--		1.0	U	multiple	1.0	0.66	--	--	2	**1.5**	**yes**	a
Cadmium	48/48	0.3		2.9		A72	2.9	--	177	0.65	1	**4.5**	**yes**	a
Chromium	1/48	2.3		2.3		A72	2.3	--	261	163	1	<1	no	b
Copper	40/48	0.6	J	36.9		A72	36.9	--	296	23.0	1	**1.6**	**yes**	a
Iron	47/48	317		7710		A72	7710	1000	--	--	1	**7.7**	**yes**	a
Lead	16/48	0.1	J	2.7		A72	0.8	--	60	1.4	1	<1	no	b
Manganese	48/48	109		2920		A72	2920	--	337	2472	1	**1.2**	**yes**	a
Nickel	29/48	0.5	J	8.2		A72	1.4	--	37	22	1	<1	no	b
Selenium	0/48	--		1.25	U	multiple	1.30	4.6	--	--	1	<1	no	b
Silver	0/48	--		1.25	U	multiple	1.25		71	0.04	1	**31.3**	**yes**	a
Zinc	48/48	66.5		1230		A72	864	--	177	204	1	**4.2**	**yes**	a

Notes:
Dissolved analytical data were used for all metals except aluminum and iron where total metals data were used.

[*] For pH, the location shown is the one with the lowest-measured pH

[**] The pH benchmark is unitless

[a] These values represent the maximum detected concentrations, or half the maximum detection limit for a non-detected analyte (except for pH which represents the lowest reported value) measured between May 2009 and September 2014 in the Animas River below mainstem Mineral Creek

[b] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the maximum concentration

[c] These benchmarks are not sensitive to surface water hardness

[d] This hardness was associated with the analyte concentration that resulted in the highest HQ measured between May 2009 and September 2014 in the Animas River below mainstem Mineral Creek

[e] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[f] The hazard quotient is calculated by dividing a screening concentration by its benchmark

[g] pH values are logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:
a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark
b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:
1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.
2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34

prepared by: SJP (1/27/14) reviewed by: RI (2/10/14)
updated by: BB (2/17/15) reviewed by: EC (2/18/15)

Table 3.9
Summary of the surface water COPECs for community-level receptors
Baseline Ecological Risk Assessment
Upper Animas River District

Analyte	mainstem Mineral Creek	mainstem Cement Creek	Animas River above mainstem Cement Creek	Animas River between mainstem Cement and Mineral Creeks	Animas River below mainstem Mineral Creek
pH	√	√		√	√
Aluminum	√	√	√	√	√
Arsenic					
Beryllium	(√)	√	(√)	(√)	(√)
Cadmium	√	√	√	√	√
Chromium					
Copper		√	√	√	√
Iron	√	√	√	√	√
Lead		√	√		
Manganese		√	√	√	√
Nickel					
Selenium					
Silver	√	(√)	(√)		(√)
Zinc	√	√	√	√	√

(√) = analyte was not detected but was retained as a COPEC because 1/2 the max detection limit exceeded the benchmark

prepared by: SJP (1/31/14)
checked by: RI (2/10/14)
updated by: BB (2/17/15)
reviewed by: EC (2/18/15)

Table 3.10
Selection of sediment COPECS for the benthic invertebrate community in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	Frequency of Detection	Minimum Detect (mg/kg)	Flag	Max Detect or 1/2 Max DL (mg/kg)	Flag	Location of Maximum	Conc. used for Screening	Benchmark (mg/kg)	Bench-mark Source	Hazard Quotient[a]	COPEC?	Reason Code
Aluminum	2 / 2	22,400	D	29,100	D	M34	29,100	26,000	2	**1.1**	**yes**	a
Arsenic	2 / 2	21.1	D	32.7	D	M34	32.7	9.8	1	**3.3**	**yes**	a
Beryllium	0 / 2	--		2.0	U	M34	2.0	NA	--	--	**yes**	c
Cadmium	2 / 2	0.9	D	1.9	D	M34	1.9	0.99	1	**1.9**	**yes**	a
Chromium	2 / 2	2.8	D	3.4	D	M34	3.4	43.4	1	<1	no	b
Copper	2 / 2	53.8	D	127	D	M34	127	31.6	1	**4.0**	**yes**	a
Iron	2 / 2	46,500	D	89,000	D	M34	89,000	190,000	2	<1	no	b
Lead	2 / 2	129	D	237	D	M34	237	35.8	1	**6.6**	**yes**	a
Manganese	2 / 2	1,160	D	1,430	D	M34	1,430	630	2	**2.3**	**yes**	a
Mercury	2 / 2	0.02	D	0.05	D	M34	0.05	0.18	1	<1	no	b
Nickel	2 / 2	4.6	D	5.9	BD	M34	5.9	22.7	1	<1	no	b
Selenium	1 / 2	1.7	D	1.7	D	M34	1.7	0.9	4	**1.9**	**yes**	a
Silver	2 / 2	0.7	D	0.9	JD	M34	0.9	1.0	3	<1	no	b
Zinc	2 / 2	270	D	666	D	M34	666	121	1	**5.5**	**yes**	a

[a] the hazard quotient is calculated by dividing a maximum concentration by its sediment screening benchmark
D = sample was diluted before analysis
U = not detected

COPEC = contaminant of potential ecological concern
DL = detection limit

Reason codes:
a = the maximum concentration exceeds the sediment screening benchmark
b = the maximum concentration falls below the sediment screening benchmark
c = a benchmark is not available

Benchmark sources:

1. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

2. Ingersoll, C.G. *et al* . 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius* . J. Great Lakes Res. 22:602-623.
3. Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
4. Thompson, P.A., J. Kurias, and S. Mihok. 2005. Derivation and use of sediment guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monit. Assess. 110:71-85.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
revised by: BB (2/10/15)
reviewed by: ES (2/11/15)

Table 3.11
Selection of sediment COPECS for the benthic invertebrate community in mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	Frequency of Detection	Minimum Detect (mg/kg)	Flag	Max Detect or 1/2 Max DL (mg/kg)	Flag	Location of Maximum	Conc. used for Screening	Benchmark (mg/kg)	Bench-mark Source	Hazard Quotient[a]	COPEC?	Reason Code
Aluminum	1 / 1	5310	D	5,310	D	CC49	5,310	26,000	2	<1	no	b
Arsenic	1 / 1	40.6	D	40.6	D	CC49	40.6	9.8	1	**4.1**	**yes**	a
Beryllium	0 / 1	--		1.0	U	CC49	1.0	NA	--	--	**yes**	c
Cadmium	1 / 1	0.6	D	0.6	D	CC49	0.6	0.99	1	<1	no	b
Chromium	1 / 1	4.6	D	4.6	D	CC49	4.6	43.4	1	<1	no	b
Copper	1 / 1	55.6	D	55.6	D	CC49	55.6	31.6	1	**1.8**	**yes**	a
Iron	1 / 1	143,000	D	143,000	D	CC49	143,000	190,000	2	<1	no	b
Lead	1 / 1	282	D	282	D	CC49	282	35.8	1	**7.9**	**yes**	a
Manganese	1 / 1	478	D	478	D	CC49	478	630	2	<1	no	b
Mercury	1 / 1	0.06	D	0.06	D	CC49	0.06	0.18	1	<1	no	b
Nickel	1 / 1	2.9	D	2.9	D	CC49	2.9	22.7	1	<1	no	b
Selenium	1 / 1	0.7	JD	0.7	JD	CC49	0.7	0.9	4	<1	no	b
Silver	1 / 1	2.0	D	2.0	D	CC49	2.0	1.0	3	**2.0**	**yes**	a
Zinc	1 / 1	195	D	195	D	CC49	195	121	1	**1.6**	**yes**	a

[a] the hazard quotient is calculated by dividing a maximum concentration by its sediment screening benchmark
J = estimated concentration
D = sample was diluted before analysis
U = not detected

COPEC = contaminant of potential ecological concern
DL = detection limit

Reason codes:
a = the maximum concentration exceeds the sediment screening benchmark
b = the maximum concentration falls below the sediment screening benchmark
c = a benchmark is not available
DL = detection limit

Benchmark sources:

1. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

2. Ingersoll, C.G. *et al* . 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius* . J. Great Lakes Res. 22:602-623.

3. Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

4. Thompson, P.A., J. Kurias, and S. Mihok. 2005. Derivation and use of sediment guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monit. Assess. 110:71-85.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
revised by: BB (2/10/15)
reviewed by: ES (2/11/15)

Table 3.12
Selection of sediment COPECs for the benthic invertebrate community in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Analyte	Frequency of Detection	Minimum Detect (mg/kg)	Flag	Maximum Detect (mg/kg)	Flag	Location of Maximum Detect	Conc. used for Screening	Benchmark (mg/kg)	Bench-mark Source	Hazard Quotient[a]	COPEC?	Reason Code
Aluminum	20 / 20	7650	D	15300	D	A68	15300	26000	2	<1	no	b
Arsenic	20 / 20	16.4	D	89.5	D	A68	89.5	9.8	1	**9.1**	**yes**	a
Beryllium	9 / 20	2.1	JD	6.8	D	A68	6.8	NA	--	--	**yes**	c
Cadmium	20 / 20	5.0	D	24.2	D	A68	24.2	0.99	1	**24.4**	**yes**	a
Chromium	20 / 20	3.6	D	6.4	D	A60	6.4	43.4	1	<1	no	b
Copper	20 / 20	166	D	745	D	A68	745	31.6	1	**23.6**	**yes**	a
Iron	20 / 20	22800	D	45300	D	A68	45300	190000	2	<1	no	b
Lead	20 / 20	554	D	3030	D	A68	3030	35.8	1	**84.6**	**yes**	a
Manganese	20 / 20	3400	D	22300	D	A68	22300	630	2	**35.4**	**yes**	a
Mercury	14 / 14	0.02	JD	0.19	D	A68	0.19	0.18	1	**1.1**	**yes**	a
Nickel	20 / 20	5.9	D	16.5	D	A68	16.5	22.7	1	<1	no	b
Selenium	4 / 20	0.91	JD	2.9	D	A68	2.9	0.9	4	**3.2**	**yes**	a
Silver	20 / 20	2.9	D	13.3	D	A68	13.3	1.0	3	**13.3**	**yes**	a
Zinc	20 / 20	1530	D	11500	D	A68	11500	121	1	**95.0**	**yes**	a

[a] the hazard quotient is calculated by dividing a maximum concentration by its sediment screening benchmark
B = analyte was also detected in the blank
J = estimated concentration
D = sample was diluted before analysis

COPEC = contaminant of potential ecological concern

Reason codes:
a = the maximum concentration exceeds the sediment screening benchmark
b = the maximum concentration falls below the sediment screening benchmark
c = a benchmark is not available

Benchmark sources:
1. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
2. Ingersoll, C.G. *et al* . 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius* . J. Great Lakes Res. 22:602-623.
3. Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
4. Thompson, P.A., J. Kurias, and S. Mihok. 2005. Derivation and use of sediment guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monit. Assess. 110:71-85.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
revised by: BB (2/10/15)
reviewed by: ES (2/11/15)

Table 3.13
Selection of sediment COPECS for the benthic invertebrate community in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	Frequency of Detection	Minimum Detect (mg/kg)	Flag	Maximum Detect (mg/kg)[a]	Flag	Location of Maximum Detect	Concentration used for Screening	Benchmark (mg/kg)	Benchmark Source	Hazard Quotient[a]	COPEC?	Reason Code
Aluminum	23 / 23	6,620	D	48,600	D	A75B	48,600	26,000	2	**1.9**	**yes**	a
Arsenic	23 / 23	9.2	D	40.6	D	A72	40.6	9.8	1	**4.1**	**yes**	a
Beryllium	9 / 23	3.2	JD	6.0	D	A75B	6.0	--	--	NA	**yes**	c
Cadmium	23 / 23	1.2	D	18.6	D	Bbridge	18.6	0.99	1	**18.8**	**yes**	a
Chromium	23 / 23	2.8	D	7.4	BD	BBridge	7.4	43.4	1	< 1	no	b
Copper	23 / 23	67	D	413	D	A75B	413	31.6	1	**13.1**	**yes**	a
Iron	23 / 23	20,100	D	109,000	D	A73	109,000	190,000	2	< 1	no	b
Lead	23 / 23	98	D	729	D	A73	729	35.8	1	**20.4**	**yes**	a
Manganese	23 / 23	1,210	D	13,100	D	BBridge	13,100	630	2	**20.8**	**yes**	a
Mercury	15 / 17	0.02	JD	0.09	D	A73B	0.09	0.18	1	< 1	no	b
Nickel	23 / 23	4.33	D	31.6	D	BBridge	31.6	22.7	1	**1.4**	**yes**	a
Selenium	13 / 23	0.59	JD	3.3	D	A75B	3.3	0.9	4	**3.7**	**yes**	a
Silver	23 / 23	0.512	JD	3.1	D	A73B	3.1	1.0	3	**3.1**	**yes**	a
Zinc	23 / 23	386	D	8,670	D	BBridge	8,670	121	1	**71.7**	**yes**	a

[a] The hazard quotient is calculated by dividing a maximum concentration by its sediment screening benchmark

B = analyte was also detected in the blank
D = sample was diluted prior to analysis
J = estimated value

COPEC = contaminant of potential ecological concern

reason code:
a = the maximum detected concentration exceeds the screening benchmark
b = the maximum detected concentration does not exceed the screening benchmark
c = the analyte does not have a benchmark

Benchmark sources:

1. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

2. Ingersoll, C.G. *et al* . 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius* . J. Great Lakes Res. 22:602-623.

3. Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

4. Thompson, P.A., J. Kurias, and S. Mihok. 2005. Derivation and use of sediment guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monit. Assess. 110:71-85.

prepared by: SJP (12/27/13)
checked by: RI (2/10/14)
revised by: BB (2/10/15)
reviewed by: ES (2/11/15)

Table 3.14
Summary of the sediment COPECs for the benthic invertebrate community
Baseline Ecological Risk Assessment
Upper Animas River District

Analyte	mainstem Mineral Creek	mainstem Cement Creek	Animas River above mainstem Cement Creek	Animas River between mainstem Cement and Mineral Creeks[a]	Animas River below mainstem Mineral Creek
Aluminum	√				√
Arsenic	√	√	√		√
Beryllium	√	√	√		√
Cadmium	√		√		√
Chromium					
Copper	√	√	√		√
Iron					
Lead	√	√	√		√
Manganese	√		√		√
Mercury			√		
Nickel					√
Selenium	√		√		√
Silver		√	√		√
Zinc	√	√	√		√

[a] this reach of the Animas River was not sampled for sediment

prepared by: SJP (1/31/14)
checked by: RI (2/10/14)
revised by: BB (2/10/15)
reviewed by: ES (2/11/15)

Table 3.15
Selection of pore water COPECs for the benthic invertebrate community in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Compound	Frequency of Detection	Minimum Detect (µg/L)[a]	Flag	Maximum Detect (µg/L)[b]	Flag	Location of Maximum Detect	Conc. used for Screening[c]	Benchmark (ug/L)[d]	Hardness (mg/L)[e]	Hardness-Adjusted Benchmark (ug/L)[f]	Bench-mark Source	Hazard Quotient[g]	COPEC?	Reason Code
Aluminum	8/11	21	J	6170	D	A61	6170	87[h]	--	--	1	**70.9**	**yes**	a
Arsenic	1/11	0.55	J	0.55	J	A60	0.55	150	--	--	1	<1	no	b
Beryllium	0/11	--		10.0	U	A61	10.0	0.66	--	--	2	**15.2**	**yes**	a
Cadmium	11/11	0.28		107	D	A61	107	--	497	1.20[i]	1	**89.2**	**yes**	a
Chromium	2/11	0.8	J	1.8	J	A66	1.8	--	141	98	1	<1	no	b
Copper	11/11	1.3		2250	D	A61	2250	--	853	29.3[i]	1	**76.8**	**yes**	a
Iron	0/11	--		500	U	A61	500	1000	--	--	1	<1	no	b
Lead	6/11	0.123	J	65.6	D	A61	65.6	--	497	10.9[i]	1	**6.0**	**yes**	a
Manganese	10/11	2.6	J	78300	D	A61	78300	--	497	2678[i]	1	**29.2**	**yes**	a
Nickel	4/11	11.3		77.5	D	A61	77.5	--	853	168[i]	1	<1	no	b
Selenium	0/11	--		5.0	U	A61	5.0	4.6	--	--	1	**1.1**	**yes**	a
Silver	0/11	--		2.5	U	A61	0.25	--	118	0.10	1	**2.5**	**yes**	a
Zinc	11/11	179		29900	D	A61	18490	--	497	428[i]	1	**43.2**	**yes**	a

[a] These values represent the minimum detected dissolved metals concentrations, or the minimum detection limit for a non-detected analyte, measured in April and September 2014 in pore water samples collected from the Animas River upstream from mainstem Cement Creek

[b] These values represent the maximum detected dissolved metals concentrations, or half the maximum detection limit for a non-detected analyte, measured in April and September 2014 in the Animas River upstream from mainstem Cement Creek

[c] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the one associated with the maximum concentration

[d] These benchmarks are not sensitive to surface water hardness

[e] This hardness was associated with the analyte concentration that resulted in the highest HQ measured in April or September 2014 in the Animas River between mainstem Cement Creek and mainstem Mineral Creek

[f] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[g] The hazard quotient is calculated by dividing a screening concentration by its benchmark

[h] CDPHE developed a benchmark equation for Al based on total Al, hardness, and pH. The latter parameter was not available. Instead, EPA's National Recommneded Water Quality Criterion of 87 µg/L was used to calculate the hazard quotients

[i] Sample hardness was greater than the 400 mg/L limit for use in deriving hardness-based criteria. Therefore, the hardness-based benchmark was derived using a hardness value of 400 mg/L

Reason codes:

a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark

b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:

1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.
34 pp

prepared by: SJP (2/24/15)

checked by: EC (2/26/15)

Table 3.16
Selection of pore water COPECs for the benthic invertebrate community in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Compound	Frequency of Detection	Minimum Detect (µg/L)[a]	Flag	Maximum Detect (µg/L)[b]	Flag	Location of Maximum Detect	Conc. used for Screening[c]	Benchmark (ug/L)[d]	Hardness (mg/L)[e]	Hardness-Adjusted Benchmark (ug/L)[f]	Bench-mark Source	Hazard Quotient[g]	COPEC?	Reason Code
Aluminum	8/9	23	J	517		A72	517	87[h]	--	--	1	**5.9**	**yes**	a
Arsenic	1/9	3.7		3.7		BBridge	3.74	150	--	--	1	<1	no	b
Beryllium	0/9	--		1.0	U	multiple	1.0	0.66	--	--	2	**1.5**	**yes**	a
Cadmium	7/9	0.33		3.0		A72	3.0	--	256	0.86	1	**3.5**	**yes**	a
Chromium	2/9	1.2	J	3.2		BBridge	3.2	--	271	168	1	<1	no	b
Copper	8/9	0.92	J	8.1		A72	8.1	--	256	20.0	1	<1	no	b
Iron	4/9	107	J	1260		BBridge	1260	1000	--	--	1	**1.3**	**yes**	**a**
Lead	3/9	0.19	J	0.45		A72	0.45	--	256	6.9	1	<1	no	b
Manganese	9/9	2.5	J	5870		BBridge	5870	--	271	2299	1	**2.6**	**yes**	a
Nickel	7/9	0.58	J	2.0		A72	2.0	--	256	115	1	<1	no	b
Selenium	0/9	--		0.5	U	multiple	0.5	4.6	--	--	1	<1	no	b
Silver	0/9	--		0.25	U	multiple	0.25	--	49	0.02	1	**12.5**	**yes**	a
Zinc	9/9	13.3	J	1630		A72	1630	--	256	285	1	**5.7**	**yes**	a

[a] These values represent the minimum detected dissolved metals concentrations, or the minimum detection limit for a non-detected analyte, measured in April and September 2014 in pore water samples collected from the Animas River upstream from mainstem Cement Creek

[b] These values represent the maximum detected dissolved metals concentrations, or half the maximum detection limit for a non-detected analyte, measured in April and September 2014 in the Animas River upstream from mainstem Cement Creek

[c] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the one associated with the maximum concentration

[d] These benchmarks are not sensitive to surface water hardness

[e] This hardness was associated with the analyte concentration that resulted in the highest HQ measured in April or September 2014 in the Animas River between mainstem Cement Creek and mainstem Mineral Creek

[f] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[g] The hazard quotient is calculated by dividing a screening concentration by its benchmark

[h] CDPHE developed a benchmark equation for Al based on total Al, hardness, and pH. The latter parameter was not available. Instead, EPA's National Recommneded Water Quality Criterion of 87 µg/L was used to calculate the hazard quotient

Reason codes:

a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark

b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:

1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.

2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pp

prepared by: SJP (2/24/15)

checked by: EC (2/26/15)

Table 3.17
Selection of pore water COPECs for the benthic invertebrate community in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Compound	Frequency of Detection	Minimum Detect (µg/L)[a]	Flag	Maximum Detect (µg/L)[b]	Flag	Location of Maximum Detect	Conc. used for Screening[c]	Benchmark (ug/L)[d]	Hardness (mg/L)[e]	Hardness-Adjusted Benchmark (ug/L)[f]	Bench-mark Source	Hazard Quotient[g]	COPEC?	Reason Code
Aluminum	1/1	45.7	J	45.7	J	M34	45.7	87[h]	--	--	1	<1	no	b
Arsenic	0/1	--		0.25	U	M34	0.25	150	--	--	1	<1	no	b
Beryllium	0/1	--		1.0	U	M34	1.0	0.66	--	--	2	**1.5**	**yes**	a
Cadmium	1/1	0.13	J	0.13	J	M34	0.13	--	139	0.54	1	<1	no	b
Chromium	0/1	--		0.5	U	M34	0.5	--	139	97	1	<1	no	b
Copper	1/1	1.2		1.2		M34	1.2	--	139	12	1	<1	no	b
Iron	0/1	--		50	U	M34	50	1000	--	--	1	<1	no	b
Lead	0/1	--		0.05	U	M34	0.05	--	139	3.6	1	<1	no	b
Manganese	1/1	27.6		27.6		M34	27.6	--	139	1841	1	<1	no	b
Nickel	0/1	--		0.25	U	M34	0.25	--	139	69	1	<1	no	b
Selenium	0/1	--		0.5	U	M34	0.5	4.6	--	--	1	<1	no	b
Silver	0/1	--		0.25	U	M34	0.25	--	139	0.10	1	**2.5**	**yes**	a
Zinc	1/1	48.2		48.2		M34	48.2	--	139	163	1	<1	no	b

[a] These values represent the minimum detected dissolved metals concentrations, or the minimum detection limit for a non-detected analyte, measured in April and September 2014 in pore water samples collected from the Animas River upstream from mainstem Cement Creek

[b] These values represent the maximum detected dissolved metals concentrations, or half the maximum detection limit for a non-detected analyte, measured in April and September 2014 in the Animas River upstream from mainstem Cement Creek

[c] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the one associated with the maximum concentration

[d] These benchmarks are not sensitive to surface water hardness

[e] This hardness was associated with the analyte concentration that resulted in the highest HQ measured between in April or September 2014 in the Animas River between mainstem Cement Creek and mainstem Mineral Creek

[f] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[g] The hazard quotient is calculated by dividing a screening concentration by its benchmark

[h] CDPHE developed a benchmark equation for Al based on total Al, hardness, and pH. The latter parameter was not available. Instead, EPA's National Recommneded Water Quality Criterion of 87 µg/L was used in the calculations

Reason codes:

a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark

b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:

1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.

2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pp

prepared by: SJP (2/24/15)

checked by: EC (2/26/15)

Table 3.18
Summary of the pore water COPECs for the benthic invertebrate community
Baseline Ecological Risk Assessment
Upper Animas River District

Analyte	mainstem Mineral Creek	mainstem Cement Creek[a]	Animas River above mainstem Cement Creek	Animas R. between Cement and Mineral Creeks[a]	Animas River below mainstem Mineral Creek
Aluminum			√		√
Arsenic					
Beryllium	(√)		(√)		(√)
Cadmium			√		√
Chromium					
Copper			√		
Iron					√
Lead			√		
Manganese			√		√
Mercury					
Nickel					
Selenium			(√)		
Silver	(√)		(√)		(√)
Zinc			√		√

[a] this reach was not sampled for pore water

(√) = analyte was not detected but was retained as a COPEC because 1/2 the max detection limit exceeded the benchmark

prepared by: SJP (2/26/15)

checked by: EC (2/26/15)

Table 3.19
October 2012 acute surface water toxicity test results for juvenile rainbow trout
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample ID	Diluent	Sample Strength	Survival	Signif.?
Site-specific acute toxicity test results				
A56 ("upstream")	none	100%	100%	NS
A68	none	100%	100%	NS
A72	none	100%	0%	S
A73B	none	100%	100%	NS
A75B	none	100%	100%	NS
Bakers Bridge	none	100%	100%	NS
Serial dilution #1 acute toxicity test results				
M34/CC48	A56	6.25%	100%	NS
M34/CC48	A56	12.5%	100%	NS
M34/CC48	A56	25%	100%	NS
M34/CC48	A56	50%	97.5%	NS
M34/CC48	A56	100%	0%	S
Serial dilution #2 acute toxicity test results				
M34/CC48	A68	6.25%	100%	NS
M34/CC48	A68	12.5%	100%	NS
M34/CC48	A68	25%	100%	NS
M34/CC48	A68	50%	37.5%	S

S = significant; NS = non significant

Statistical significance was tested against the laboratory control water sample

Table 3.20
November 2012 acute surface water toxicity test results for juvenile rainbow trout
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample ID	Diluent	Sample Strength	Survival	Signif.?
Site-specific acute toxicity test results				
A68	none	100%	92.5%	NS
M34	none	100%	0%	S
Serial dilution #1 acute toxicity test results				
A72	A68	5%	92.5%	NS
A72	A68	10%	94.7%	NS
A72	A68	25%	92.2%	NS
A72	A68	50%	100%	NS
A72	A68	75%	100%	NS
A72	A68	100%	2.5%	S
Serial dilution #2 acute toxicity test results				
CC48	A68	1%	85%	NS
CC48	A68	3%	97.5%	NS
CC48	A68	6%	97.5%	NS
CC48	A68	12%	90%	NS
CC48	A68	25%	90%	NS
CC48	A68	50%	0%	S
Serial dilution #3 acute toxicity test results				
M34/CC48	A68	4%	97.5%	NS
M34/CC48	A68	9%	95%	NS
M34/CC48	A68	20%	100%	NS
M34/CC48	A68	40%	92.5%	NS
M34/CC48	A68	65%	0%	S
M34/CC48	A68	85%	0%	S

S = significant; NS = non significant

The statistical significance of the three serial dilution results was tested against the laboratory control water sample, whereas the statistical significance of survival in samples A68 and M34 was determined using a *t*-test

prepared by: SJP (1/6/14)
reviewed by: MC (2/27/19)

Table 3.21
April 2013 acute surface water toxicity test results for juvenile rainbow trout
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample ID	Diluent	Sample Strength	Survival	Signif.?
Site-specific acute toxicity test results				
A68	none	100%	67.5%	S
A72	none	100%	0%	S
A73	none	100%	98%	NS
A73B	none	100%	97.5%	NS
A75B	none	100%	100%	NS
M34	none	100%	15%	S
Serial dilution #1 acute toxicity test results				
A72	HRW	12%	100%	NS
A72	HRW	25%	100%	NS
A72	HRW	35%	100%	NS
A72	HRW	50%	100%	NS
A72	HRW	75%	100%	NS
A72	HRW	88%	97.5%	NS
Serial dilution #2 acute toxicity test results				
CC48/M34	A68	25%	100%	NS
CC48/M34	A68	50%	90%	NS
CC48/M34	A68	75%	0%	S
CC48/M34	A68	80%	0%	S
CC48/M34	A68	90%	0%	S
CC48/M34	A68	95%	0%	S
Serial dilution #3 acute toxicity test results				
CC48/M34	HRW	25%	100%	NS
CC48/M34	HRW	50%	100%	NS
CC48/M34	HRW	75%	100%	NS
CC48/M34	HRW	90%	0%	S
CC48/M34	HRW	95%	0%	S

HRW = hard reconstituted water

S = significant; NS = non significant

Statistical significance was tested against the laboratory control water sample

Table 3.22
Summary of the acute surface water toxicity test results for juvenile rainbow trout
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Sampling Timeframe					
	Oct. 2012	signif.?	Nov. 2012	signif.?	April 2013	signif.?
Animas River						
A56 ("upstream")	100%	NS	nt	--	nt	--
A68	100%	NS	92.5%	NS	67.5%	S
A72	0%	S	2.5%	S	0%	S
A73	nt	--	nt	--	98%	NS
A73B	100%	NS	nt	--	97.5%	NS
A75B	100%	NS	nt	--	100%	NS
Bakers Bridge	100%	NS	nt	--	nt	--
Mineral Creek						
M34	nt	--	0%	S	15%	S
Cement Creek						
CC48	nt	--	0%	S	nt	--

value shown is survival
nt = not tested
S = significant; NS = non significant

prepared by: SJP (1/29/14)
reviewed by: MC (2/27/19)

Table 3.23
Toxicity in the amphipod *H. azteca* exposed to sediment in the laboratory
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample ID	Dec. 2012 test		Nov. 2014 test		Dec. 2012 test		Nov. 2014 test	
	Survival (mean±SE)	Signif?[a]	Survival (mean±SE)	Signif?[a]	Biomass[b] (mean±SE)	Signif?[a]	Biomass[b] (mean±SE)	Signif?[a]
Laboratory control sample								
Lab	97.5±1.6%	--	92.5±3.1%	--	69.8±3.5 µg/org	--	78.1±4.2 µg/org	--
Animas River "upstream"								
A56	62.5±8.2%	Y	43.8±9.2%	Y	20.3±1.9 µg/org	Y	14.3±3.2 µg/org	Y
Animas River above main stem Cement Creek								
A60	not tested	--	77.5±6.5%	N	not tested	--	23.1±1.9 µg/org	Y
A68	56.3±3.2%	Y	70.0±10.0%	N	22.6±1.6 µg/org	Y	23.2±3.3 µg/org	Y
Mainstem Cement Creek								
CC49	0%	Y	not tested	--	no survival	--	not tested	--
Mainstem Mineral Creek								
M34	8.8±3.5%	Y	not tested	--	5.1±2.0 µg/org	Y	not tested	--
Animas River below mainstem Mineral Creek								
A72	36.3±4.2%	Y	70.0±4.6%	N	16.1±1.7 µg/org	Y	27.9±2.4 µg/org	Y
A73	not tested	--	73.8±7.8%	N	not tested	--	21.2±2.4 µg/org	Y
A73B	5.0±1.9%	Y	not tested	--	4.0±1.7 µg/org	Y	not tested	--
A75D	not tested	--	76.3±7.5%	N	not tested	--	24.9±3.2 µg/org	Y
A75B	48.8±5.2%	Y	not tested	--	17.8±1.9 µg/org	Y	not tested	--
Bbridge	76.3±3.8%	Y	86.3±3.8%	N	26.2±1.0 µg/org	Y	30.7±2.2 µg/org	Y

SE = standard error

[a] is the response statistically significant from that observed in the test-specific laboratory control sample?

[b] biomass = total dry weight of surviving organisms on day 10/number of organisms originally introduced on day 0

prepared by: SJP (2/24/15)

reviewed by: EC (2/25/15)

Table 3.24
Summary of select benthic invertebrate community data from the Animas River, mainstem Cement Creek, and mainstem Mineral Creek (Sep. 2014)
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	total # of taxa	# of EPT taxa	# of intolerant taxa	H'	HBI	EPT Index[a]	Ephemerata Abundance[c]	%EPT[b]	Tolerant Organisms[d]	Filterers[d]	Scrapers[d]	Clingers[d]
Animas River above mains stem Cement Creek												
A56 ("upstream")	18	13	12	2.24	4.28	72.2%	10.8%	37.8%	1.3%	73.0%	8.3%	90.8%
A60	25	14	16	3.21	3.67	56.0%	11.3%	39.1%	3.4%	44.9%	12.3%	64.8%
A68	17	10	9	2.83	4.19	58.8%	15.5%	32.6%	2.7%	38.7%	11.9%	48.8%
Animas River below main stem Mineral Creek												
A72	9	4	3	2.19	1.87	44.4%	3.4%	54.3%	2.6%	38.8%	0.9%	53.4%
A73	11	7	8	1.61	1.28	63.6%	3.9%	96.1%	0.0%	71.3%	7.8%	92.2%
A75D	21	9	12	3.27	2.46	42.9%	24.8%	64.4%	15.8%	32.7%	15.8%	61.4%
Bakers Bridge	17	8	8	2.33	3.94	47.1%	52.9%	77.1%	2.7%	37.7%	1.3%	39.9%
main stem Cement Creek												
CC49	2	0	0	0.72	8.00	0.0%	0.0%	0.0%	20.0%	0.0%	0.0%	0.0%
main stem Mineral Creek												
M34	12	7	6	2.1	1.66	58.3%	3.9%	86.3%	3.9%	62.7%	3.9%	86.3%

Source: Appendix G (Macroinvertebrate assemblage results report), U.S. Environmental Protection Agency. 2014. Sampling Activities Report. 2014 Sampling Events. Upper Animas Mining District, Gladstone, San Juan County, CO. Draft prepared for the USEPA Region 8, Ecosystem Protection and Remediation – Program Support, Denver, CO.

H' = Shannon Weaver Diversity

HBI = Hilsendorf Biotic Index

EPT = Ephemeroptera, Plecoptera, Trichoptera

[a] % of total number of taxa

[b] % of total number of organisms consisiting of EPT

[c] Ephemoptera abundance = % of total number

[d] % of total number of organisms

prepared by: SJP (2/13/15)
reviewed by: MC (2/27/19)

Table 4.1
Surface water EPCs for community-level receptors in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Max Detect or 1/2 max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
PRE-RUNOFF PERIOD							
Aluminum (total)	4 / 4	4,575	5,950	6,544	95% Student's-t UCL	5,950	4,575
Cadmium (dissolved)	4 / 4	1.3	2.0	1.85	95% Student's-t UCL	1.85	1.3
Iron (total)	4 / 4	5,868	6,830	7,240	95% Student's-t UCL	6,830	5,868
Silver (dissolved)	2 / 4	0.4	0.6	NA	NA	0.6	0.4
Zinc (dissolved)	4 / 4	358	499	470	95% Student's-t UCL	470	358
RUNOFF PERIOD							
Aluminum (total)	7 / 7	1353	2610	1910	95% Student's-t UCL	1,910	1,353
Cadmium (dissolved)	5 / 7	0.3	0.6	0.40	95% KM (t) UCL	0.4	0.3
Iron (total)	7 / 7	2,664	6,330	4,119	95% Student's-t UCL	4,119	2,664
Silver (dissolved)	0 / 7	0.4	1.3 U	NA	NA	1.3	0.4
Zinc (dissolved)	6 / 7	83.9	146	104.4	95% KM (t) UCL	104	83.9
POST-RUNOFF PERIOD							
Aluminum (total)	13 / 13	2,267	4,590	2,826	95% Student's-t UCL	2,826	2,267
Cadmium (dissolved)	13 / 13	0.61	1.0	0.724	95% Student's-t UCL	0.724	0.6
Iron (total)	13 / 13	3,339	8,290	4,316	95% Student's-t UCL	4,316	3,339
Silver (dissolved)	0 / 13	0.3	1.3 U	NA	NA	1.3	0.3
Zinc (dissolved)	13 / 13	160	317	194	95% Student's-t UCL	194	160

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.2
Surface water EPCs for community-level receptors in mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Max Detect or 1/2 max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
PRE-RUNOFF PERIOD							
Aluminum (total)	4 / 4	7,318	8,610	9,192	95% Student's-t UCL	8,610	7,318
Beryllium (dissolved)	3 / 4	1.2	1.3	1.311	95% KM (t) UCL	1.3	1.2
Cadmium (dissolved)	4 / 4	5.3	5.5	5.546	95% Student's-t UCL	5.5	5.3
Copper (dissolved)	4 / 4	107	119	122	95% Student's-t UCL	119	107
Iron (total)	4 / 4	17,150	21,700	22,006	95% Student's-t UCL	21,700	17,150
Lead (dissolved)	4 / 4	14.2	15.1	15.1	95% Student's-t UCL	15.1	14.2
Manganese (dissolved)	4 / 4	4,618	5,290	5,867	95% Student's-t UCL	5,290	4,618
Zinc (dissolved)	4 / 4	2,303	2,670	2,878	95% Student's-t UCL	2,670	2,303
RUNOFF PERIOD							
Aluminum (total)	7 / 7	2,389	3,280	2,876	95% Student's-t UCL	2,876	2,389
Beryllium (dissolved)	0 / 7	0.7	1.0 U	NA	NA	1.0	0.7
Cadmium (dissolved)	7 / 7	2.8	3.8	3.3	95% Student's-t UCL	3.3	2.8
Copper (dissolved)	7 / 7	68.6	90.6	78.1	95% Student's-t UCL	78.1	68.6
Iron (total)	7 / 7	8,067	17,200	12,554	95% Student's-t UCL	12,554	8,067
Lead (dissolved)	7 / 7	8.4	13.1	10.4	95% Student's-t UCL	10.4	8.4
Manganese (dissolved)	7 / 7	1,268	1,770	1,620	95% Student's-t UCL	1,620	1,268
Zinc (dissolved)	7 / 7	929.3	1,310	1,144	95% Student's-t UCL	1,144	929
POST-RUNOFF PERIOD							
Aluminum (total)	14 / 14	6,360	7,930	7,110	95% Student's-t UCL	7,110	6,360
Beryllium (dissolved)	6 / 14	1.1	1.2	1.0	95% KM(t) UCL	1.0	1.1
Cadmium (dissolved)	14 / 14	5.6	7.0	6.1	95% Student's-t UCL	6.1	5.6
Copper (dissolved)	14 / 14	130	221	152	95% Student's-t UCL	152	130
Iron (total)	14 / 14	10,801	18,600	12,725	95% Student's-t UCL	12,725	10,801
Lead (dissolved)	14 / 14	15.5	21.4	17.1	95% Student's-t UCL	17.1	15.5
Manganese (dissolved)	14 / 14	4,112	5,300	5,801	95% Chebyshev (Mean, Sd) UCL	5,300	4,112
Zinc (dissolved)	14 / 14	2,190	2,890	3,033	95% Chebyshev (Mean, Sd) UCL	2,890	2,190

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.3
Surface water EPCs for community-level receptors in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Max Detect or 1/2 max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
PRE-RUNOFF PERIOD							
Aluminum (total)	5 / 5	305	438	401	95% Student's-t UCL	401	305
Cadmium (dissolved)	5 / 5	2.6	4.1	3.6	95% Student's-t UCL	3.6	2.6
Copper (dissolved)	2 / 5	7.2	8.3	8.435	95% KM (t) UCL	8.3	7.2
Iron (total)	5 / 5	259	334	309.3	95% Student's-t UCL	309	259
Lead (dissolved)	0 / 5	0.4	0.5 U	NA	NA	0.5	0.4
Manganese (dissolved)	5 / 5	3,300	3,730	3,676	95% Student's-t UCL	3,676	3,300
Zinc (dissolved)	5 / 5	840	1,030	1,012	95% Student's-t UCL	1,012	840
RUNOFF PERIOD							
Aluminum (total)	17 / 17	480	1,010	566	95% Student's-t UCL	566	480
Cadmium (dissolved)	17 / 17	1.04	1.5	1.15	95% Modified-t UCL	1.1	1.0
Copper (dissolved)	15 / 17	10.0	16.5	11.3	95% KM (t) UCL	11.3	10.0
Iron (total)	16 / 17	469	1,100	556	95% KM(t) UCL	556	469
Lead (dissolved)	13 / 17	1.0	1.5	1.08	95% KM(t) UCL	1.1	1.0
Manganese (dissolved)	17 / 17	514	1,220	633	95% Student's-t UCL	633	514
Zinc (dissolved)	17 / 17	344.2	509	381	95% Modified-t UCL	381	344
POST-RUNOFF PERIOD							
Aluminum (total)	13 / 18	153	217	154	95% KM (t) UCL	154	153
Cadmium (dissolved)	18 / 18	1.1	1.7	1.2	95% Student's-t UCL	1.2	1.1
Copper (dissolved)	7 / 18	3.17	3.5	3.223	95% KM (Percentile Bootstrap) UCL	3.2	3.2
Iron (total)	10 / 18	154	234	149	95% KM (Percentile Bootstrap) UCL	149	154
Lead (dissolved)	7 / 18	0.308	0.4	0.339	95% KM (Percentile Bootstrap) UCL	0.3	0.3
Manganese (dissolved)	18 / 18	1,031	2,380	1,247	95% Student's-t UCL	1,247	1,031
Zinc (dissolved)	18 / 18	327	567	362	95% Student's-t UCL	362	327

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.4
Surface water EPCs for community-level receptors in the Animas River between mainstem Cement Creek and mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	2 / 2	2,490	2,520	NA	NA	2,520	2,490
Cadmium (dissolved)	2 / 2	2.7	2.7	NA	NA	2.7	2.7
Copper (dissolved)	2 / 2	20.6	24.8	NA	NA	24.8	20.6
Iron (total)	2 / 2	4,995	5,100	NA	NA	5,100	4,995
Manganese (dissolved)	2 / 2	2,565	2,590	NA	NA	2,590	2,565
Zinc (dissolved)	2 / 2	1,160	1,160	NA	NA	1,160	1,160

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.5
Surface water EPCs for community-level receptors at sampling location A71B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	1 / 1	2,780	2,780	NA	NA	2,780	2,780
Cadmium (dissolved)	1 / 1	1.9	1.9	NA	NA	1.9	1.9
Copper (dissolved)	1 / 1	8.7	8.7	NA	NA	8.7	8.7
Iron (total)	1 / 1	4,640	4,640	NA	NA	4,640	4,640
Manganese (dissolved)	1 / 1	1,660	1,660	NA	NA	1,660	1,660
Zinc (dissolved)	1 / 1	743	743	NA	NA	743	743

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.6
Surface water EPCs for community-level receptors at sampling location A72 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Max Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
PRE-RUNOFF PERIOD							
Aluminum (total)	4 / 4	3,455	4,440	4,739	95% Student's-t UCL	4,440	3,455
Cadmium (dissolved)	4 / 4	2.7	2.9	2.9	95% Student's-t UCL	2.9	2.7
Copper (dissolved)	4 / 4	28.9	35.9	38	95% Student's-t UCL	35.9	28.9
Iron (total)	4 / 4	6,018	7,710	7,967	95% Student's-t UCL	7,710	6,018
Manganese (dissolved)	4 / 4	2,435	2,920	3,028	95% Student's-t UCL	2,920	2,435
Zinc (dissolved)	4 / 4	1,044	1,230	1,232	95% Student's-t UCL	1,230	1,044
RUNOFF PERIOD							
Aluminum (total)	7 / 7	1,359	3,060	2,065	95% Student's-t UCL	2,065	1,359
Cadmium (dissolved)	7 / 7	0.9	1.4	1.0	95% Student's-t UCL	1.0	0.9
Copper (dissolved)	5 / 7	5.2	7.6	6.7	95% KM(t) UCL	6.7	5.2
Iron (total)	7 / 7	2,905	7,200	4,687	95% Student's-t UCL	4,687	2,905
Manganese (dissolved)	7 / 7	427	823	578	95% Student's-t UCL	578	427
Zinc (dissolved)	7 / 7	273	453	352	95% Student's-t UCL	352	273
POST-RUNOFF PERIOD							
Aluminum (total)	13 / 13	1,777	2,750	2,129	95% Student's-t UCL	2,129	1,777
Cadmium (dissolved)	13 / 13	1.6	2.8	1.9	95% Student's-t UCL	1.9	1.6
Copper (dissolved)	8 / 13	14.2	36.9	17.3	95% KM(t) UCL	17.3	14.2
Iron (total)	13 / 13	2,701	5,490	3,409	95% Student's-t UCL	3,409	2,701
Manganese (dissolved)	13 / 13	1,242	2,490	1,514	95% Student's-t UCL	1,514	1,242
Zinc (dissolved)	13 / 13	579	1,120	696	95% Student's-t UCL	696	579

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.7
Surface water EPCs for community-level receptors at sampling location A73 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	5 / 5	1,461	2,420	2,030	95% Student's-t UCL	2,030	1,461
Cadmium (dissolved)	5 / 5	1.3	1.8	1.704	95% Student's-t UCL	1.7	1.3
Copper (dissolved)	5 / 5	3.7	5.0	5.082	95% Student's-t UCL	5.0	3.7
Iron (total)	5 / 5	2,986	4,210	4,163	95% Student's-t UCL	4,163	2,986
Manganese (dissolved)	5 / 5	1,009	1,830	1,592	95% Student's-t UCL	1,592	1,009
Zinc	5 / 5	463	701	666	95% Student's-t UCL	666	463

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.8
Surface water EPCs for community-level receptors at sampling location A73B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	4 / 4	975	1,980	1,764	95% Students (t) UCL	1,764	975
Cadmium (dissolved)	4 / 4	0.7	1.4	1.271	95% Students (t) UCL	1.3	0.7
Copper (dissolved)	4 / 4	2.6	3.8	3.844	95% Students (t) UCL	3.8	2.6
Iron (total)	4 / 4	1,570	2,790	2,649	95% Students (t) UCL	2,649	1,570
Manganese (dissolved)	4 / 4	508	1,210	1,079	95% Students (t) UCL	1,079	508
Zinc (dissolved)	4 / 4	250	561	500.1	95% Students (t) UCL	500	250

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.9
Surface water EPCs for community-level receptors at sampling location A75D in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	5 / 5	1,255	1,790	1,728	95% Student's-t UCL	1,728	1,255
Cadmium (dissolved)	5 / 5	0.8	1.1	1.036	95% Student's-t UCL	1.0	0.8
Copper (dissolved)	5 / 5	2.5	4.2	3.887	95% Student's-t UCL	3.9	2.5
Iron (total)	5 / 5	2,556	4,610	3,922	95% Student's-t UCL	3,922	2,556
Manganese (dissolved)	5 / 5	590	1,090	935.1	95% Student's-t UCL	935	590
Zinc	5 / 5	261	427	384.2	95% Student's-t UCL	384	261

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.10
Surface water EPCs for community-level receptors at sampling location A75B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	4 / 4	1,021	1,650	1,565	95% Student's-t UCL	1,565	1,021
Cadmium (dissolved)	4 / 4	0.7	1.1	1.031	95% Student's-t UCL	1.0	0.7
Copper (dissolved)	4 / 4	2.6	4.1	4.476	95% Student's-t UCL	4.1	2.6
Iron (total)	4 / 4	2,224	4,810	4,454	95% Student's-t UCL	4,454	2,224
Manganese (dissolved)	4 / 4	462	856	781.7	95% Student's-t UCL	782	462
Zinc	4 / 4	235	442	401.5	95% Student's-t UCL	402	235

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.11
Surface water EPCs for community-level receptors at sampling location Bakers Bridge in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	5 / 5	704	1,310	1103	95% Student's-t UCL	1,103	704
Cadmium (dissolved)	5 / 5	0.5	0.7	0.613	95% Student's-t UCL	0.613	0.5
Copper (dissolved)	4 / 5	2.9	3.7	3.701	95% KM (t) UCL	3.7	2.9
Iron (total)	4 / 5	1,717	3,560	2,742	95% KM (t) UCL	2,742	1,717
Manganese (dissolved)	5 / 5	356	584	542.5	95% Student's-t UCL	543	356
Zinc	5 / 5	136	241	203.9	95% Student's-t UCL	204	136

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.12
Sediment EPCs for mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs	
							RME	CTE
Metals (mg/kg)								
Arsenic	2 / 2	26.9	32.7 D	--	NA	NA	32.7	26.9
Copper	2 / 2	90.4	127 D	--	NA	NA	127	90.4
Lead	2 / 2	183	237 D	--	NA	NA	237	183
Manganese	2 / 2	1,295	1,430 D	--	NA	NA	1,430	1,295
Selenium	1 / 2	1.7	1.7 D	--	NA	NA	1.7	1.7
Zinc	2 / 2	468	666 D	--	NA	NA	666	468

mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
NC = not calculated because of small sample size.
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.13
Sediment EPCs for mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs	
							RME	CTE
Metals (mg/kg)								
Arsenic	1 / 1	40.6	40.6 D	--	NA	NA	40.6	40.6
Copper	1 / 1	55.6	55.6 D	--	NA	NA	55.6	55.6
Lead	1 / 1	282	282 D		NA	NA	282	282
Silver	1 / 1	2.0	2.0 D	--	NA	NA	2.0	2.0
Zinc	1 / 1	195	195 D	--	NA	NA	195	195

mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
NC = not calculated because of small sample size.
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.14
Sediment EPCs for the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC? benthos	COPEC? wildlife	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs RME	Sediment EPCs CTE
Metals (mg/kg)										
Arsenic[a]	yes	yes	20 / 20	27.4	89.5 D	--	34.24	95% Modified-tUCL	34.2	27.4
Cadmium[a]	yes	yes	20 / 20	11.1	24.2 D	--	12.91	95% Student's-t UCL	12.9	11.1
Chromium[a]	no	yes	20 / 20	4.7	6.4 D	--	4.971	95% Student's-t UCL	5.0	4.7
Copper[a]	yes	yes	20 / 20	339	745 D	--	399.3	95% Adjusted Gamma UCL	399	339
Lead[a]	yes	yes	20 / 20	1,508	3,030 D	--	1,733	95% Student's-t UCL	1,733	1,508
Manganese	yes	no	20 / 20	10,617	22,300 D	--	12,566	95% Student's-t UCL	12,566	10,617
Mercury[a]	yes	yes	14 / 14	0.07	0.19 D	--	0.0914	95% Student's-t UCL	0.1	0.07
Nickel[a]	no	yes	20 / 20	8.2	16.5 D	--	9.2	95% Modified-t UCL	9.2	8.2
Selenium[a]	yes	yes	4 / 20	1.54	2.9 D	--	0.998	95%KM (t) UCL	0.998	1.5
Silver[a]	yes	yes	20 / 20	5.5	13.3 D	--	6.43	95% Student's-t UCL	6.4	5.5
Zinc[a]	yes	yes	20 / 20	3,172	11,500 D	--	4,054	95% Modified-t UCL	4,054	3,172

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
NC = not calculated because of small sample size.
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB (2/25/15)

Table 4.15
Sediment EPCs at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC? benthos	COPEC? wildlife	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs RME	Sediment EPCs CTE
Metals (mg/kg)										
Aluminum	yes	no	5 / 5	14,872	21,500 D	--	19,659	95% Student's-t UCL	19,659	14,872
Arsenic[a]	yes	yes	5 / 5	33.4	40.6 D	--	39.58	95% Student's-t UCL	39.6	33.4
Cadmium[a]	yes	yes	5 / 5	2.1	3.03 D	--	2.852	95% Student's-t UCL	2.9	2.1
Chromium[a]	no	yes	5 / 5	4.6	6.41 BD	--	6.087	95% Student's-t UCL	6.1	4.6
Copper[a]	yes	yes	5 / 5	137	179 D	--	172.9	95% Student's-t UCL	173	137
Lead[a]	yes	yes	5 / 5	478	581 D	--	581.8	95% Student's-t UCL	581	478
Manganese	yes	no	5 / 5	2,100	3,400 D	--	2979	95% Student's-t UCL	2,979	2,100
Mercury[a]	no	yes	4 / 4	0.055	0.072 D	--	0.072	95% Student's-t UCL	0.07	0.06
Nickel[a]	yes	yes	5 / 5	5.1	6.4 D	--	5.884	95% Student's-t UCL	5.9	5.1
Selenium[a]	yes	yes	4 / 5	1.5	2.0 D	--	1.881	95% KM (t) UCL	1.9	1.5
Silver[a]	yes	yes	5 / 5	1.9	2.8 D	--	2.425	95% Student's-t UCL	2.4	1.9
Zinc[a]	yes	yes	5 / 5	650.8	858 D	--	818.5	95% Student's-t UCL	819	651

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB (2/25/15)

Table 4.16
Sediment EPCs at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analytes	COPEC? benthos	COPEC? wildlife	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs RME	Sediment EPCs CTE
Metals (mg/kg)										
Aluminum	yes	no	4 / 4	17,123	40,700 D	--	35,775	95% Student's-t UCL	35,775	17,123
Arsenic[a]	yes	yes	4 / 4	27.9	33.8 D	--	35.09	95% Student's-t UCL	33.8	27.9
Cadmium[a]	yes	yes	4 / 4	4.0	5.6 D	--	5.433	95% Student's-t UCL	5.4	4.0
Chromium[a]	no	yes	4 / 4	4.0	5.6 BD	--	5.376	95% Student's-t UCL	5.4	4.0
Copper[a]	yes	yes	4 / 4	199	284 D	--	284.2	95% Student's-t UCL	284	199
Lead[a]	yes	yes	4 / 4	513	729 D	--	733.6	95% Student's-t UCL	729	513
Manganese	yes	no	4 / 4	4,340	7,120 D	--	6,618	95% Student's-t UCL	6,618	4,340
Mercury[a]	no	yes	3 / 3	0.04	0.05 D	--	0.0606	95% Student's-t UCL	0.05	0.04
Nickel[a]	yes	yes	4 / 4	6.4	7.2 D	--	7.295	95% Student's-t UCL	7.2	6.4
Selenium[a]	yes	yes	2 / 4	1.1	1.4 D	--	1.409	95% KM (t) UCL	1.4	1.1
Silver[a]	yes	yes	4 / 4	1.9	2.8 D	--	2.805	95% Student's-t UCL	2.8	1.9
Zinc[a]	yes	yes	4 / 4	1049	1,450 D	--	1,393	95% Student's-t UCL	1,393	1,049

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB (2/25/15)

Table 4.17
Sediment EPCs at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC? benthos	COPEC? wildlife	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs RME	Sediment EPCs CTE
Metals (mg/kg)										
Aluminum	yes	no	3 / 3	16,373	31,900 D	--	39,289	95% Student's-t UCL	31,900	16,373
Arsenic[a]	yes	yes	3 / 3	29.9	39.4 D	--	46.35	95% Student's-t UCL	39.4	29.9
Cadmium[a]	yes	yes	3 / 3	3.5	4.2 D	--	4.79	95% Student's-t UCL	4.2	3.5
Chromium[a]	no	yes	3 / 3	4.5	5.02 D	--	5.659	95% Student's-t UCL	5.0	4.5
Copper[a]	yes	yes	3 / 3	177	292 D	--	348.5	95% Student's-t UCL	292	177
Lead[a]	yes	yes	3 / 3	534	593 BD	--	639.4	95% Student's-t UCL	593	534
Manganese	yes	no	3 / 3	3,143	4,340 D	--	4,894	95% Student's-t UCL	4,340	3,143
Mercury[a]	no	yes	2 / 2	0.07	0.09 D	--	NA	NA	0.09	0.07
Nickel[a]	yes	yes	3 / 3	10.0	12.1 D	--	13.35	95% Student's-t UCL	12.1	10.0
Selenium[a]	yes	yes	1 / 3	2.9	2.9 D	--	NA	NA	2.9	2.9
Silver[a]	yes	yes	3 / 3	2.0	3.1 D	--	3.628	95% Student's-t UCL	3.1	2.0
Zinc[a]	yes	yes	3 / 3	1,114	1,720 D	--	2,035	95% Student's-t UCL	1,720	1,114

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.18
Sediment EPCs at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC? benthos	COPEC? wildlife	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs RME	Sediment EPCs CTE
Metals (mg/kg)										
Aluminum	yes	no	4 / 4	15,428	29,900 D	--	27,525	95% Student's-t UCL	27,525	15,428
Arsenic[a]	yes	yes	4 / 4	19.4	28.5 D	--	26.98	95% Student's-t UCL	27.0	19.4
Cadmium[a]	yes	yes	4 / 4	4.8	6.75 D	--	6.443	95% Student's-t UCL	6.4	4.8
Chromium[a]	no	yes	4 / 4	4.2	4.99 BD	--	4.924	95% Student's-t UCL	4.9	4.2
Copper[a]	yes	yes	4 / 4	147	223 D	--	211.9	95% Student's-t UCL	212	147
Lead[a]	yes	yes	4 / 4	300	367 BD	--	374.8	95% Student's-t UCL	367	300
Manganese	yes	no	4 / 4	4,348	6,900 D	--	6,390	95% Student's-t UCL	6,390	4,348
Mercury[a]	no	yes	2 / 3	0.04	0.04 D	--	NA	NA	0.04	0.04
Nickel[a]	yes	yes	4 / 4	9.4	13.1 D	--	12.44	95% Student's-t UCL	12.4	9.4
Selenium[a]	yes	yes	2 / 4	1.2	1.4 D	--	1.505	95% KM (t) UCL	1.4	1.2
Silver[a]	yes	yes	4 / 4	1.1	1.4 D	--	1.427	95% Student's-t UCL	1.4	1.1
Zinc[a]	yes	yes	4 / 4	1,738	2,910 D	--	2,778	95% Student's-t UCL	2,778	1,738

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
B = analyte was also detected in the blank
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB (2/25/15)

Table 4.19
Sediment EPCs at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC? benthos	COPEC? wildlife	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs RME	Sediment EPCs CTE
Metals (mg/kg)										
Aluminum	yes	no	3 / 3	20,820	48,600 D	--	61,382	95% Student's-t UCL	48,600	20,820
Arsenic[a]	yes	yes	3 / 3	19.9	37.2 D	--	45.39	95% Student's-t UCL	37.2	19.9
Cadmium[a]	yes	yes	3 / 3	5.0	10.5 D	--	13.03	95% Student's-t UCL	10.5	5.0
Chromium[a]	no	yes	3 / 3	5.2	5.45 BD	--	5.584	95% Student's-t UCL	5.5	5.2
Copper[a]	yes	yes	3 / 3	188	413 D	--	517	95% Student's-t UCL	413	188
Lead[a]	yes	yes	3 / 3	296	435 D	--	592.2	95% Student's-t UCL	435	296
Manganese	yes	no	3 / 3	2,743	3,820 D	--	4,332	95% Student's-t UCL	3,820	2,743
Mercury[a]	no	yes	2 / 2	0.07	0.07 D	--	NA	NA	0.07	0.07
Nickel[a]	yes	yes	3 / 3	9.7	16.5 D	--	19.64	95% Student's-t UCL	16.5	9.7
Selenium[a]	yes	yes	2 / 3	1.9	3.3 D	--	7.901	97.5% KM (Chebyshev) UCL	3.3	1.9
Silver[a]	yes	yes	3 / 3	1.4	2.2 D	--	2.816	95% Student's-t UCL	2.2	1.4
Zinc[a]	yes	yes	3 / 3	2,190	5,320 D	--	6,760	95% Student's-t UCL	5,320	2,190

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
B = analyte was also detected in the blank
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.20
Sediment EPCs at sampling location Bakers Bridge on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC? benthos	COPEC? wildlife	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs RME	Sediment EPCs CTE
Metals (mg/kg)										
Aluminum	yes	no	4 / 4	20,025	37,400 D	--	37,463	95% Student's-t UCL	37,400	20,025
Arsenic[a]	yes	yes	4 / 4	21.9	29.7 D	--	30.11	95% Student's-t UCL	29.7	21.9
Cadmium[a]	yes	yes	4 / 4	10.1	18.6 D	--	19.21	95% Student's-t UCL	18.6	10.1
Chromium[a]	no	yes	4 / 4	5.4	7.38 BD	--	7.017	95% Student's-t UCL	7.0	5.4
Copper[a]	yes	yes	4 / 4	191	357 D	--	331.9	95% Student's-t UCL	332	191
Lead[a]	yes	yes	4 / 4	300	378 D	--	376.1	95% Student's-t UCL	376	300
Manganese	yes	no	4 / 4	7,425	13,100 D	--	13,563	95% Student's-t UCL	13,100	7,425
Mercury[a]	no	yes	3 / 3	0.04	0.06 D	--	0.07	95% Student's-t UCL	0.06	0.04
Nickel[a]	yes	yes	4 / 4	18.3	31.6 D	--	30.95	95% Student's-t UCL	31.0	18.3
Selenium[a]	yes	yes	2 / 4	2.1	3.1 D	--	3.088	95% Student's-t UCL	3.1	2.1
Silver[a]	yes	yes	4 / 4	1.3	1.7 D	--	1.654	95% Student's-t UCL	1.7	1.3
Zinc[a]	yes	yes	4 / 4	4,620	8,670 D	--	8,544	95% Student's-t UCL	8,544	4,620

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
B = analyte was also detected in the blank
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.21
Pore water EPCs for community-level receptors for mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Beryllium (dissolved)	0 / 1	1.0	1.0 U	NA	NA	1.0	1.0
Silver (dissolved)	0 / 1	0.25	0.25 U	NA	NA	0.25	0.25

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.22
Pore water EPCs for community-level receptors in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean*	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolved)	8 / 11	1,259	6,170 D	4,514	95% Adjusted Gamma KM-UCL	4,514	1,259
Beryllium (dissolved)	0 / 11	2.2	10 U	NA	NA	10	2.2
Cadmium (dissolved)	11 / 11	23.6	106.5 D	93.35	95% Adjusted Gamma-UCL	93	24
Copper (dissolved)	11 / 11	224	2,250 D	2,242	95% Chebyshev (Mean, Sd) UCL	2,242	224
Lead (dissolved)	6 / 11	13.7	65.6 D	19.22	95% KM (Percentile Bootstrap) UCL	19	14
Manganese (dissolved)	10 / 11	17,912	78,300 D	115,211	95% GROS Adjusted Gamma-UCL	78,300	17,912
Selenium (dissolved)	0 / 11	1.6	5.0 U	NA	NA	5.0	1.6
Silver (dissolved)	0 / 11	0.8	2.5 U	NA	NA	2.5	0.8
Zinc (dissolved)	11 / 11	5,735	29,900 D	19,367	95% Adjusted Gamma-UCL	19,367	5,735

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.23
Pore water EPCs for community-level receptors at sampling location A72 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolved)	2 / 2	282	517	NA	NA	517	282
Beryllium (dissolved)	0 / 2	1.0	1.0 U	NA	NA	1.0	1.0
Cadmium (dissolved)	2 / 2	2.19	2.98	NA	NA	3.0	2.2
Iron (dissolved)	1 / 2	338	338	NA	NA	338	338
Manganese (dissolved)	2 / 2	722	995	NA	NA	995	722
Silver (dissolved)	0 / 2	0.25	0.25 U	NA	NA	0.25	0.25
Zinc (dissolved)	2 / 2	1,019	1,630	NA	NA	1,630	1,019

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.24
Pore water EPCs for community-level receptors at sampling location A73 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolvedl)	2 / 2	26	29 J	NA	NA	29	26
Beryllium(dissolved)	0 / 2	1.0	1.0 U	NA	NA	1.0	1.0
Cadmium (dissolved)	2 / 2	1.2	2.03	NA	NA	2.03	1.2
Iron (dissolved)	1 / 2	341	341	NA	NA	341	341
Manganese (dissolved)	2 / 2	936	1,870	NA	NA	1,870	936
Silver (dissolved)	0 / 2	0.25	0.25 U	NA	NA	0.25	0.25
Zinc (dissolved)	2 / 2	536	709	NA	NA	709	536

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.25
Pore water EPCs for community-level receptors at sampling location A73B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolved)	0 / 1	10	10 U	NA	NA	10	10
Beryllium (dissolved)	0 / 1	1.0	1.0 U	NA	NA	1.0	1.0
Cadmium (dissolved)	0 / 1	0.05	0.05 U	NA	NA	0.05	0.05
Iron (dissolved)	0 / 1	50	50 U	NA	NA	50	50
Manganese (dissolved)	1 / 1	3.37	3.37 J	NA	NA	3.37	3.37
Silver (dissolved)	0 / 1	0.25	0.25 U	NA	NA	0.25	0.25
Zinc (dissolved)	1 / 1	32.9	32.9	NA	NA	33	33

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.26
Pore water EPCs for community-level receptors at sampling location A75D in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolved)	2 / 2	34	40 J	NA	NA	40	34
Beryllium (dissolved)	0 / 2	1.0	1.0 U	NA	NA	1.0	1.0
Cadmium (dissolved)	2 / 2	0.59	0.79	NA	NA	0.79	0.59
Iron (dissolved)	1 / 2	107	107 J	NA	NA	107	107
Manganese (dissolved)	2 / 2	238	290	NA	NA	290	238
Silver (dissolved)	0 / 2	0.25	0.25 U	NA	NA	0.25	0.25
Zinc (dissolved)	2 / 2	182	190	NA	NA	190	182

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.27
Pore water EPCs for community-level receptors at Bakers Bridge in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolvedl)	2 / 2	41	47 J	NA	NA	47	41
Beryllium(dissolved)	0 / 2	1.0	1.0 U	NA	NA	1.0	1.0
Cadmium (dissolved)	1 / 2	0.33	0.33	NA	NA	0.33	0.33
Iron (dissolved)	1 / 2	1,260	1,260	NA	NA	1,260	1,260
Manganese (dissolved)	2 / 2	3,098	5,870	NA	NA	5,870	3,098
Silver (dissolved)	0 / 2	0.25	0.25 U	NA	NA	0.25	0.25
Zinc (dissolved)	2 / 2	64	115	NA	NA	115	64

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.28
Surface water EPCs for wildlife receptors foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Cadmium	40 / 40	1.4	4.0	1.557	95% Modified-t UCL	1.6	1.4
Copper	32 / 40	15.5	33.5	16.2	95% KM (BCA) UCL	16.2	15.5
Lead	40 / 40	11.6	52.3	21.93	95% Chebyshev (Mean, SD) UCL	21.9	11.6
Zinc	40 / 40	432	1180	487.8	95% Modified-t UCL	488	432

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling

ug/L = microgram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

RME = reasonable maximum exposure

95% UCL - 95% Upper Confidence Limit of mean concentration

The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.29
Surface water EPCs for wildlife receptors foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Arsenic	1 / 24	5.0	5.0	NA	NA	5.0	5.0
Cadmium	24 / 24	1.6	2.9	1.9	95% Student's-t UCL	1.9	1.6
Copper	23 / 24	27.4	46.7	30.66	95% KM (t) UCL	30.7	27.4
Lead	24 / 24	12.8	99.8	30.46	95% Chebyshev (MEAN, Sd) UCL	30.5	12.8
Nickel	9 / 24	5.0	7.0	3.713	95% KM (Percentile Bootstrap) UCL	3.7	5.0
Zinc	24 / 24	600	1320	711.4	95% Student's-t UCL	711	600

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.30
Surface water EPCs for wildlife receptors foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Cadmium	5 / 5	1.5	2.2	2.1	95% Student's-t UCL	2.1	1.5
Copper	5 / 5	17.8	22.8	23.46	95% Student's-t UCL	22.8	17.8
Lead	5 / 5	11.1	33.7	23.41	95% Student's-t UCL	23.4	11.1
Nickel	1 / 5	3.8	3.8	NA	NA	3.8	3.8
Zinc	5 / 5	521	768	703.8	95% Student's-t UCL	704	521

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.31
Surface water EPCs for wildlife receptors foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Cadmium	2 / 4	1.0	1.5	NA	NA	1.5	1.0
Chromium	1 / 4	5.8	5.8	NA	NA	5.8	5.8
Copper	4 / 4	9.4	13.1	14.1	95% Student's-t UCL	13.1	9.4
Lead	4 / 4	5.5	11.7	10.6	95% Student's-t UCL	10.6	5.5
Nickel	1 / 4	2.9	2.9	NA	NA	2.9	2.9
Zinc	4 / 4	265	557	498	95% Student's-t UCL	498	265

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.32
Surface water EPCs for wildlife receptors foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Cadmium	5 / 5	1.0	1.4	1.4	95% Student's-t UCL	1.4	1.0
Copper	5 / 5	13.8	20.6	19.7	95% Student's-t UCL	19.7	13.8
Lead	5 / 5	11.2	32.6	23.1	95% Student's-t UCL	23.1	11.2
Zinc	5 / 5	361	545	503.2	95% Student's-t UCL	503	361

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling

ug/L = microgram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

NA = not applicable

RME = reasonable maximum exposure

95% UCL - 95% Upper Confidence Limit of the mean concentration

The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.33
Surface water EPCs for wildlife receptors foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Cadmium	4 / 4	0.9	1.1	1.2	95% Student's-t UCL	1.1	0.9
Copper	4 / 4	12.2	21.5	22.6	95% Student's-t UCL	21.5	12.2
Lead	4 / 4	12.1	34.5	30.3	95% Student's-t UCL	30.3	12.1
Zinc	4 / 4	302	445	428.9	95% Student's-t UCL	429	302

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.34
Surface water EPCs for wildlife foraging at sampling location Bakers Bridge on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Cadmium	4 / 5	0.7	0.8	0.8	95% KM (t) UCL	0.8	0.7
Copper	4 / 5	9.5	16.3	13.8	95% KM (t) UCL	13.8	9.5
Lead	5 / 5	7.8	26.0	17.7	95% Student's-t UCL	17.7	7.8
Zinc	5 / 5	216	273	272.4	95% Student's-t UCL	272	216

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.35
EDD formulas for the targeted wildlife receptors
Baseline Ecological Risk Assessment
Upper Animas Mining District

Avian insectivore - American dipper						
estimated daily dose (EDD_x)	=	**aquatic insect exposure** $FIR*FC_{inverts}*PDF*AUF$	+	**surface water exposure** $WIR*WC_x*AUF$	+	**sediment exposure** $SIR*SC_x*AUF$
mg/kg BW-day		mg/kg BW-day		L/kg BW-day		mg/kg BW-day
Avian omnivore - mallard [#]						
estimated daily dose (EDD_x)	=	**invertebrate and plant exposure**[#] $FIR[(FC_{invert}*PDF)+(FC_{plant}*PDF)]*AUF$	+	**surface water exposure** $WIR*WC_x*AUF$	+	**sediment exposure** $SIR*SC_x*AUF$
mg/kg BW-day		mg/kg BW-day		L/kg BW-day		mg/kg BW-day
Avian piscivore - belted kingfisher						
estimated daily dose (EDD_x)	=	**fish exposure** $FIR*FC_{fish}*PDF*AUF$	+	**surface water exposure** $WIR*WC_x*AUF$	+	**sediment exposure** $SIR*SC_x*AUF$
mg/kg BW-day		mg/kg BW-day		L/kg BW-day		mg/kg BW-day
Mammalian herbivore - muskrat						
estimated daily dose (EDD_x)	=	**aquatic plant exposure** $FIR*FC_{plant}*PDF*AUF$	+	**surface water exposure** $WIR*WC_x*AUF$	+	**sediment exposure** $SIR*SC_x*AUF$
mg/kg BW-day		mg/kg BW-day		L/kg BW-day		mg/kg BW-day

[#] The mallard is modeled for two diets: 100% benthic invertebrates to represent feeding by females during the egg-laying season, and an equal diet of benthic invertebrates (50%) and aquatic plants (50%) for the rest of the year.

$FC_{xi} = SC_x * AF_x$

Where: EDD_x = estimated daily dose of COPEC "x" (mg COPEC/kg BW-day)
FIR = food ingestion rate (kg dw/kg BW-day)
FC_{xi} = concentration of COPEC "x" in food item "i" (mg/kg dw)
PDF = proportion of diet composed of food type "i" (unitless)
WIR = water ingestion rate (L/day)
WC_x = concentration of COPEC "x" in surface water (mg/L)
SIR = sediment ingestion rate (kg dw/day)
SC_x = concentration of COPEC"x" in sediment (mg/kg [calculated as a receptor-specific fraction of the FIR])
BW = body weight (kg)
AUF = area use factor (unitless; assumed 1.0)

created by: SJP (1/9/14)
reviewed by: MC (2/27/19)

Table 4.36
Exposure parameters for the four wildlife receptors used in food chain modeling
Baseline Ecological Risk Assessment
Upper Animas Mining District

wildlife species	body weight (kg)	ingestion rates: food (kg/kg BW-day, dw)	ingestion rates: water (L/kg BW-day)	ingestion rates: sediment (kg/kg BW-day, dw)	dietary composition (%): aquatic invert.	dietary composition (%): fish	dietary composition (%): aquatic plants	home range
Aquatic Insectivorous Birds								
American dipper (*Cinclus mexicanus*)	0.0565[g]	0.2173[a]	0.152[e]	0.02173[n]	100[j]	--	--	759 m (along a water course)
Aquatic Herbivorous Mammals								
muskrat (*Ondatra zibethicus*)	1.17[h]	0.0839[b]	0.0975[f]	0.00839[n]	--	--	100[j]	0.13 hectares
Piscivorous Birds								
belted kingfisher (*Ceryle alcyon*)	0.147[i]	0.0869[c]	0.111[e]	0.00174 [o]	--	100[j]	--	2.25 km
Omnivorous Birds								
mallard (*Anas platyrhynchos*)	1.162[i]	0.0519[d]	0.056[e]	0.00104[m]	100[k] 50[l]	-- --	-- 50[l]	111 hectares

[a] Calculated using IR_{food} (g dw/day) = 0.398*BW(g)$^{0.850}$, adjusted to 1.0 kg of receptor (see eq. 3-4 [passerines] on p. 3-4 in EPA, 1993)

[b] Calculated using IR_{food} (g dw/day) = 0.577*BW(g)$^{0.727}$, adjusted to 1.0 kg of receptor (see eq. 3-9 [herbivores] on p. 3-6 in EPA, 1993)

[c] Calculated using IR_{food} (g dw/day) = 0.301*BW(g)$^{0.751}$, adjusted to 1.0 kg of receptor (see eq. 3-5 [non-passerines] on p. 3-5 in EPA, 1993)

[d] Calculated using IR_{food} (g dw/day) = 0.301*BW(g)$^{0.751}$, adjusted to 1.0 kg of receptor (see eq. 3-5 [non-passerines] on p. 3-5 in EPA, 1993)

[e] Calculated using IR_{water} (L/day) = 0.059*BW(kg)$^{0.67}$, adjusted to 1.0 kg of receptor (see eq. 3-15 [all birds] on p. 3-8 in EPA, 1993)

[f] Calculated using IR_{water} (L/day) = 0.099*BW(kg)$^{0.90}$, adjusted to 1.0 kg of receptor (see eq. 3-17 [all mammals] on p. 3-10 in EPA, 1993)

[g] Ealey, D., 1977

[h] Silva and Downing, 1995

[i] EPA, 1993

[j] Conservative assumption

[k] the100% aquatic invertebrate diet is for females foraging prior to egg production in the spring

[l] the 50% aquatic invertebrates + 50% aquatic plants represents an average mallard diet for the rest of the year.

[m] Table 4-4 in EPA, 1993 (value represents 2% of food intake on a dry-weight basis)

[n] best professional judgment (value represents 10% of food intake on a dry-weight basis)

[o] best professional judgment (value represents 2% of food intake on a dry-weight basis)

BW - Body weight
dw - dry weight

created by: SJP (1/9/14)
reviewed by: MC (2/27/19)

Table 4.37
Soil-to-plant regression models and uptake factors for use in food chain modeling
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	soil-to-plant regression models (dry weight)[a]		soil-to-plant uptake factors (dry weight)[a]		
	model	reference	value	basis	reference
arsenic	$C_p = e^{(-1.992 + 0.564(\ln Cs))}$	Bechtel Jacobs, 1998b (Table 7)	regression model available		
cadmium	$C_p = e^{(-0.476 + 0.546(\ln Cs))}$	EPA, 2007 (Table 4a)	regression model available		
chromium	--		0.041	median	EPA, 2007 (Table 4a)
copper	$C_p = e^{(0.669 + 0.394(\ln Cs))}$	EPA, 2007 (Table 4a)	regression model available		
lead	$C_p = e^{(-1.328 + 0.561(\ln Cs))}$	EPA, 2007 (Table 4a)	regression model available		
mercury	$C_p = e^{(-0.996 + 0.544(\ln Cs))}$	Bechtel Jacobs, 1998b (Table 7)	regression model available		
nickel	$C_p = e^{(-2.224 + 0.748(\ln Cs))}$	EPA, 2007 (Table 4a)	regression model available		
selenium	$C_p = e^{(-0.678 + 1.104(\ln Cs))}$	EPA, 2007 (Table 4a)	regression model available		
silver	--		0.014	median	EPA, 2007 (Table 4a)
zinc	$C_p = e^{(1.575 + 0.555(\ln Cs))}$	EPA, 2007 (Table 4a)	regression model available		

[a] Tissue residue levels in the above-ground vegetative portion of rooted aquatic plants were estimated using the methods developed for terrestrial plants, except that sediment exposure point concentrations were used in the calculations

[b] C_p = concentration of an analyte in the plant; C_s = concentration of an analyte in the sediment

References:

Bechtel Jacobs. 1998b. Empirical models for the uptake of inorganic chemicals from soil by plants. Prepared for the U.S. Department of Energy. BJC/OR-133. September 1998.

U.S. Environmental Protection Agency (EPA). 2007e. Guidance for developing ecological soil screening levels. Attachment 4-1. OSWER Directive 9285.7-55. April

prepared by: SJP (12/2/13)

reviewed by: MC (2/27/19)

Table 4.38
Sediment-to-benthic invertebrate regression models and uptake factors for use in food chain modeling
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	sediment-to-benthic invert. regression models (dry weight)		sediment-to-benthic invertebrate uptake factors (dry weight)		
	model[a]	reference	value	basis	reference
arsenic	$C_i = 10^{(-0.292 + 0.754(\log Csd))}$	Bechtel Jacobs, 1998a (Table 3 - all)	regression model available		
cadmium	$C_i = 10^{(-0.314 + 0.513(\log Csd))}$	Bechtel Jacobs, 1998a (Table 3 - dep)	regression model available		
chromium	$C_i = 10^{(0.2092 + 0.365(\log Csd))}$	Bechtel Jacobs, 1998a (Table 3 - all)	regression model available		
copper	--		0.824	geometric mean	Bechtel Jacobs, 1998a (Table 2 - dep)
lead	$C_i = 10^{(-0.515 + 0.653(\log Csd))}$	Bechtel Jacobs, 1998a (Table 3 - dep)	regression model available		
mercury	--		1.186	geometric mean	Bechtel Jacobs, 1998a (Table 2 - all)
nickel	$C_i = 10^{(-0.440 + 0.695(\log Csd))}$	Bechtel Jacobs, 1998a (Table 3 - dep)	regression model available		
selenium	--		1.00	assumed	
silver	--		0.18	mean	Hirsch, 1998
zinc	$C_i = 10^{(1.89 + 0.126(\log Csd))}$	Bechtel Jacobs, 1998a (Table 3 - dep)	regression model available		

[a] C_p = concentration of an analyte in the plant; C_s = concentration of an analyte in the sediment

References:

Bechtel Jacobs, 1998a. Biota sediment accumulation factors for invertebrates: review and recommendations for Oak Ridge Reservation. Prepared for U.S. Department of Energy. BJC/OR-112. August 1998.

Hirsch, M.P. 1998. Bioaccumulation of silver from laboratory-spiked sediments in the oligochaete (*Lumbriculus variegatus*). Environ. Toxicol. Chem. 17:605-609.

prepared by: SJP (12/2/13)
reviewed by: MC (2/27/19)

Table 4.39
Sediment-to-fish uptake factors for use in food chain modeling
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	sediment-to-fish regression models (dry weight)		Sediment bioaccumulation factors for fish (dry weight)		
	model	reference	value	basis	reference
arsenic	no regression model available		0.126	average	Pascoe *et al* ., 1996
cadmium	no regression model available		0.164	average	Pascoe *et al.* , 1996
chromium	no regression model available		0.038	average	Krantzberg and Boyd, 1992
copper	no regression model available		0.100	average	Krantzberg and Boyd, 1992
lead	no regression model available		0.070	average	Krantzberg and Boyd, 1992
mercury	no regression model available		3.25	average	Cope *et al.* , 1990
nickel	no regression model available		1.00	assumed	--
selenium	no regression model available		1.00	assumed	--
silver	no regression model available		1.00	assumed	--
zinc	no regression model available		0.147	average	Pascoe *et al.* , 1996

References:

Cope, W.G., J.G. Wiener, and R.G. Rada. 1990. Mercury accumulation in yellow perch in Wisconsin seepage lakes: relation to lake characteristics. Environ. Toxicol. Chem. 9:931-940.

Krantzberg, G. and D. Boyd. 1992. The biological significance of contaminants in sediment from Hamilton Harbour, Lake Ontario. Environ. Toxicol. Chem. 11:1527-1540.

Pascoe, G.A., R.J. Blanchet, and G. Linder. 1996. Food chain analysis of exposures and risks to wildlife at a metals-contaminated wetland. Arch. Environ. Contam. Toxicol. 30:306-318.

prepared by: SJP (2/2/14)
reviewed by: MC (2/27/19)

Table 4.40
Estimated daily doses for the American dipper foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)					CTE** Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet		Sediment	Water				Diet		Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	34.2	-	2.10	4.57E-01	7.43E-01	-	1.20E+00	27.4	-	1.27	2.75E-01	5.95E-01	-	8.71E-01
Cadmium	12.9	0.0016	3.86	8.39E-01	2.80E-01	2.43E-04	1.12E+00	11.1	0.0014	2.84	6.17E-01	2.41E-01	2.13E-04	8.58E-01
Chromium	5.0	-	2.78	6.03E-01	1.09E-01	-	7.12E-01	4.7	-	2.56	5.56E-01	1.02E-01	-	6.58E-01
Copper	399	0.0162	64.9	1.41E+01	8.67E+00	2.46E-03	2.28E+01	339	0.0155	62.4	1.36E+01	7.37E+00	2.36E-03	2.09E+01
Lead	1733	0.0219	25.2	5.48E+00	3.77E+01	3.33E-03	4.31E+01	1508	0.0116	21.3	4.64E+00	3.28E+01	1.76E-03	3.74E+01
Mercury	0.10	-	0.09	1.91E-02	2.17E-03	-	2.13E-02	0.07	-	0.09	1.85E-02	1.52E-03	-	2.00E-02
Nickel	9.2	-	0.52	1.12E-01	2.00E-01	-	3.12E-01	8.2	-	0.52	1.12E-01	1.78E-01	-	2.90E-01
Selenium	1.0	-	0.88	1.92E-01	2.17E-02	-	2.13E-01	1.5	-	0.88	1.92E-01	3.26E-02	-	2.24E-01
Silver	6.4	-	0.22	4.78E-02	1.39E-01	-	1.87E-01	5.5	-	0.21	4.61E-02	1.20E-01	-	1.66E-01
Zinc	4054	0.488	799	1.74E+02	8.81E+01	7.42E-02	2.62E+02	3172	0.432	579	1.26E+02	6.89E+01	6.57E-02	1.95E+02

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from invertebrate tissue samples collected at A60 and A68 (Appendix 4)

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times AUF$
2 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.2173
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.152
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.02173

Created by: EC 1/20/14
QC'd by: 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.41
EDDs for the American dipper foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)					CTE** Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet		Sediment	Water				Diet		Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	39.6	0.0050	0.27	5.78E-02	8.61E-01	7.60E-04	9.19E-01	33.4	0.0050	0.27	5.78E-02	7.26E-01	7.60E-04	7.84E-01
Cadmium	2.9	0.0019	0.68	1.48E-01	6.30E-02	2.89E-04	2.11E-01	2.1	0.0016	0.68	1.48E-01	4.56E-02	2.43E-04	1.93E-01
Chromium	6.1	-	2.16	4.70E-01	1.33E-01	-	6.02E-01	4.6	-	2.16	4.70E-01	1.00E-01	-	5.70E-01
Copper	173	0.0307	38	8.32E+00	3.76E+00	4.67E-03	1.21E+01	137	0.0274	38	8.32E+00	2.98E+00	4.16E-03	1.13E+01
Lead	581	0.0305	7.6	1.64E+00	1.26E+01	4.64E-03	1.43E+01	478	0.0128	7.6	1.64E+00	1.04E+01	1.95E-03	1.20E+01
Mercury	0.070	-	0.11	2.33E-02	1.52E-03	-	2.48E-02	0.06	-	0.11	2.33E-02	1.30E-03	-	2.46E-02
Nickel	5.9	0.0037	0.27	5.78E-02	1.28E-01	5.62E-04	1.87E-01	5.1	0.0050	0.27	5.78E-02	1.11E-01	7.60E-04	1.69E-01
Selenium	1.9	-	0.53	1.16E-01	4.13E-02	-	1.57E-01	1.5	-	0.53	1.16E-01	3.26E-02	-	1.49E-01
Silver	2.4	-	0.27	5.78E-02	5.22E-02	-	1.10E-01	1.9	-	0.27	5.78E-02	4.13E-02	-	9.91E-02
Zinc	819	0.711	166	3.61E+01	1.78E+01	1.08E-01	5.40E+01	651	0.600	166	3.61E+01	1.41E+01	9.12E-02	5.03E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at A72 (Appendix 4)

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times AUF$
2 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.2173
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.152
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.02173

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QC'd by: RI 3/3/15

Table 4.42
EDDs for the American dipper foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)					CTE** Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet		Sediment	Water				Diet		Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	33.8	-	0.69	1.51E-01	7.34E-01	-	8.85E-01	27.9	0.000	0.69	1.51E-01	6.06E-01	-	7.57E-01
Cadmium	5.4	0.0021	0.94	2.03E-01	1.17E-01	3.19E-04	3.21E-01	4.0	0.0015	0.94	2.03E-01	8.69E-02	2.28E-04	2.91E-01
Chromium	5.4	-	2.03	4.41E-01	1.17E-01	-	5.59E-01	4.0	0.000	2.03	4.41E-01	8.69E-02	-	5.28E-01
Copper	284	0.0228	33	7.22E+00	6.17E+00	3.47E-03	1.34E+01	199	0.0178	33	7.22E+00	4.32E+00	2.71E-03	1.15E+01
Lead	729	0.0234	6.7	1.46E+00	1.58E+01	3.56E-03	1.73E+01	513	0.0111	6.7	1.46E+00	1.11E+01	1.69E-03	1.26E+01
Mercury	0.05	-	0.11	2.39E-02	1.09E-03	-	2.50E-02	0.04	0.000	0.11	2.39E-02	8.69E-04	-	2.48E-02
Nickel	7.2	0.0038	0.58	1.25E-01	1.56E-01	5.78E-04	2.82E-01	6.4	0.0038	0.58	1.25E-01	1.39E-01	5.78E-04	2.65E-01
Selenium	1.4	-	0.55	1.19E-01	3.04E-02	-	1.50E-01	1.1	0.000	0.55	1.19E-01	2.39E-02	-	1.43E-01
Silver	2.8	-	0.28	5.98E-02	6.08E-02	-	1.21E-01	1.9	0.000	0.28	5.98E-02	4.13E-02	-	1.01E-01
Zinc	1393	0.704	197	4.29E+01	3.03E+01	1.07E-01	7.33E+01	1049	0.521	197	4.29E+01	2.28E+01	7.92E-02	6.58E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight

* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at A73 (Appendix 4)

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times AUF$
2 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.2173
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.152
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.02173

Created by:EC 1/20/14
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Table 4.43
EDDS for the American dipper foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Invert tissue concentration ($C_{invert, dw}$)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Invert tissue concentration ($C_{invert, dw}$)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	39.4	-	Equation	8.15	1.77E+00	8.56E-01	-	2.63E+00	29.9	-	Equation	6.62	1.44E+00	6.50E-01	-	2.09E+00
Cadmium	4.20	0.0015	Equation	1.01	2.20E-01	9.13E-02	2.28E-04	3.12E-01	3.50	0.0010	Equation	0.92	2.01E-01	7.61E-02	1.52E-04	2.77E-01
Chromium	5.00	0.0058	Equation	2.91	6.33E-01	1.09E-01	8.82E-04	7.43E-01	4.50	0.0058	Equation	2.80	6.09E-01	9.78E-02	8.82E-04	7.08E-01
Copper	292	0.0131	0.824	241	5.23E+01	6.35E+00	1.99E-03	5.86E+01	177	0.0094	0.824	146	3.17E+01	3.85E+00	1.43E-03	3.55E+01
Lead	593	0.0106	Equation	19.8	4.29E+00	1.29E+01	1.61E-03	1.72E+01	534	0.0055	Equation	18.5	4.01E+00	1.16E+01	8.36E-04	1.56E+01
Mercury	0.09	-	1.186	0.11	2.32E-02	1.96E-03	-	2.52E-02	0.07	-	1.186	0.08	1.80E-02	1.52E-03	-	1.96E-02
Nickel	12.1	0.0029	Equation	2.05	4.46E-01	2.63E-01	4.41E-04	7.10E-01	10.0	0.0029	Equation	1.80	3.91E-01	2.17E-01	4.41E-04	6.09E-01
Selenium	2.90	-	1.00	2.90	6.30E-01	6.30E-02	-	6.93E-01	2.90	-	1.00	2.90	6.30E-01	6.30E-02	-	6.93E-01
Silver	3.10	-	0.18	0.56	1.21E-01	6.74E-02	-	1.89E-01	2.00	-	0.18	0.36	7.82E-02	4.35E-02	-	1.22E-01
Zinc	1720	0.498	Equation	198	4.31E+01	3.74E+01	7.57E-02	8.06E+01	1114	0.265	Equation	188	4.08E+01	2.42E+01	4.03E-02	6.51E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-to-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-benthic invertebrate regression models or factors (Table 4.38)

Equations
1 $Dose_{invert} = IR_{diet}$ X C_{invert} X AUF
Where C_{invert} = ($EPC_{sediment}$ X Invert BSAF) or the result of the BSAF regression equation
2 $Dose_{sed} = IR_{sediment}$ X $EPC_{sediment}$ X AUF
3 $Dose_{water} = IR_{water}$ X C_{water} X AUF
4 Total EDD = $Dose_{invert}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.2173
IR_{water} (L/kg BW-day)	0.152
$IR_{sediment}$ (kg/kg BW-day, dw)	0.02173

Created by:EC 1/20/14
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QC'd by: RI 3/3/15

Table 4.44
EDDS for the American dipper foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)					CTE** Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet		Sediment	Water				Diet		Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	27.0	-	0.61	1.33E-01	5.87E-01	-	7.20E-01	19.4	-	0.61	1.33E-01	4.22E-01	-	5.55E-01
Cadmium	6.40	0.0014	0.78	1.70E-01	1.39E-01	2.13E-04	3.09E-01	4.80	0.0010	0.78	1.70E-01	1.04E-01	1.52E-04	2.75E-01
Chromium	4.90	-	3.26	7.08E-01	1.06E-01	-	8.14E-01	4.20	-	3.26	7.08E-01	9.13E-02	-	7.99E-01
Copper	212	0.0197	15.1	3.27E+00	4.61E+00	2.99E-03	7.88E+00	147	0.0138	15.1	3.27E+00	3.19E+00	2.10E-03	6.47E+00
Lead	367	0.0231	2.29	4.98E-01	7.97E+00	3.51E-03	8.48E+00	300	0.0112	2.29	4.98E-01	6.52E+00	1.70E-03	7.02E+00
Mercury	0.04	-	0.25	5.32E-02	8.69E-04	-	5.41E-02	0.04	-	0.25	5.32E-02	8.69E-04	-	5.41E-02
Nickel	12.4	-	0.61	1.33E-01	2.69E-01	-	4.03E-01	9.40	-	0.61	1.33E-01	2.04E-01	-	3.37E-01
Selenium	1.40	-	1.22	2.66E-01	3.04E-02	-	2.96E-01	1.20	-	1.22	2.66E-01	2.61E-02	-	2.92E-01
Silver	1.40	-	0.61	1.33E-01	3.04E-02	-	1.64E-01	1.10	-	0.61	1.33E-01	2.39E-02	-	1.57E-01
Zinc	2778	0.503	187	4.07E+01	6.04E+01	7.65E-02	1.01E+02	1738	0.361	187	4.07E+01	3.78E+01	5.49E-02	7.85E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at A75D (Appendix 4)

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times AUF$
2 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.2173
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.152
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.02173

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Table 4.45
EDDs for the American dipper foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Invert tissue concentration ($C_{invert, dw}$)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Invert tissue concentration ($C_{invert, dw}$)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	37.2	-	Equation	7.80	1.70E+00	8.08E-01	-	2.50E+00	19.9	0.000	Equation	4.87	1.06E+00	4.32E-01	-	1.49E+00
Cadmium	10.5	0.0011	Equation	1.62	3.52E-01	2.28E-01	1.67E-04	5.81E-01	5.0	0.0009	Equation	1.11	2.41E-01	1.09E-01	1.37E-04	3.50E-01
Chromium	5.5	-	Equation	3.02	6.55E-01	1.20E-01	-	7.75E-01	5.2	0.000	Equation	2.95	6.42E-01	1.13E-01	-	7.55E-01
Copper	413	0.0215	0.824	340	7.39E+01	8.97E+00	3.27E-03	8.29E+01	188	0.0122	0.824	154.912	3.37E+01	4.09E+00	1.85E-03	3.77E+01
Lead	435	0.0303	Equation	16.1	3.51E+00	9.45E+00	4.61E-03	1.30E+01	296	0.0121	Equation	12.6	2.73E+00	6.43E+00	1.84E-03	9.16E+00
Mercury	0.07	-	1.186	0.08	1.80E-02	1.52E-03	-	1.96E-02	0.07	0.000	1.186	0.08	1.80E-02	1.52E-03	-	1.96E-02
Nickel	16.5	-	Equation	2.55	5.54E-01	3.59E-01	-	9.12E-01	9.7	0.000	Equation	1.76	3.83E-01	2.11E-01	-	5.93E-01
Selenium	3.3	-	1.00	3.30	7.17E-01	7.17E-02	-	7.89E-01	1.9	0.000	1.00	1.90	4.13E-01	4.13E-02	-	4.54E-01
Silver	2.2	-	0.18	0.40	8.61E-02	4.78E-02	-	1.34E-01	1.4	0.000	0.18	0.25	5.48E-02	3.04E-02	-	8.52E-02
Zinc	5320	0.429	Equation	229	4.97E+01	1.16E+02	6.52E-02	1.65E+02	2190	0.302	Equation	205	4.45E+01	4.76E+01	4.59E-02	9.21E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-to-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-benthic invertebrate regression models or factors (Table 4.38)

Equations
1 $Dose_{invert} = IR_{diet}$ X C_{invert} X AUF
Where C_{invert} = ($EPC_{sediment}$ X Invert BSAF) or the result of the BSAF regression equation
2 $Dose_{sed} = IR_{sediment}$ X $EPC_{sediment}$ X AUF
3 $Dose_{water} = IR_{water}$ X C_{water} X AUF
4 Total EDD = $Dose_{invert}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.2173
IR_{water} (L/kg BW-day)	0.152
$IR_{sediment}$ (kg/kg BW-day, dw)	0.02173

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Table 4.46
EDDs for the American dipper foraging at the Bakers Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)					CTE** Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet		Sediment	Water				Diet		Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	29.7	-	0.23	5.02E-02	6.45E-01	-	6.96E-01	21.9	-	0.23	5.02E-02	4.76E-01	-	5.26E-01
Cadmium	18.6	0.0008	1.59	3.46E-01	4.04E-01	1.22E-04	7.50E-01	10.1	0.0007	1.59	3.46E-01	2.19E-01	1.06E-04	5.66E-01
Chromium	7.0	-	2.05	4.45E-01	1.52E-01	-	5.97E-01	5.4	-	2.05	4.45E-01	1.17E-01	-	5.62E-01
Copper	332	0.0138	17.6	3.82E+00	7.21E+00	2.10E-03	1.10E+01	191	0.0095	17.6	3.82E+00	4.15E+00	1.44E-03	7.97E+00
Lead	376	0.0177	2.53	5.51E-01	8.17E+00	2.69E-03	8.72E+00	300	0.0078	2.53	5.51E-01	6.52E+00	1.19E-03	7.07E+00
Mercury	0.06	-	0.09	2.02E-02	1.30E-03	-	2.15E-02	0.04	-	0.09	2.02E-02	8.69E-04	-	2.11E-02
Nickel	31.0	-	1.59	3.45E-01	6.74E-01	-	1.02E+00	18.3	-	1.59	3.45E-01	3.98E-01	-	7.43E-01
Selenium	3.1	-	0.47	1.01E-01	6.74E-02	-	1.68E-01	2.1	-	0.47	1.01E-01	4.56E-02	-	1.47E-01
Silver	1.7	-	0.23	5.02E-02	3.69E-02	-	8.71E-02	1.3	-	0.23	5.02E-02	2.82E-02	-	7.84E-02
Zinc	8544	0.272	353	7.67E+01	1.86E+02	4.13E-02	2.62E+02	4620	0.216	353	7.67E+01	1.00E+02	3.28E-02	1.77E+02

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at Bakers Bridge (Appendix 4)

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times AUF$
2 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.2173
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.152
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.02173

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Table 4.47
EDDs for the Mallard foraging on the Animas River above Cement Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)					CTE** Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet		Sediment	Water				Diet		Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert tissue Concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert tissue Concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	34.2	-	2.10	1.09E-01	3.56E-02	-	1.45E-01	27.4	-	1.27	6.58E-02	2.85E-02	-	9.43E-02
Cadmium	12.9	0.0016	3.86	2.00E-01	1.34E-02	8.96E-05	2.14E-01	11.1	0.0014	2.84	1.47E-01	1.15E-02	7.84E-05	1.59E-01
Chromium	5.00	-	2.78	1.44E-01	5.20E-03	-	1.49E-01	4.70	-	2.56	1.33E-01	4.89E-03	-	1.38E-01
Copper	399	0.0162	64.9	3.37E+00	4.15E-01	9.07E-04	3.79E+00	339	0.0155	62.4	3.24E+00	3.53E-01	8.68E-04	3.59E+00
Lead	1733	0.0219	25.2	1.31E+00	1.80E+00	1.23E-03	3.11E+00	1508	0.0116	21.3	1.11E+00	1.57E+00	6.50E-04	2.68E+00
Mercury	0.10	-	0.09	4.57E-03	1.04E-04	-	4.67E-03	0.07	-	0.09	4.41E-03	7.28E-05	-	4.48E-03
Nickel	9.20	-	0.52	2.68E-02	9.57E-03	-	3.63E-02	8.20	-	0.52	2.68E-02	8.53E-03	-	3.53E-02
Selenium	1.00	-	0.88	4.58E-02	1.04E-03	-	4.68E-02	1.50	-	0.88	4.58E-02	1.56E-03	-	4.73E-02
Silver	6.40	-	0.22	1.14E-02	6.66E-03	-	1.81E-02	5.50	-	0.21	1.10E-02	5.72E-03	-	1.67E-02
Zinc	4054	0.488	799	4.15E+01	4.22E+00	2.73E-02	4.57E+01	3172	0.432	579	3.01E+01	3.30E+00	2.42E-02	3.34E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from invertebrate tissue samples collected at A60 and A68 (Appendix 4)

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times AUF$
2 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.0519
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.056
$\mathbf{IR_{sed}}$ (kg/kg DW-day,dw)	0.00104

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Table 4.48
EDDs for mallards foraging at sampling location A72 on the Animas River below Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)					CTE** Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet		Sediment	Water				Diet		Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	39.6	0.0050	0.27	1.38E-02	4.12E-02	2.80E-04	5.53E-02	33.4	0.0050	0.27	1.38E-02	3.47E-02	2.80E-04	4.88E-02
Cadmium	2.90	0.0019	0.68	3.52E-02	3.02E-03	1.06E-04	3.84E-02	2.10	0.0016	0.68	3.52E-02	2.18E-03	8.96E-05	3.75E-02
Chromium	6.10	-	2.16	1.12E-01	6.34E-03	-	1.18E-01	4.60	-	2.16	1.12E-01	4.78E-03	-	1.17E-01
Copper	173	0.0307	38.3	1.99E+00	1.80E-01	1.72E-03	2.17E+00	137	0.0274	38.3	1.99E+00	1.42E-01	1.53E-03	2.13E+00
Lead	581	0.0305	7.56	3.92E-01	6.04E-01	1.71E-03	9.98E-01	478	0.0128	7.56	3.92E-01	4.97E-01	7.17E-04	8.90E-01
Mercury	0.07	-	0.11	5.55E-03	7.28E-05	-	5.63E-03	0.06	-	0.11	5.55E-03	6.24E-05	-	5.62E-03
Nickel	5.90	0.0037	0.27	1.38E-02	6.14E-03	2.07E-04	2.01E-02	5.10	0.0050	0.27	1.38E-02	5.30E-03	2.80E-04	1.94E-02
Selenium	1.90	-	0.53	2.77E-02	1.98E-03	-	2.97E-02	1.50	-	0.53	2.77E-02	1.56E-03	-	2.93E-02
Silver	2.40	-	0.27	1.38E-02	2.50E-03	-	1.63E-02	1.90	-	0.27	1.38E-02	1.98E-03	-	1.58E-02
Zinc	819	0.711	166	8.62E+00	8.52E-01	3.98E-02	9.52E+00	651	0.600	166	8.62E+00	6.77E-01	3.36E-02	9.33E+00

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at A72 (Appendix 4)

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times AUF$
2 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.0519
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.056
$\mathbf{IR_{sed}}$ (kg/kg DW-day,dw)	0.00104

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Table 4.49
EDDs for mallards foraging at sampling location A73 on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)					CTE** Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet		Sediment	Water				Diet		Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	Dose $_{invert}$ [1]	Dose $_{sed}$ [2]	Dose$_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	Dose $_{invert}$ [1]	Dose $_{sed}$ [2]	Dose$_{water}$ [3]	Total EDD[4]
Arsenic	33.8	-	0.69	3.60E-02	3.52E-02	-	7.11E-02	27.9	-	0.69	3.60E-02	2.90E-02	-	6.50E-02
Cadmium	5.4	0.0021	0.94	4.86E-02	5.62E-03	1.18E-04	5.43E-02	4.0	0.0015	0.94	4.86E-02	4.16E-03	8.40E-05	5.28E-02
Chromium	5.4	-	2.03	1.05E-01	5.62E-03	-	1.11E-01	4.0	-	2.03	1.05E-01	4.16E-03	-	1.10E-01
Copper	284	0.0228	33.2	1.72E+00	2.95E-01	1.28E-03	2.02E+00	199	0.0178	33.2	1.72E+00	2.07E-01	9.97E-04	1.93E+00
Lead	729	0.0234	6.73	3.49E-01	7.58E-01	1.31E-03	1.11E+00	513	0.0111	6.73	3.49E-01	5.34E-01	6.22E-04	8.83E-01
Mercury	0.05	-	0.11	5.71E-03	5.20E-05	-	5.76E-03	0.04	-	0.11	5.71E-03	4.16E-05	-	5.75E-03
Nickel	7.2	0.0038	0.58	2.99E-02	7.49E-03	2.13E-04	3.76E-02	6.4	0.0038	0.58	2.99E-02	6.66E-03	2.13E-04	3.68E-02
Selenium	1.4	-	0.55	2.85E-02	1.46E-03	-	2.99E-02	1.1	-	0.55	2.85E-02	1.14E-03	-	2.96E-02
Silver	2.8	-	0.28	1.43E-02	2.91E-03	-	1.72E-02	1.9	-	0.28	1.43E-02	1.98E-03	-	1.62E-02
Zinc	1393	0.704	197	1.02E+01	1.45E+00	3.94E-02	1.17E+01	1049	0.521	197	1.02E+01	1.09E+00	2.92E-02	1.14E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at A73 (Appendix 4)

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times AUF$
2 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
IR_{sed} (kg/kg DW-day,dw)	0.00104

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Table 4.50
EDDs for mallards foraging at sampling location A73B on the Animas River below mainstem Mineral Creek (100% benthic invertebrate diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (ug/L)	BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)#	$Dose_{invert}$ [1]	Dose $_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)#	$Dose_{invert}$ [1]	Dose $_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	39.4	-	Equation	8.15	4.23E-01	4.10E-02	-	4.64E-01	29.9	-	Equation	6.62	3.43E-01	3.11E-02	-	3.75E-01
Cadmium	4.20	0.0015	Equation	1.01	5.26E-02	4.37E-03	8.40E-05	5.70E-02	3.50	0.0010	Equation	0.92	4.79E-02	3.64E-03	5.60E-05	5.16E-02
Chromium	5.00	0.0058	Equation	2.91	1.51E-01	5.20E-03	3.25E-04	1.57E-01	4.50	0.0058	Equation	2.80	1.45E-01	4.68E-03	3.25E-04	1.50E-01
Copper	292	0.0131	0.824	241	1.25E+01	3.04E-01	7.34E-04	1.28E+01	177	0.0094	0.824	146	7.57E+00	1.84E-01	5.26E-04	7.75E+00
Lead	593	0.0106	Equation	19.8	1.03E+00	6.17E-01	5.94E-04	1.64E+00	534	0.0055	Equation	18.5	9.58E-01	5.55E-01	3.08E-04	1.51E+00
Mercury	0.09	-	1.186	0.11	5.54E-03	9.36E-05	-	5.63E-03	0.07	-	1.186	0.08	4.31E-03	7.28E-05	-	4.38E-03
Nickel	12.1	0.0029	Equation	2.05	1.07E-01	1.26E-02	1.62E-04	1.19E-01	10.0	0.0029	Equation	1.80	9.34E-02	1.04E-02	1.62E-04	1.04E-01
Selenium	2.90	-	1.00	2.90	1.51E-01	3.02E-03	-	1.54E-01	2.90	-	1.00	2.90	1.51E-01	3.02E-03	-	1.54E-01
Silver	3.10	-	0.18	0.56	2.90E-02	3.22E-03	-	3.22E-02	2.00	-	0.18	0.36	1.87E-02	2.08E-03	-	2.08E-02
Zinc	1720	0.498	Equation	198	1.03E+01	1.79E+00	2.79E-02	1.21E+01	1114	0.265	Equation	188	9.75E+00	1.16E+00	1.48E-02	1.09E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-benthic invertebrate regression models or factors (Table 4.38)

Equations
1 $Dose_{invert}$ = IR_{diet} X C_{invert} X AUF
Where C_{invert} = ($EPC_{sediment}$ X Invert BSAF) or the result of the BSAF regression equation
2 Dose $_{sed}$= $IR_{sediment}$ X $EPC_{sediment}$ X AUF
3 $Dose_{water}$ = IR_{water} X C_{water} X AUF
4 Total EDD = $Dose_{invert}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

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Table 4.51
EDDs for mallards foraging at sampling location A75D on the Animas River below mainstem Mineral Creek (100% benthic invertebrate diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)					CTE** Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet		Sediment	Water				Diet		Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	27.0	-	0.61	3.18E-02	2.81E-02	-	5.99E-02	19.4	-	0.61	3.18E-02	2.02E-02	-	5.20E-02
Cadmium	6.40	0.0014	0.78	4.06E-02	6.66E-03	7.84E-05	4.74E-02	4.80	0.0010	0.78	4.06E-02	4.99E-03	5.60E-05	4.57E-02
Chromium	4.90	-	3.26	1.69E-01	5.10E-03	-	1.74E-01	4.20	-	3.26	1.69E-01	4.37E-03	-	1.73E-01
Copper	212	0.0197	15.1	7.81E-01	2.20E-01	1.10E-03	1.00E+00	147	0.0138	15.1	7.81E-01	1.53E-01	7.73E-04	9.35E-01
Lead	367	0.0231	2.29	1.19E-01	3.82E-01	1.29E-03	5.02E-01	300	0.0112	2.29	1.19E-01	3.12E-01	6.27E-04	4.32E-01
Mercury	0.04	-	0.25	1.27E-02	4.16E-05	-	1.28E-02	0.04	-	0.25	1.27E-02	4.16E-05	-	1.28E-02
Nickel	12.4	-	0.61	3.18E-02	1.29E-02	-	4.47E-02	9.40	-	0.61	3.18E-02	9.78E-03	-	4.16E-02
Selenium	1.40	-	1.22	6.35E-02	1.46E-03	-	6.50E-02	1.20	-	1.22	6.35E-02	1.25E-03	-	6.48E-02
Silver	1.40	-	0.61	3.18E-02	1.46E-03	-	3.33E-02	1.10	-	0.61	3.18E-02	1.14E-03	-	3.30E-02
Zinc	2778	0.503	187	9.71E+00	2.89E+00	2.82E-02	1.26E+01	1738	0.361	187	9.71E+00	1.81E+00	2.02E-02	1.15E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at A75D (Appendix 4)

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times AUF$
2 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.0519
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.056
$\mathbf{IR_{sediment}}$ (kg/kg DW-day,dw)	0.00104

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Table 4.52
Estimated daily doses for mallards foraging at sampling location A75B on the Animas R. below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)#	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	37.2	-	Equation	7.80	4.05E-01	3.87E-02	-	4.44E-01	19.9	-	Equation	4.87	2.53E-01	2.07E-02	-	2.73E-01
Cadmium	10.5	0.0011	Equation	1.62	8.41E-02	1.09E-02	6.16E-05	9.51E-02	5.0	0.0009	Equation	1.11	5.75E-02	5.20E-03	5.04E-05	6.28E-02
Chromium	5.5	-	Equation	3.02	1.57E-01	5.72E-03	-	1.62E-01	5.2	-	Equation	2.95	1.53E-01	5.41E-03	-	1.59E-01
Copper	413	0.0215	0.824	340	1.77E+01	4.30E-01	1.20E-03	1.81E+01	188	0.0122	0.824	155	8.04E+00	1.96E-01	6.83E-04	8.24E+00
Lead	435	0.0303	Equation	16.1	8.38E-01	4.52E-01	1.70E-03	1.29E+00	296	0.0121	Equation	12.6	6.52E-01	3.08E-01	6.78E-04	9.60E-01
Mercury	0.07	-	1.186	0.08	4.31E-03	7.28E-05	-	4.38E-03	0.07	-	1.186	0.08	4.31E-03	7.28E-05	-	4.38E-03
Nickel	16.5	-	Equation	2.55	1.32E-01	1.72E-02	-	1.49E-01	9.7	-	Equation	1.76	9.14E-02	1.01E-02	-	1.01E-01
Selenium	3.3	-	1.00	3.30	1.71E-01	3.43E-03	-	1.75E-01	1.9	-	1.00	1.90	9.86E-02	1.98E-03	-	1.01E-01
Silver	2.2	-	0.18	0.40	2.06E-02	2.29E-03	-	2.28E-02	1.4	-	0.18	0.25	1.31E-02	1.46E-03	-	1.45E-02
Zinc	5320	0.429	Equation	229	1.19E+01	5.53E+00	2.40E-02	1.74E+01	2190	0.302	Equation	205	1.06E+01	2.28E+00	1.69E-02	1.29E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-benthic invertebrate regression models or factors (Table 4.38)

Equations

1 $Dose_{invert}$ = IR_{diet} X C_{invert} X AUF
Where C_{invert} = ($EPC_{sediment}$ X Invert BSAF) or the result of the BSAF regression equation
2 $Dose_{sed}$ = $IR_{sediment}$ X $EPC_{sediment}$ X AUF
3 $Dose_{water}$ = IR_{water} X C_{water} X AUF
4 Total EDD = $Dose_{invert}$ + $Dose_{sediment}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 4.53
EDDs for mallards foraging at the Baker Bridge sampling location on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)					CTE** Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet		Sediment	Water				Diet		Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration ($C_{invert, dw}$)#	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	29.7	-	0.23	1.20E-02	3.09E-02	-	4.29E-02	21.9	-	0.23	1.20E-02	2.28E-02	-	3.48E-02
Cadmium	18.6	0.0008	1.59	8.26E-02	1.93E-02	4.48E-05	1.02E-01	10.1	0.0007	1.59	8.26E-02	1.05E-02	3.92E-05	9.32E-02
Chromium	7.00	-	2.05	1.06E-01	7.28E-03	-	1.14E-01	5.40	-	2.05	1.06E-01	5.62E-03	-	1.12E-01
Copper	332	0.0138	17.6	9.13E-01	3.45E-01	7.73E-04	1.26E+00	191	0.0095	17.6	9.13E-01	1.99E-01	5.32E-04	1.11E+00
Lead	376	0.0177	2.53	1.32E-01	3.91E-01	9.91E-04	5.24E-01	300	0.0078	2.53	1.32E-01	3.12E-01	4.37E-04	4.44E-01
Mercury	0.06	-	0.09	4.83E-03	6.24E-05	-	4.89E-03	0.04	-	0.09	4.83E-03	4.16E-05	-	4.87E-03
Nickel	31.0	-	1.59	8.24E-02	3.22E-02	-	1.15E-01	18.3	-	1.59	8.24E-02	1.90E-02	-	1.01E-01
Selenium	3.10	-	0.47	2.41E-02	3.22E-03	-	2.74E-02	2.10	-	0.47	2.41E-02	2.18E-03	-	2.63E-02
Silver	1.70	-	0.23	1.20E-02	1.77E-03	-	1.38E-02	1.30	-	0.23	1.20E-02	1.35E-03	-	1.33E-02
Zinc	8544	0.272	353	1.83E+01	8.89E+00	1.52E-02	2.72E+01	4620	0.216	353	1.83E+01	4.80E+00	1.21E-02	2.31E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at Bakers Bridge (Appendix 4)

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.0519
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.056
$\mathbf{IR_{sediment}}$ (kg/kg DW-day,dw)	0.00104

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Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 4.54
EDDs for the mallard foraging on the Animas River above Cement Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)									
			Diet							Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	DF_{Invert}	Plant BSAFs	Plant Concentration ($C_{plant, dw}$)##	DF_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	34.2	-	2.10	0.50	Equation	1.00	0.50	5.45E-02	2.60E-02	3.56E-02	-	1.16E-01
Cadmium	12.9	0.0016	3.86	0.50	Equation	2.51	0.50	1.00E-01	6.51E-02	1.34E-02	8.96E-05	1.79E-01
Chromium	5.00	-	2.78	0.50	0.04	0.21	0.50	7.21E-02	5.32E-03	5.20E-03	-	8.26E-02
Copper	399	0.0162	64.9	0.50	Equation	20.7	0.50	1.69E+00	5.36E-01	4.15E-01	9.07E-04	2.64E+00
Lead	1733	0.0219	25.2	0.50	Equation	17.4	0.50	6.54E-01	4.51E-01	1.80E+00	1.23E-03	2.91E+00
Mercury	0.10	-	0.09	0.50	Equation	0.11	0.50	2.28E-03	2.74E-03	1.04E-04	-	5.13E-03
Nickel	9.20	-	0.52	0.50	Equation	0.57	0.50	1.34E-02	1.48E-02	9.57E-03	-	3.77E-02
Selenium	1.00	-	0.88	0.50	Equation	0.51	0.50	2.29E-02	1.31E-02	1.04E-03	-	3.71E-02
Silver	6.40	-	0.22	0.50	0.014	0.09	0.50	5.71E-03	2.33E-03	6.66E-03	-	1.47E-02
Zinc	4054	0.488	799	0.50	Equation	486	0.50	2.07E+01	1.26E+01	4.22E+00	2.73E-02	3.76E+01

COPECs	CTE** Exposure Point Concentration		EDD (mg/kg bw-day)									
			Diet							Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert Tissue Concentration (dw)#	DF_{Invert}	Plant BSAFs	Plant Concentration ($C_{plant, dw}$)##	DF_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	27.4	-	1.27	0.50	Equation	0.88	0.50	3.29E-02	2.29E-02	2.85E-02	-	8.43E-02
Cadmium	11.1	0.0014	2.84	0.50	Equation	2.31	0.50	7.37E-02	6.00E-02	1.15E-02	7.84E-05	1.45E-01
Chromium	4.70	-	2.56	0.50	0.04	0.19	0.50	6.64E-02	5.00E-03	4.89E-03	-	7.63E-02
Copper	339	0.0155	62.4	0.50	Equation	19.4	0.50	1.62E+00	5.03E-01	3.53E-01	8.68E-04	2.48E+00
Lead	1508	0.0116	21.3	0.50	Equation	16.1	0.50	5.54E-01	4.17E-01	1.57E+00	6.50E-04	2.54E+00
Mercury	0.07	-	0.09	0.50	Equation	0.09	0.50	2.21E-03	2.26E-03	7.28E-05	-	4.53E-03
Nickel	8.20	-	0.52	0.50	Equation	0.52	0.50	1.34E-02	1.35E-02	8.53E-03	-	3.55E-02
Selenium	1.50	-	0.88	0.50	Equation	0.79	0.50	2.29E-02	2.06E-02	1.56E-03	-	4.51E-02
Silver	5.50	-	0.21	0.50	0.014	0.08	0.50	5.50E-03	2.00E-03	5.72E-03	-	1.32E-02
Zinc	3172	0.432	579	0.50	Equation	424	0.50	1.50E+01	1.10E+01	3.30E+00	2.42E-02	2.94E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue samples collected at A60 and A68 (Appendix 4)
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$

2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$

Where C_{plant} = ($EPC_{sediment}$ X plant BSAF) or the result of the BSAF regression equation

3 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$

4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$

5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

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Table 4.55
EDDs for mallards foraging at sampling location A72 on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)									
			Diet							Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	DF_{Invert}	Plant BSAFs	Plant Concentration ($C_{plant, dw}$)##	DF_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	39.6	0.0050	0.27	0.50	Equation	1.09	0.50	6.90E-03	2.82E-02	4.12E-02	2.80E-04	7.66E-02
Cadmium	2.90	0.0019	0.68	0.50	Equation	1.11	0.50	1.76E-02	2.88E-02	3.02E-03	1.06E-04	4.96E-02
Chromium	6.10	-	2.16	0.50	0.04	0.25	0.50	5.61E-02	6.49E-03	6.34E-03	-	6.89E-02
Copper	173	0.0307	38	0.50	Equation	14.9	0.50	9.94E-01	3.86E-01	1.80E-01	1.72E-03	1.56E+00
Lead	581	0.0305	7.56	0.50	Equation	9.42	0.50	1.96E-01	2.44E-01	6.04E-01	1.71E-03	1.05E+00
Mercury	0.07	-	0.11	0.50	Equation	0.09	0.50	2.78E-03	2.26E-03	7.28E-05	-	5.11E-03
Nickel	5.90	0.0037	0.27	0.50	Equation	0.41	0.50	6.90E-03	1.06E-02	6.14E-03	2.07E-04	2.38E-02
Selenium	1.90	-	0.53	0.50	Equation	1.03	0.50	1.39E-02	2.68E-02	1.98E-03	-	4.26E-02
Silver	2.40	-	0.27	0.50	0.014	0.034	0.50	6.90E-03	8.72E-04	2.50E-03	-	1.03E-02
Zinc	819	0.711	166	0.50	Equation	200	0.50	4.31E+00	5.19E+00	8.52E-01	3.98E-02	1.04E+01

COPECs	CTE** Exposure Point Concentration		EDD (mg/kg bw-day)									
			Diet							Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	DF_{Invert}	Plant BSAFs	Plant Concentration ($C_{plant, dw}$)##	DF_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	33.4	0.0050	0.27	0.50	Equation	0.99	0.50	6.90E-03	2.56E-02	3.47E-02	2.80E-04	6.75E-02
Cadmium	2.10	0.0016	0.68	0.50	Equation	0.93	0.50	1.76E-02	2.42E-02	2.18E-03	8.96E-05	4.41E-02
Chromium	4.60	-	2.16	0.50	0.04	0.19	0.50	5.61E-02	4.89E-03	4.78E-03	-	6.58E-02
Copper	137	0.0274	38	0.50	Equation	13.6	0.50	9.94E-01	3.52E-01	1.42E-01	1.53E-03	1.49E+00
Lead	478	0.0128	7.56	0.50	Equation	8.44	0.50	1.96E-01	2.19E-01	4.97E-01	7.17E-04	9.13E-01
Mercury	0.06	-	0.11	0.50	Equation	0.08	0.50	2.78E-03	2.07E-03	6.24E-05	-	4.91E-03
Nickel	5.10	0.0050	0.27	0.50	Equation	0.37	0.50	6.90E-03	9.50E-03	5.30E-03	2.80E-04	2.20E-02
Selenium	1.50	-	0.53	0.50	Equation	0.79	0.50	1.39E-02	2.06E-02	1.56E-03	-	3.60E-02
Silver	1.90	-	0.27	0.50	0.014	0.027	0.50	6.90E-03	6.90E-04	1.98E-03	-	9.57E-03
Zinc	651	0.600	166	0.50	Equation	176	0.50	4.31E+00	4.57E+00	6.77E-01	3.36E-02	9.59E+00

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at A72 (Appendix 4)
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$

2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$

Where C_{plant} = ($EPC_{sediment}$ X plant BSAF) or the result of the BSAF regression equation

3 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$

4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$

5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

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Table 4.56
EDDs for mallards foraging at sampling location A73 on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)									
			Diet							Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	DF_{plant}	Dose $_{invert}$ [1]	Dose $_{plant}$ [2]	Dose $_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	33.8	-	0.69	0.50	Equation	0.99	0.50	1.80E-02	2.58E-02	3.52E-02	-	7.89E-02
Cadmium	5.40	0.0021	0.94	0.50	Equation	1.56	0.50	2.43E-02	4.05E-02	5.62E-03	1.18E-04	7.05E-02
Chromium	5.40	-	2.03	0.50	0.04	0.22	0.50	5.27E-02	5.75E-03	5.62E-03	-	6.41E-02
Copper	284	0.0228	33.2	0.50	Equation	18.1	0.50	8.62E-01	4.69E-01	2.95E-01	1.28E-03	1.63E+00
Lead	729	0.0234	6.73	0.50	Equation	10.7	0.50	1.75E-01	2.78E-01	7.58E-01	1.31E-03	1.21E+00
Mercury	0.05	-	0.11	0.50	Equation	0.07	0.50	2.85E-03	1.88E-03	5.20E-05	-	4.79E-03
Nickel	7.20	0.0038	0.58	0.50	Equation	0.47	0.50	1.49E-02	1.23E-02	7.49E-03	2.13E-04	3.49E-02
Selenium	1.40	-	0.55	0.50	Equation	0.74	0.50	1.42E-02	1.91E-02	1.46E-03	-	3.48E-02
Silver	2.80	-	0.28	0.50	0.014	0.04	0.50	7.14E-03	1.02E-03	2.91E-03	-	1.11E-02
Zinc	1393	0.704	197	0.50	Equation	268	0.50	5.12E+00	6.97E+00	1.45E+00	3.94E-02	1.36E+01

COPECs	CTE** Exposure Point Concentration		EDD (mg/kg bw-day)									
			Diet							Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	DF_{plant}	Dose $_{invert}$ [1]	Dose $_{plant}$ [2]	Dose $_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	27.9	-	0.69	0.50	Equation	0.89	0.50	1.80E-02	2.31E-02	2.90E-02	-	7.01E-02
Cadmium	4.00	0.0015	0.94	0.50	Equation	1.32	0.50	2.43E-02	3.44E-02	4.16E-03	8.40E-05	6.29E-02
Chromium	4.00	-	2.03	0.50	0.04	0.16	0.50	5.27E-02	4.26E-03	4.16E-03	-	6.11E-02
Copper	199	0.0178	33.2	0.50	Equation	15.7	0.50	8.62E-01	4.08E-01	2.07E-01	9.97E-04	1.48E+00
Lead	513	0.0111	6.73	0.50	Equation	8.78	0.50	1.75E-01	2.28E-01	5.34E-01	6.22E-04	9.37E-01
Mercury	0.04	-	0.11	0.50	Equation	0.06	0.50	2.85E-03	1.66E-03	4.16E-05	-	4.56E-03
Nickel	6.40	0.0038	0.58	0.50	Equation	0.43	0.50	1.49E-02	1.13E-02	6.66E-03	2.13E-04	3.31E-02
Selenium	1.10	-	0.55	0.50	Equation	0.56	0.50	1.42E-02	1.46E-02	1.14E-03	-	3.00E-02
Silver	1.90	-	0.28	0.50	0.014	0.03	0.50	7.14E-03	6.90E-04	1.98E-03	-	9.80E-03
Zinc	1049	0.521	197	0.50	Equation	229	0.50	5.12E+00	5.95E+00	1.09E+00	2.92E-02	1.22E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at A73 (Appendix 4)
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$
Where C_{plant} = ($EPC_{sediment}$ X plant BSAF) or the result of the BSAF regression equation
3 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

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Table 4.57
EDDs for mallards foraging at sampling location A73B on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)										
			Diet								Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)#	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})##	DF_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	39.4	-	Equation	8.15	0.50	Equation	1.08	0.50	2.11E-01	2.81E-02	4.10E-02	-	2.81E-01
Cadmium	4.20	0.0015	Equation	1.01	0.50	Equation	1.36	0.50	2.63E-02	3.53E-02	4.37E-03	8.40E-05	6.60E-02
Chromium	5.00	0.0058	Equation	2.91	0.50	0.04	0.21	0.50	7.56E-02	5.32E-03	5.20E-03	3.25E-04	8.64E-02
Copper	292	0.0131	0.824	241	0.50	Equation	18.3	0.50	6.24E+00	4.74E-01	3.04E-01	7.34E-04	7.02E+00
Lead	593	0.0106	Equation	19.8	0.50	Equation	9.53	0.50	5.13E-01	2.47E-01	6.17E-01	5.94E-04	1.38E+00
Mercury	0.09	-	1.186	0.11	0.50	Equation	0.10	0.50	2.77E-03	2.59E-03	9.36E-05	-	5.45E-03
Nickel	12.1	0.0029	Equation	2.05	0.50	Equation	0.70	0.50	5.33E-02	1.81E-02	1.26E-02	1.62E-04	8.42E-02
Selenium	2.90	-	1.00	2.90	0.50	Equation	1.64	0.50	7.53E-02	4.27E-02	3.02E-03	-	1.21E-01
Silver	3.10	-	0.18	0.56	0.50	0.014	0.04	0.50	1.45E-02	1.13E-03	3.22E-03	-	1.88E-02
Zinc	1720	0.498	Equation	198	0.50	Equation	302	0.50	5.15E+00	7.83E+00	1.79E+00	2.79E-02	1.48E+01

COPECs	CTE** Exposure Point Concentration		EDD (mg/kg bw-day)										
			Diet								Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)#	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})##	DF_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	29.9	-	Equation	6.62	0.50	Equation	0.93	0.50	1.72E-01	2.41E-02	3.11E-02	-	2.27E-01
Cadmium	3.50	0.0010	Equation	0.92	0.50	Equation	1.23	0.50	2.39E-02	3.20E-02	3.64E-03	5.60E-05	5.96E-02
Chromium	4.50	0.0058	Equation	2.80	0.50	0.04	0.18	0.50	7.27E-02	4.79E-03	4.68E-03	3.25E-04	8.25E-02
Copper	177	0.0094	0.824	146	0.50	Equation	15.0	0.50	3.78E+00	3.89E-01	1.84E-01	5.26E-04	4.36E+00
Lead	534	0.0055	Equation	18.5	0.50	Equation	8.98	0.50	4.79E-01	2.33E-01	5.55E-01	3.08E-04	1.27E+00
Mercury	0.07	-	1.186	0.08	0.50	Equation	0.09	0.50	2.15E-03	2.26E-03	7.28E-05	-	4.48E-03
Nickel	10.0	0.0029	Equation	1.80	0.50	Equation	0.61	0.50	4.67E-02	1.57E-02	1.04E-02	1.62E-04	7.30E-02
Selenium	2.90	-	1.00	2.90	0.50	Equation	1.64	0.50	7.53E-02	4.27E-02	3.02E-03	-	1.21E-01
Silver	2.00	-	0.18	0.36	0.50	0.014	0.03	0.50	9.34E-03	7.27E-04	2.08E-03	-	1.21E-02
Zinc	1114	0.265	Equation	188	0.50	Equation	237	0.50	4.88E+00	6.15E+00	1.16E+00	1.48E-02	1.22E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-benthic invertebrate models or factors (Table 4.38)
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
Where $C_{invert} = (EPC_{sediment} \times$ Invert BSAF) or the result of the BSAF regression equation
2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$
Where $C_{plant} = (EPC_{sediment} \times$ plant BSAF) or the result of the BSAF regression equation
3 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

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Updated by: EC 2/27/15
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Table 4.58
EDDs for mallards foraging at sampling location A75D on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)									
			Diet							Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})##	DF_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	27.0	-	0.61	0.50	Equation	0.88	0.50	1.59E-02	2.27E-02	2.81E-02	-	6.67E-02
Cadmium	6.40	0.0014	0.78	0.50	Equation	1.71	0.50	2.03E-02	4.44E-02	6.66E-03	7.84E-05	7.15E-02
Chromium	4.90	-	3.26	0.50	0.04	0.20	0.50	8.45E-02	5.21E-03	5.10E-03	-	9.48E-02
Copper	212	0.0197	15.1	0.50	Equation	16.1	0.50	3.91E-01	4.18E-01	2.20E-01	1.10E-03	1.03E+00
Lead	367	0.0231	2.29	0.50	Equation	7.28	0.50	5.95E-02	1.89E-01	3.82E-01	1.29E-03	6.31E-01
Mercury	0.04	-	0.25	0.50	Equation	0.06	0.50	6.36E-03	1.66E-03	4.16E-05	-	8.06E-03
Nickel	12.4	-	0.61	0.50	Equation	0.71	0.50	1.59E-02	1.85E-02	1.29E-02	-	4.73E-02
Selenium	1.40	-	1.22	0.50	Equation	0.74	0.50	3.18E-02	1.91E-02	1.46E-03	-	5.23E-02
Silver	1.40	-	0.61	0.50	0.014	0.02	0.50	1.59E-02	5.09E-04	1.46E-03	-	1.79E-02
Zinc	2778	0.503	187	0.50	Equation	394	0.50	4.86E+00	1.02E+01	2.89E+00	2.82E-02	1.80E+01

COPECs	CTE** Exposure Point Concentration		EDD (mg/kg bw-day)									
			Diet							Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})##	DF_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	19.4	-	0.61	0.50	Equation	0.73	0.50	1.59E-02	1.89E-02	2.02E-02	-	5.49E-02
Cadmium	4.80	0.0010	0.78	0.50	Equation	1.46	0.50	2.03E-02	3.80E-02	4.99E-03	5.60E-05	6.33E-02
Chromium	4.20	-	3.26	0.50	0.04	0.17	0.50	8.45E-02	4.47E-03	4.37E-03	-	9.34E-02
Copper	147	0.0138	15.1	0.50	Equation	13.9	0.50	3.91E-01	3.62E-01	1.53E-01	7.73E-04	9.06E-01
Lead	300	0.0112	2.29	0.50	Equation	6.50	0.50	5.95E-02	1.69E-01	3.12E-01	6.27E-04	5.41E-01
Mercury	0.04	-	0.25	0.50	Equation	0.06	0.50	6.36E-03	1.66E-03	4.16E-05	-	8.06E-03
Nickel	9.40	-	0.61	0.50	Equation	0.58	0.50	1.59E-02	1.50E-02	9.78E-03	-	4.07E-02
Selenium	1.20	-	1.22	0.50	Equation	0.62	0.50	3.18E-02	1.61E-02	1.25E-03	-	4.91E-02
Silver	1.10	-	0.61	0.50	0.014	0.02	0.50	1.59E-02	4.00E-04	1.14E-03	-	1.75E-02
Zinc	1738	0.361	187	0.50	Equation	304	0.50	4.86E+00	7.88E+00	1.81E+00	2.02E-02	1.46E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at A75D (Appendix 4)
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$
Where $C_{plant} = (EPC_{sediment} \times \text{plant BSAF})$ or the result of the BSAF regression equation
3 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

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Table 4.59
EDDs for mallards foraging at sampling location A75B on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)										
			Diet								Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (ug/L)	BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)#	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})##	Df_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	37.2	-	Equation	7.80	0.50	Equation	1.05	0.50	2.02E-01	2.72E-02	3.87E-02	-	2.68E-01
Cadmium	10.5	0.0011	Equation	1.62	0.50	Equation	2.24	0.50	4.21E-02	5.82E-02	1.09E-02	6.16E-05	1.11E-01
Chromium	5.50	-	Equation	3.02	0.50	0.04	0.23	0.50	7.83E-02	5.85E-03	5.72E-03	-	8.98E-02
Copper	413	0.0215	0.824	340	0.50	Equation	21.0	0.50	8.83E+00	5.44E-01	4.30E-01	1.20E-03	9.81E+00
Lead	435	0.0303	Equation	16.1	0.50	Equation	8.01	0.50	4.19E-01	2.08E-01	4.52E-01	1.70E-03	1.08E+00
Mercury	0.07	-	1.186	0.08	0.50	Equation	0.09	0.50	2.15E-03	2.26E-03	7.28E-05	-	4.48E-03
Nickel	16.5	-	Equation	2.55	0.50	Equation	0.88	0.50	6.61E-02	2.29E-02	1.72E-02	-	1.06E-01
Selenium	3.30	-	1.00	3.30	0.50	Equation	1.90	0.50	8.56E-02	4.92E-02	3.43E-03	-	1.38E-01
Silver	2.20	-	0.18	0.40	0.50	0.014	0.03	0.50	1.03E-02	7.99E-04	2.29E-03	-	1.34E-02
Zinc	5320	0.429	Equation	229	0.50	Equation	565	0.50	5.94E+00	1.47E+01	5.53E+00	2.40E-02	2.62E+01

	CTE** Exposure Point Concentration		EDD (mg/kg bw-day)										
			Diet								Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (ug/L)	BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)#	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})##	Df_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	19.9	-	Equation	4.87	0.50	Equation	0.74	0.50	1.26E-01	1.91E-02	2.07E-02	-	1.66E-01
Cadmium	5.00	0.0009	Equation	1.11	0.50	Equation	1.50	0.50	2.88E-02	3.88E-02	5.20E-03	5.04E-05	7.28E-02
Chromium	5.20	-	Equation	2.95	0.50	0.04	0.21	0.50	7.67E-02	5.53E-03	5.41E-03	-	8.76E-02
Copper	188	0.0122	0.824	155	0.50	Equation	15.4	0.50	4.02E+00	3.99E-01	1.96E-01	6.83E-04	4.61E+00
Lead	296	0.0121	Equation	12.6	0.50	Equation	6.45	0.50	3.26E-01	1.67E-01	3.08E-01	6.78E-04	8.02E-01
Mercury	0.07	-	1.186	0.08	0.50	Equation	0.09	0.50	2.15E-03	2.26E-03	7.28E-05	-	4.48E-03
Nickel	9.70	-	Equation	1.76	0.50	Equation	0.59	0.50	4.57E-02	1.54E-02	1.01E-02	-	7.12E-02
Selenium	1.90	-	1.00	1.90	0.50	Equation	1.03	0.50	4.93E-02	2.68E-02	1.98E-03	-	7.80E-02
Silver	1.40	-	0.18	0.25	0.50	0.014	0.02	0.50	6.54E-03	5.09E-04	1.46E-03	-	8.50E-03
Zinc	2190	0.302	Equation	205	0.50	Equation	345	0.50	5.31E+00	8.96E+00	2.28E+00	1.69E-02	1.66E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-benthic invertebrate models or factors (Table 4.38)
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
Where $C_{invert} = (EPC_{sediment} \times$ Invert BSAF) or the result of the BSAF regression equation
2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$
Where $C_{plant} = (EPC_{sediment} \times$ plant BSAF) or the result of the BSAF regression equation
3 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$
4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.0519
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.056
$\mathbf{IR_{sediment}}$ (kg/kg DW-day,dw)	0.00104

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Table 4.60
EDDs for mallards foraging at the Bakers Bridge sampling location on the Animas R. below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration									Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})##	DF_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	29.7	-	0.23	0.50	Equation	0.92	0.50	5.99E-03	2.40E-02	3.09E-02	-	6.09E-02
Cadmium	18.6	0.0008	1.59	0.50	Equation	3.06	0.50	4.13E-02	7.95E-02	1.93E-02	4.48E-05	1.40E-01
Chromium	7.00	-	2.05	0.50	0.04	0.29	0.50	5.31E-02	7.45E-03	7.28E-03	-	6.79E-02
Copper	332	0.0138	17.6	0.50	Equation	19.2	0.50	4.56E-01	4.99E-01	3.45E-01	7.73E-04	1.30E+00
Lead	376	0.0177	2.53	0.50	Equation	7.38	0.50	6.58E-02	1.91E-01	3.91E-01	9.91E-04	6.49E-01
Mercury	0.06	-	0.09	0.50	Equation	0.08	0.50	2.41E-03	2.07E-03	6.24E-05	-	4.55E-03
Nickel	31.0	-	1.59	0.50	Equation	1.41	0.50	4.12E-02	3.66E-02	3.22E-02	-	1.10E-01
Selenium	3.10	-	0.47	0.50	Equation	1.77	0.50	1.21E-02	4.59E-02	3.22E-03	-	6.12E-02
Silver	1.70	-	0.23	0.50	0.014	0.02	0.50	5.99E-03	6.18E-04	1.77E-03	-	8.38E-03
Zinc	8544	0.272	353	0.50	Equation	735	0.50	9.16E+00	1.91E+01	8.89E+00	1.52E-02	3.71E+01

COPECs	CTE** Exposure Point Concentration									Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)#	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})##	DF_{plant}	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	21.9	-	0.23	0.50	Equation	0.78	0.50	5.99E-03	2.02E-02	2.28E-02	-	4.90E-02
Cadmium	10.1	0.0007	1.59	0.50	Equation	2.20	0.50	4.13E-02	5.70E-02	1.05E-02	3.92E-05	1.09E-01
Chromium	5.40	-	2.05	0.50	0.04	0.22	0.50	5.31E-02	5.75E-03	5.62E-03	-	6.45E-02
Copper	191	0.0095	17.6	0.50	Equation	15.5	0.50	4.56E-01	4.01E-01	1.99E-01	5.32E-04	1.06E+00
Lead	300	0.0078	2.53	0.50	Equation	6.50	0.50	6.58E-02	1.69E-01	3.12E-01	4.37E-04	5.47E-01
Mercury	0.04	-	0.09	0.50	Equation	0.06	0.50	2.41E-03	1.66E-03	4.16E-05	-	4.12E-03
Nickel	18.3	-	1.59	0.50	Equation	0.95	0.50	4.12E-02	2.47E-02	1.90E-02	-	8.49E-02
Selenium	2.10	-	0.47	0.50	Equation	1.15	0.50	1.21E-02	2.99E-02	2.18E-03	-	4.41E-02
Silver	1.30	-	0.23	0.50	0.014	0.02	0.50	5.99E-03	4.72E-04	1.35E-03	-	7.82E-03
Zinc	4620	0.216	353	0.50	Equation	522	0.50	9.16E+00	1.36E+01	4.80E+00	1.21E-02	2.75E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
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* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived from measured values obtained from one invertebrate tissue sample collected at Bakers Bridge (Appendix 4)
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$

2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$

Where C_{plant} = ($EPC_{sediment}$ X plant BSAF) or the result of the BSAF regression equation

3 $Dose_{sed} = IR_{sediment} \times EPC_{sediment} \times AUF$

4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$

5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.61
EDDs for the belted kingfisher foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	34.2	-	0.126	4.31	3.74E-01	5.94E-02	-	4.34E-01	27.4	-	0.126	3.45	3.00E-01	4.76E-02	-	3.48E-01
Cadmium	12.9	0.0016	0.164	2.12	1.84E-01	2.24E-02	1.78E-04	2.06E-01	11.1	0.0014	0.164	1.82	1.58E-01	1.93E-02	1.55E-04	1.78E-01
Chromium	5.00	-	0.038	0.19	1.65E-02	8.69E-03	-	2.52E-02	4.70	-	0.038	0.18	1.55E-02	8.17E-03	-	2.37E-02
Copper	399	0.0162	0.100	39.9	3.47E+00	6.93E-01	1.80E-03	4.16E+00	339	0.0155	0.100	33.9	2.95E+00	5.89E-01	1.72E-03	3.54E+00
Lead	1733	0.0219	0.070	121	1.05E+01	3.01E+00	2.43E-03	1.36E+01	1508	0.0116	0.070	106	9.17E+00	2.62E+00	1.29E-03	1.18E+01
Mercury (inorganic)	0.10	-	3.25	0.33	2.82E-02	1.74E-04	-	2.84E-02	0.07	-	3.25	0.23	1.98E-02	1.22E-04	-	1.99E-02
Nickel	9.20	-	1.00	9.20	7.99E-01	1.60E-02	-	8.15E-01	8.20	-	1.00	8.2	7.13E-01	1.43E-02	-	7.27E-01
Selenium	1.00	-	1.00	1.00	8.67E-02	1.73E-03	-	8.85E-02	1.50	-	1.00	1.50	1.30E-01	2.61E-03	-	1.33E-01
Silver	6.40	-	1.00	6.40	5.56E-01	1.11E-02	-	5.67E-01	5.50	-	1.00	5.50	4.78E-01	9.56E-03	-	4.88E-01
Zinc	4054	0.488	0.147	596	5.18E+01	7.05E+00	5.42E-02	5.89E+01	3172	0.432	0.147	466	4.05E+01	5.51E+00	4.80E-02	4.61E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-fish BSAFs (Table 4.39)

Equations

1 $Dose_{fish} = IR_{diet} \times C_{fish} \times AUF$
Where $C_{fish} = EPC_{sediment} \times BSAF$
2 $Dose_{sediment} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.0869
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.111
$\mathbf{IR_{sed}}$ (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 4.62
EDDs for the belted kingfisher foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	39.6	0.0050	0.126	4.99	4.34E-01	6.88E-02	5.55E-04	5.03E-01	33.4	0.0050	0.126	4.21	3.66E-01	5.80E-02	5.55E-04	4.24E-01
Cadmium	2.90	0.002	0.164	0.48	4.13E-02	5.04E-03	2.11E-04	4.66E-02	2.10	0.0016	0.164	0.34	2.99E-02	3.65E-03	1.78E-04	3.38E-02
Chromium	6.10	-	0.038	0.23	2.01E-02	1.06E-02	-	3.07E-02	4.60	0.000	0.038	0.17	1.52E-02	7.99E-03	-	2.32E-02
Copper	173	0.0307	0.100	17.3	1.50E+00	3.01E-01	3.41E-03	1.81E+00	137	0.0274	0.100	13.7	1.19E+00	2.38E-01	3.04E-03	1.43E+00
Lead	581	0.0305	0.070	40.7	3.53E+00	1.01E+00	3.39E-03	4.55E+00	478	0.0128	0.070	33.5	2.91E+00	8.31E-01	1.42E-03	3.74E+00
Mercury (inorganic)	0.070	-	3.25	0.23	1.98E-02	1.22E-04	-	1.99E-02	0.06	0.000	3.25	0.195	1.69E-02	1.04E-04	-	1.70E-02
Nickel	5.90	0.0037	1.00	5.90	5.13E-01	1.03E-02	4.11E-04	5.23E-01	5.10	0.0050	1.00	5.10	4.43E-01	8.86E-03	5.55E-04	4.53E-01
Selenium	1.90	-	1.00	1.90	1.65E-01	3.30E-03	-	1.68E-01	1.50	0.000	1.00	1.500	1.30E-01	2.61E-03	-	1.33E-01
Silver	2.40	-	1.00	2.40	2.09E-01	4.17E-03	-	2.13E-01	1.90	0.000	1.00	1.90	1.65E-01	3.30E-03	-	1.68E-01
Zinc	819	0.711	0.147	120	1.05E+01	1.42E+00	7.89E-02	1.20E+01	651	0.600	0.147	95.7	8.32E+00	1.13E+00	6.66E-02	9.51E+00

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-fish BSAFs (Table 4.39)

Equations

1 $Dose_{fish} = IR_{diet} X C_{fish} X AUF$

Where $C_{fish} = EPC_{sediment} X BSAF$

2 $Dose_{sediment} = IR_{sediment} X EPC_{sediment} X AUF$

3 $Dose_{water} = IR_{water} X C_{water} X AUF$

4 Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0869
IR_{water} (L/kg BW-day)	0.111
IR_{sed} (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 4.63
EDDs for the belted kingfisher foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	33.8	-	0.126	4.26	3.70E-01	5.87E-02	-	4.29E-01	27.9	-	0.126	3.52	3.05E-01	4.85E-02	-	3.54E-01
Cadmium	5.40	0.0021	0.164	0.89	7.70E-02	9.39E-03	2.33E-04	8.66E-02	4.00	0.0015	0.164	0.66	5.70E-02	6.95E-03	1.67E-04	6.41E-02
Chromium	5.40	-	0.038	0.21	1.78E-02	9.39E-03	-	2.72E-02	4.00	-	0.038	0.15	1.32E-02	6.95E-03	-	2.02E-02
Copper	284	0.0228	0.100	28.4	2.47E+00	4.94E-01	2.53E-03	2.96E+00	199	0.0178	0.100	19.9	1.73E+00	3.46E-01	1.98E-03	2.08E+00
Lead	729	0.0234	0.070	51.0	4.43E+00	1.27E+00	2.60E-03	5.70E+00	513	0.0111	0.070	35.9	3.12E+00	8.92E-01	1.23E-03	4.01E+00
Mercury (inorganic)	0.05	-	3.25	0.16	1.41E-02	8.69E-05	-	1.42E-02	0.04	-	3.25	0.13	1.13E-02	6.95E-05	-	1.14E-02
Nickel	7.20	0.0038	1.00	7.20	6.26E-01	1.25E-02	4.22E-04	6.39E-01	6.40	0.0038	1.00	6.40	5.56E-01	1.11E-02	4.22E-04	5.68E-01
Selenium	1.40	-	1.00	1.40	1.22E-01	2.43E-03	-	1.24E-01	1.10	-	1.00	1.10	9.56E-02	1.91E-03	-	9.75E-02
Silver	2.80	-	1.00	2.80	2.43E-01	4.87E-03	-	2.48E-01	1.90	-	1.00	1.90	1.65E-01	3.30E-03	-	1.68E-01
Zinc	1393	0.704	0.147	205	1.78E+01	2.42E+00	7.81E-02	2.03E+01	1049	0.521	0.147	154	1.34E+01	1.82E+00	5.78E-02	1.53E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-fish BSAFs (Table 4.39)

Equations

1 $Dose_{fish} = IR_{diet} X C_{fish} X AUF$
Where $C_{fish} = EPC_{sediment} X BSAF$
2 $Dose_{sediment} = IR_{sediment} X EPC_{sediment} X AUF$
3 $Dose_{water} = IR_{water} X C_{water} X AUF$
4 Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0869
IR_{water} (L/kg BW-day)	0.111
IR_{sed} (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 4.64
EDDs for the belted kingfisher foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	39.4	-	0.126	4.96	4.31E-01	6.85E-02	-	5.00E-01	29.9	-	0.126	3.77	3.27E-01	5.20E-02	-	3.79E-01
Cadmium	4.20	0.0015	0.164	0.69	5.99E-02	7.30E-03	1.67E-04	6.73E-02	3.5	0.0010	0.164	0.57	4.99E-02	6.08E-03	1.11E-04	5.61E-02
Chromium	5.00	0.0058	0.038	0.19	1.65E-02	8.69E-03	6.44E-04	2.58E-02	4.5	0.0058	0.038	0.17	1.49E-02	7.82E-03	6.44E-04	2.33E-02
Copper	292	0.0131	0.100	29.2	2.54E+00	5.07E-01	1.45E-03	3.05E+00	177	0.0094	0.100	17.7	1.54E+00	3.08E-01	1.04E-03	1.85E+00
Lead	593	0.0106	0.070	41.5	3.61E+00	1.03E+00	1.18E-03	4.64E+00	534	0.0055	0.070	37	3.25E+00	9.28E-01	6.11E-04	4.18E+00
Mercury (inorganic)	0.09	-	3.25	0.293	2.54E-02	1.56E-04	-	2.56E-02	0.07	-	3.25	0.228	1.98E-02	1.22E-04	-	1.99E-02
Nickel	12.1	0.0029	1.00	12.1	1.05E+00	2.10E-02	3.22E-04	1.07E+00	10.0	0.0029	1.00	10.0	8.69E-01	1.74E-02	3.22E-04	8.87E-01
Selenium	2.90	-	1.00	2.90	2.52E-01	5.04E-03	-	2.57E-01	2.9	-	1.00	2.900	2.52E-01	5.04E-03	-	2.57E-01
Silver	3.10	-	1.00	3.10	2.69E-01	5.39E-03	-	2.75E-01	2.0	-	1.00	2.00	1.74E-01	3.48E-03	-	1.77E-01
Zinc	1720	0.498	0.147	253	2.20E+01	2.99E+00	5.53E-02	2.50E+01	1114	0.265	0.147	164	1.42E+01	1.94E+00	2.94E-02	1.62E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-fish BSAFs (Table 4.39)

Equations

1 $Dose_{fish} = IR_{diet} \times C_{fish} \times AUF$
Where $C_{fish} = EPC_{sediment} \times BSAF$
2 $Dose_{sediment} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0869
IR_{water} (L/kg BW-day)	0.111
IR_{sed} (kg/kg BW-day, dw)	0.001738

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Table 4.65
EDDs for the belted kingfisher foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	27.0	-	0.126	3.40	2.96E-01	4.69E-02	-	3.43E-01	19.4	0.000	0.126	2.44	2.12E-01	3.37E-02	-	2.46E-01
Cadmium	6.40	0.0014	0.164	1.05	9.12E-02	1.11E-02	1.55E-04	1.02E-01	4.80	0.0010	0.164	0.79	6.84E-02	8.34E-03	1.11E-04	7.69E-02
Chromium	4.90	-	0.038	0.19	1.62E-02	8.52E-03	-	2.47E-02	4.20	0.000	0.038	0.16	1.39E-02	7.30E-03	-	2.12E-02
Copper	212	0.0197	0.100	21.2	1.84E+00	3.68E-01	2.19E-03	2.21E+00	147	0.0138	0.100	14.7	1.28E+00	2.55E-01	1.53E-03	1.53E+00
Lead	367	0.0231	0.070	25.7	2.23E+00	6.38E-01	2.56E-03	2.87E+00	300	0.0112	0.070	21.0	1.82E+00	5.21E-01	1.24E-03	2.35E+00
Mercury (inorganic)	0.04	-	3.25	0.13	1.13E-02	6.95E-05	-	1.14E-02	0.04	0.000	3.25	0.13	1.13E-02	6.95E-05	-	1.14E-02
Nickel	12.4	-	1.00	12.4	1.08E+00	2.16E-02	-	1.10E+00	9.40	0.000	1.00	9.40	8.17E-01	1.63E-02	-	8.33E-01
Selenium	1.40	-	1.00	1.40	1.22E-01	2.43E-03	-	1.24E-01	1.20	0.000	1.00	1.20	1.04E-01	2.09E-03	-	1.06E-01
Silver	1.40	-	1.00	1.40	1.22E-01	2.43E-03	-	1.24E-01	1.10	0.000	1.00	1.10	9.56E-02	1.91E-03	-	9.75E-02
Zinc	2778	0.503	0.147	408	3.55E+01	4.83E+00	5.58E-02	4.04E+01	1738	0.361	0.147	255	2.22E+01	3.02E+00	4.01E-02	2.53E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-fish BSAFs (Table 4.39)

Equations

1 $Dose_{fish} = IR_{diet} \times C_{fish} \times AUF$

Where $C_{fish} = EPC_{sediment} \times BSAF$

2 $Dose_{sediment} = IR_{sediment} \times EPC_{sediment} \times AUF$

3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$

4 Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0869
IR_{water} (L/kg BW-day)	0.111
IR_{sed} (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
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Qc'd by: RI 3/3/15

Table 4.66
EDDs for the belted kingfisher foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	37.2	-	0.126	4.69	4.07E-01	6.47E-02	-	4.72E-01	19.9	-	0.126	2.51	2.18E-01	3.46E-02	-	2.52E-01
Cadmium	10.5	0.0011	0.164	1.72	1.50E-01	1.82E-02	1.22E-04	1.68E-01	5.00	0.0009	0.164	0.82	7.13E-02	8.69E-03	9.99E-05	8.00E-02
Chromium	5.50	-	0.038	0.21	1.82E-02	9.56E-03	-	2.77E-02	5.20	-	0.038	0.20	1.72E-02	9.04E-03	-	2.62E-02
Copper	413	0.0215	0.100	41.3	3.59E+00	7.18E-01	2.39E-03	4.31E+00	188	0.0122	0.100	18.8	1.63E+00	3.27E-01	1.35E-03	1.96E+00
Lead	435	0.0303	0.070	30.5	2.65E+00	7.56E-01	3.36E-03	3.41E+00	296	0.0121	0.070	20.7	1.80E+00	5.14E-01	1.34E-03	2.32E+00
Mercury (inorganic)	0.07	-	3.25	0.228	1.98E-02	1.22E-04	-	1.99E-02	0.07	-	3.25	0.23	1.98E-02	1.22E-04	-	1.99E-02
Nickel	16.5	-	1.00	16.5	1.43E+00	2.87E-02	-	1.46E+00	9.70	-	1.00	9.70	8.43E-01	1.69E-02	-	8.60E-01
Selenium	3.30	-	1.00	3.30	2.87E-01	5.74E-03	-	2.93E-01	1.90	-	1.00	1.90	1.65E-01	3.30E-03	-	1.68E-01
Silver	2.20	-	1.00	2.20	1.91E-01	3.82E-03	-	1.95E-01	1.40	-	1.00	1.40	1.22E-01	2.43E-03	-	1.24E-01
Zinc	5320	0.429	0.147	782	6.80E+01	9.25E+00	4.76E-02	7.73E+01	2190	0.302	0.147	322	2.80E+01	3.81E+00	3.35E-02	3.18E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-fish BSAFs (Table 4.39)

Equations

1 $Dose_{fish} = IR_{diet} X C_{fish} X AUF$
Where $C_{fish} = EPC_{sediment} X BSAF$
2 $Dose_{sediment} = IR_{sediment} X EPC_{sediment} X AUF$
3 $Dose_{water} = IR_{water} X C_{water} X AUF$
4 Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0869
IR_{water} (L/kg BW-day)	0.111
IR_{sed} (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 4.67
EDDs for the belted kingfisher foraging at the Bakers Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet				Water				Diet				Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)#	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	29.7	-	0.126	3.74	3.25E-01	5.16E-02	-	3.77E-01	21.9	-	0.126	2.76	2.40E-01	3.81E-02	-	2.78E-01
Cadmium	18.6	0.0008	0.164	3.05	2.65E-01	3.23E-02	8.88E-05	2.97E-01	10.1	0.0007	0.164	1.66	1.44E-01	1.76E-02	7.77E-05	1.62E-01
Chromium	7.00	-	0.038	0.27	2.31E-02	1.22E-02	-	3.53E-02	5.40	-	0.038	0.21	1.78E-02	9.39E-03	-	2.72E-02
Copper	332	0.0138	0.100	33.2	2.89E+00	5.77E-01	1.53E-03	3.46E+00	191	0.0095	0.100	19.1	1.66E+00	3.32E-01	1.05E-03	1.99E+00
Lead	376	0.0177	0.070	26.3	2.29E+00	6.53E-01	1.96E-03	2.94E+00	300	0.0078	0.070	21.0	1.82E+00	5.21E-01	8.66E-04	2.35E+00
Mercury (inorganic)	0.06	-	3.25	0.20	1.69E-02	1.04E-04	-	1.70E-02	0.04	-	3.25	0.13	1.13E-02	6.95E-05	-	1.14E-02
Nickel	31.0	-	1.00	31.0	2.69E+00	5.39E-02	-	2.75E+00	18.3	-	1.00	18.3	1.59E+00	3.18E-02	-	1.62E+00
Selenium	3.10	-	1.00	3.10	2.69E-01	5.39E-03	-	2.75E-01	2.10	-	1.00	2.10	1.82E-01	3.65E-03	-	1.86E-01
Silver	1.70	-	1.00	1.70	1.48E-01	2.95E-03	-	1.51E-01	1.30	-	1.00	1.30	1.13E-01	2.26E-03	-	1.15E-01
Zinc	8544	0.272	0.147	1256	1.09E+02	1.48E+01	3.02E-02	1.24E+02	4620	0.216	0.147	679	5.90E+01	8.03E+00	2.40E-02	6.71E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-fish BSAFs (Table 4.39)

Equations

1 $Dose_{fish} = IR_{diet} \times C_{fish} \times AUF$
Where $C_{fish} = EPC_{sediment} \times BSAF$
2 $Dose_{sediment} = IR_{sediment} \times EPC_{sediment} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.0869
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.111
$\mathbf{IR_{sed}}$ (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 4.68
EDDs for the muskrat foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	34.2	-	Equation	1.00	8.39E-02	2.87E-01	-	3.71E-01	27.4	0.000	Equation	0.88	7.41E-02	2.30E-01	-	3.04E-01
Cadmium	12.9	0.0016	Equation	2.51	2.11E-01	1.08E-01	1.56E-04	3.19E-01	11.1	0.0014	Equation	2.31	1.94E-01	9.31E-02	1.37E-04	2.87E-01
Chromium	5.00	-	0.041	0.21	1.72E-02	4.20E-02	-	5.91E-02	4.70	0.000	0.04	0.19	1.62E-02	3.94E-02	-	5.56E-02
Copper	399	0.0162	Equation	20.7	1.73E+00	3.35E+00	1.58E-03	5.08E+00	339	0.0155	Equation	19.4	1.63E+00	2.84E+00	1.51E-03	4.47E+00
Lead	1733	0.0219	Equation	17.4	1.46E+00	1.45E+01	2.14E-03	1.60E+01	1508	0.0116	Equation	16.1	1.35E+00	1.27E+01	1.13E-03	1.40E+01
Mercury	0.10	-	Equation	0.11	8.86E-03	8.39E-04	-	9.69E-03	0.07	0.000	Equation	0.09	7.29E-03	5.87E-04	-	7.88E-03
Nickel	9.20	-	Equation	0.57	4.77E-02	7.72E-02	-	1.25E-01	8.20	0.000	Equation	0.52	4.38E-02	6.88E-02	-	1.13E-01
Selenium	1.00	-	Equation	0.51	4.25E-02	8.37E-03	-	5.09E-02	1.50	0.000	Equation	0.79	6.66E-02	1.26E-02	-	7.92E-02
Silver	6.40	-	0.014	0.09	7.52E-03	5.37E-02	-	6.12E-02	5.50	0.000	0.014	0.08	6.46E-03	4.61E-02	-	5.26E-02
Zinc	4054	0.488	Equation	486	4.08E+01	3.40E+01	4.76E-02	7.48E+01	3172	0.432	Equation	424	3.56E+01	2.66E+01	4.21E-02	6.22E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations
1 $Dose_{plant}$ =IR_{diet} X C_{plant} X AUF
Where C_{plant} = ($EPC_{sediment}$ X BSAF) or the result of the BSAF regression equation
2 $Dose_{sed}$= $IR_{sediment}$ X $EPC_{sediment}$ X AUF
3 $Dose_{water}$ = IR_{water} X C_{water} X AUF
4 Total EDD = $Dose_{plant}$ + $Dose_{sed}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

Created by: EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 4.69
EDDs for the muskrat foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	39.6	0.0050	Equation	1.09	9.11E-02	3.32E-01	4.88E-04	4.24E-01	33.4	0.0050	Equation	0.99	8.28E-02	2.80E-01	4.88E-04	3.64E-01
Cadmium	2.90	0.002	Equation	1.11	9.32E-02	2.43E-02	1.85E-04	1.18E-01	2.10	0.0016	Equation	0.93	7.82E-02	1.76E-02	1.56E-04	9.59E-02
Chromium	6.10	-	0.04	0.25	2.10E-02	5.12E-02	-	7.22E-02	4.60	-	0.04	0.19	1.58E-02	3.86E-02	-	5.44E-02
Copper	173	0.0307	Equation	14.9	1.25E+00	1.45E+00	2.99E-03	2.70E+00	137	0.0274	Equation	13.6	1.14E+00	1.15E+00	2.67E-03	2.29E+00
Lead	581	0.0305	Equation	9.42	7.90E-01	4.87E+00	2.97E-03	5.67E+00	478	0.0128	Equation	8.44	7.08E-01	4.01E+00	1.25E-03	4.72E+00
Mercury	0.070	-	Equation	0.09	7.29E-03	5.87E-04	-	7.88E-03	0.06	-	Equation	0.08	6.71E-03	5.03E-04	-	7.21E-03
Nickel	5.90	0.0037	Equation	0.41	3.42E-02	4.95E-02	3.61E-04	8.41E-02	5.10	0.0050	Equation	0.37	3.07E-02	4.28E-02	4.88E-04	7.40E-02
Selenium	1.90	-	Equation	1.03	8.65E-02	1.59E-02	-	1.02E-01	1.50	-	Equation	0.79	6.66E-02	1.26E-02	-	7.92E-02
Silver	2.40	-	0.014	0.03	2.82E-03	2.01E-02	-	2.30E-02	1.90	-	0.014	0.03	2.23E-03	1.59E-02	-	1.82E-02
Zinc	819	0.711	Equation	200	1.68E+01	6.87E+00	6.93E-02	2.37E+01	651	0.600	Equation	176	1.48E+01	5.46E+00	5.85E-02	2.03E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations
1 $Dose_{plant}$ =IR_{diet} X C_{plant} X AUF
Where C_{plant} = ($EPC_{sediment}$ X BSAF) or the result of the BSAF regression equation
2 $Dose_{sed}$= $IR_{sediment}$ X $EPC_{sediment}$ X AUF
3 $Dose_{water}$ = IR_{water} X C_{water} X AUF
4 Total EDD = $Dose_{plant}$ + $Dose_{sed}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 4.70
EDDs for the muskrat foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	33.8	-	Equation	0.99	8.34E-02	2.84E-01	-	3.67E-01	27.9	-	Equation	0.89	7.48E-02	2.34E-01	-	3.09E-01
Cadmium	5.40	0.0021	Equation	1.56	1.31E-01	4.53E-02	2.05E-04	1.76E-01	4.00	0.0015	Equation	1.32	1.11E-01	3.36E-02	1.46E-04	1.45E-01
Chromium	5.40	-	0.04	0.22	1.86E-02	4.53E-02	-	6.39E-02	4.00	-	0.04	0.16	1.38E-02	3.36E-02	-	4.73E-02
Copper	284	0.0228	Equation	18.1	1.52E+00	2.38E+00	2.22E-03	3.90E+00	199	0.0178	Equation	15.7	1.32E+00	1.67E+00	1.74E-03	2.99E+00
Lead	729	0.0234	Equation	10.7	8.97E-01	6.12E+00	2.28E-03	7.02E+00	513	0.0111	Equation	8.78	7.37E-01	4.30E+00	1.08E-03	5.04E+00
Mercury	0.05	-	Equation	0.07	6.07E-03	4.20E-04	-	6.49E-03	0.04	-	Equation	0.06	5.38E-03	3.36E-04	-	5.71E-03
Nickel	7.20	0.0038	Equation	0.47	3.97E-02	6.04E-02	3.71E-04	1.01E-01	6.40	0.0038	Equation	0.43	3.64E-02	5.37E-02	3.71E-04	9.05E-02
Selenium	1.40	-	Equation	0.74	6.17E-02	1.17E-02	-	7.35E-02	1.10	-	Equation	0.56	4.73E-02	9.23E-03	-	5.65E-02
Silver	2.80	-	0.014	0.04	3.29E-03	2.35E-02	-	2.68E-02	1.90	-	0.014	0.03	2.23E-03	1.59E-02	-	1.82E-02
Zinc	1393	0.704	Equation	268	2.25E+01	1.17E+01	6.86E-02	3.43E+01	1049	0.521	Equation	229	1.92E+01	8.80E+00	5.08E-02	2.81E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations
1 $Dose_{plant} = IR_{diet}$ X C_{plant} X AUF
Where C_{plant} = ($EPC_{sediment}$ X BSAF) or the result of the BSAF regression equation
2 $Dose_{sed} = IR_{sediment}$ X $EPC_{sediment}$ X AUF
3 $Dose_{water} = IR_{water}$ X C_{water} X AUF
4 Total EDD = $Dose_{plant}$ + $Dose_{sed}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 4.71
EDDs for the muskrat foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	39.4	-	Equation	1.08	9.09E-02	3.31E-01	-	4.21E-01	29.9	-	Equation	0.93	7.78E-02	2.51E-01	-	3.29E-01
Cadmium	4.20	0.0015	Equation	1.36	1.14E-01	3.52E-02	1.46E-04	1.49E-01	3.5	0.0010	Equation	1.23	1.03E-01	2.94E-02	9.75E-05	1.33E-01
Chromium	5.00	0.0058	0.04	0.21	1.72E-02	4.20E-02	5.66E-04	5.97E-02	4.5	0.0058	0.04	0.18	1.55E-02	3.78E-02	5.66E-04	5.38E-02
Copper	292	0.0131	Equation	18.3	1.53E+00	2.45E+00	1.28E-03	3.98E+00	177	0.0094	Equation	15.0	1.26E+00	1.49E+00	9.17E-04	2.74E+00
Lead	593	0.0106	Equation	9.53	7.99E-01	4.98E+00	1.03E-03	5.78E+00	534	0.0055	Equation	8.98	7.54E-01	4.48E+00	5.36E-04	5.23E+00
Mercury	0.09	-	Equation	0.10	8.36E-03	7.55E-04	-	9.12E-03	0.07	-	Equation	0.09	7.29E-03	5.87E-04	-	7.88E-03
Nickel	12.1	0.0029	Equation	0.70	5.86E-02	1.02E-01	2.83E-04	1.60E-01	10.0	0.0029	Equation	0.61	5.08E-02	8.39E-02	2.83E-04	1.35E-01
Selenium	2.90	-	Equation	1.64	1.38E-01	2.43E-02	-	1.62E-01	2.9	-	Equation	1.64	1.38E-01	2.43E-02	-	1.62E-01
Silver	3.10	-	0.014	0.04	3.64E-03	2.60E-02	-	2.97E-02	2.0	-	0.014	0.03	2.35E-03	1.68E-02	-	1.91E-02
Zinc	1720	0.498	Equation	302	2.53E+01	1.44E+01	4.86E-02	3.98E+01	1114	0.265	Equation	237	1.99E+01	9.35E+00	2.58E-02	2.93E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations
1 $Dose_{plant} = IR_{diet}$ X C_{plant} X AUF
Where C_{plant} = ($EPC_{sediment}$ X BSAF) or the result of the BSAF regression equation
2 $Dose_{sed}$= $IR_{sediment}$ X $EPC_{sediment}$ X AUF
3 $Dose_{water}$ = IR_{water} X C_{water} X AUF
4 Total EDD = $Dose_{plant}$ + $Dose_{sed}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 4.72
EDDs for the muskrat foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	27.0	-	Equation	0.88	7.34E-02	2.27E-01	-	3.00E-01	19.4	-	Equation	0.73	6.09E-02	1.63E-01	-	2.24E-01
Cadmium	6.40	0.0014	Equation	1.71	1.44E-01	5.37E-02	1.37E-04	1.97E-01	4.80	0.0010	Equation	1.46	1.23E-01	4.03E-02	9.75E-05	1.63E-01
Chromium	4.90	-	0.04	0.20	1.69E-02	4.11E-02	-	5.80E-02	4.20	-	0.04	0.17	1.44E-02	3.52E-02	-	4.97E-02
Copper	212	0.0197	Equation	16.1	1.35E+00	1.78E+00	1.92E-03	3.13E+00	147	0.0138	Equation	13.9	1.17E+00	1.23E+00	1.35E-03	2.40E+00
Lead	367	0.0231	Equation	7.28	6.11E-01	3.08E+00	2.25E-03	3.69E+00	300	0.0112	Equation	6.50	5.45E-01	2.52E+00	1.09E-03	3.06E+00
Mercury	0.04	-	Equation	0.06	5.38E-03	3.36E-04	-	5.71E-03	0.04	-	Equation	0.06	5.38E-03	3.36E-04	-	5.71E-03
Nickel	12.4	-	Equation	0.71	5.97E-02	1.04E-01	-	1.64E-01	9.40	-	Equation	0.58	4.85E-02	7.89E-02	-	1.27E-01
Selenium	1.40	-	Equation	0.74	6.17E-02	1.17E-02	-	7.35E-02	1.20	-	Equation	0.62	5.21E-02	1.01E-02	-	6.22E-02
Silver	1.40	-	0.014	0.02	1.64E-03	1.17E-02	-	1.34E-02	1.10	-	0.014	0.02	1.29E-03	9.23E-03	-	1.05E-02
Zinc	2778	0.503	Equation	394	3.30E+01	2.33E+01	4.90E-02	5.64E+01	1738	0.361	Equation	304	2.55E+01	1.46E+01	3.52E-02	4.01E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations
1 $Dose_{plant} = IR_{diet}$ X C_{plant} X AUF
Where C_{plant} = ($EPC_{sediment}$ X BSAF) or the result of the BSAF regression equation
2 $Dose_{sed}$= $IR_{sediment}$ X $EPC_{sediment}$ X AUF
3 $Dose_{water}$ = IR_{water} X C_{water} X AUF
4 Total EDD = $Dose_{plant}$ + $Dose_{sed}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

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Table 4.73
EDDs for the muskrat foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	37.2	-	Equation	1.05	8.80E-02	3.12E-01	-	4.00E-01	19.9	0.000	Equation	0.74	6.18E-02	1.67E-01	-	2.29E-01
Cadmium	10.5	0.0011	Equation	2.24	1.88E-01	8.81E-02	1.07E-04	2.76E-01	5.00	0.0009	Equation	1.50	1.26E-01	4.20E-02	8.78E-05	1.68E-01
Chromium	5.50	-	0.04	0.23	1.89E-02	4.61E-02	-	6.51E-02	5.20	0.000	0.04	0.21	1.79E-02	4.36E-02	-	6.15E-02
Copper	413	0.0215	Equation	21.0	1.76E+00	3.47E+00	2.10E-03	5.23E+00	188	0.0122	Equation	15.4	1.29E+00	1.58E+00	1.19E-03	2.87E+00
Lead	435	0.0303	Equation	8.01	6.72E-01	3.65E+00	2.95E-03	4.32E+00	296	0.0121	Equation	6.45	5.41E-01	2.48E+00	1.18E-03	3.03E+00
Mercury	0.07	-	Equation	0.09	7.29E-03	5.87E-04	-	7.88E-03	0.07	0.000	Equation	0.09	7.29E-03	5.87E-04	-	7.88E-03
Nickel	16.5	-	Equation	0.88	7.39E-02	1.38E-01	-	2.12E-01	9.70	0.000	Equation	0.59	4.97E-02	8.14E-02	-	1.31E-01
Selenium	3.30	-	Equation	1.90	1.59E-01	2.77E-02	-	1.87E-01	1.90	0.000	Equation	1.03	8.65E-02	1.59E-02	-	1.02E-01
Silver	2.20	-	0.014	0.03	2.58E-03	1.85E-02	-	2.10E-02	1.40	0.000	0.014	0.02	1.64E-03	1.17E-02	-	1.34E-02
Zinc	5320	0.429	Equation	565	4.74E+01	4.46E+01	4.18E-02	9.21E+01	2190	0.302	Equation	345	2.90E+01	1.84E+01	2.94E-02	4.74E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations
1 $Dose_{plant} = IR_{diet}$ X C_{plant} X AUF
Where C_{plant} = ($EPC_{sediment}$ X BSAF) or the result of the BSAF regression equation
2 $Dose_{sed}$= $IR_{sediment}$ X $EPC_{sediment}$ X AUF
3 $Dose_{water}$ = IR_{water} X C_{water} X AUF
4 Total EDD = $Dose_{plant}$ + $Dose_{sed}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

Created by:EC 1/20/14
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Table 4.74
EDDs for the muskrat foraging at the Bakers Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)						CTE** Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet			Sediment	Water				Diet			Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)#	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	29.7	-	Equation	0.92	7.75E-02	2.49E-01	-	3.27E-01	21.9	-	Equation	0.78	6.53E-02	1.84E-01	-	2.49E-01
Cadmium	18.6	0.0008	Equation	3.06	2.57E-01	1.56E-01	7.80E-05	4.13E-01	10.1	0.0007	Equation	2.20	1.84E-01	8.47E-02	6.83E-05	2.69E-01
Chromium	7.00	-	0.04	0.29	2.41E-02	5.87E-02	-	8.28E-02	5.40	-	0.04	0.22	1.86E-02	4.53E-02	-	6.39E-02
Copper	332	0.0138	Equation	19.2	1.61E+00	2.79E+00	1.35E-03	4.40E+00	191	0.0095	Equation	15.5	1.30E+00	1.60E+00	9.26E-04	2.90E+00
Lead	376	0.0177	Equation	7.38	6.19E-01	3.15E+00	1.73E-03	3.78E+00	300	0.0078	Equation	6.50	5.45E-01	2.52E+00	7.61E-04	3.06E+00
Mercury	0.06	-	Equation	0.08	6.71E-03	5.03E-04	-	7.21E-03	0.04	-	Equation	0.06	5.38E-03	3.36E-04	-	5.71E-03
Nickel	31.0	-	Equation	1.41	1.18E-01	2.60E-01	-	3.79E-01	18.3	-	Equation	0.95	7.98E-02	1.54E-01	-	2.33E-01
Selenium	3.10	-	Equation	1.77	1.49E-01	2.60E-02	-	1.75E-01	2.10	-	Equation	1.15	9.66E-02	1.76E-02	-	1.14E-01
Silver	1.70	-	0.014	0.02	2.00E-03	1.43E-02	-	1.63E-02	1.30	-	0.014	0.02	1.53E-03	1.09E-02	-	1.24E-02
Zinc	8544	0.272	Equation	735	6.16E+01	7.17E+01	2.65E-02	1.33E+02	4620	0.216	Equation	522	4.38E+01	3.88E+01	2.11E-02	8.26E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DW - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% Upper Confidence Level (UCL) or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.
The RMEs and CTEs were derived using sediment-to-plant regression models or factors (Table 4.37)

Equations
1 $Dose_{plant} = IR_{diet}$ X C_{plant} X AUF
Where C_{plant} = ($EPC_{sediment}$ X BSAF) or the result of the BSAF regression equation
2 $Dose_{sed} = IR_{sediment}$ X $EPC_{sediment}$ X AUF
3 $Dose_{water} = IR_{water}$ X C_{water} X AUF
4 Total EDD = $Dose_{plant}$ + $Dose_{sed}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
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Table 5.1
Summary of the risk estimation approaches by receptor group, exposure unit, and measurement endpoint
Baseline Ecological Risk Assessments
Upper Animas Mining District

receptor group	exposure units[a]	measurement endpoint		risk estimation approach
		exposure	effect	
benthic invertebrate community	CC, MC, AR above CC, AR below MC	total metals in bulk sediment	no effect & effect sediment benchmarks	HQ method
	MC, AR above CC, AR below MC,	dissolved metals in pore water	chronic surface water benchmarks	HQ method
	CC, MC, AR above CC, and AR below MR	10-day sediment toxicity test using juvenile amphipods (*Hyalella azteca*)		statistical method
	CC, MC, AR above CC, and AR below MR	macroinvertebrate benthic community survey		graphical analysis
fish community	CC, MC, AR above CC, AR between CC & MR, AR below MC	total or dissolved metals in surface water	chronic surface water benchmarks	HQ method
	CC, MC, AR above CC, AR below MC	96-hour acute surface water toxicity tests using juvenile rainbow trout		statistical method
insectivorous birds	AR aboce CC; AR below MC	exposure modeling to calculate RME and CTE EDDs	bird no-effect and effect TRVs	HQ method
omnivorous birds	AR aboce CC; AR below MC	exposure modeling to calculate RME and CTE EDDs	bird no-effect and effect TRVs	HQ method
piscivorous birds	AR aboce CC; AR below MC	exposure modeling to calculate RME and CTE EDDs	bird no-effect and effect TRVs	HQ method
herbivorous mammals	AR aboce CC; AR below MC	exposure modeling to calculate RME and CTE EDDs	mammal no-effect and effect TRVs	HQ method

[a] CC = Cement Creek; MC = Mineral Creek; AR = Animas River

CTE = central tendency exposure

EDD = estimated daily dose

HQ = hazard quotient

RME = reasonable maximum exposure

TRV = toxicity reference value

created by: SJP (1/9/14)

reviewed by: EC (3/16/15)

Table 5.2
Sediment HQs for mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Arsenic	32.7	26.9	9.8	33	**3.3**	**2.7**	<1	<1
Copper	127	90.4	31.6	149	**4.0**	**2.9**	<1	<1
Lead	237	183	35.8	128	**6.6**	**5.1**	**1.9**	**1.4**
Manganese	1430	1295	630	1,200	**2.3**	**2.1**	**1.2**	**1.1**
Selenium	1.7	1.7	0.9	4.7	**1.9**	**1.9**	<1	<1
Zinc	666	468	121	459	**5.5**	**3.9**	**1.5**	**1.02**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.3
Sediment HQs for mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Arsenic	40.6	40.6	9.8	33	**4.1**	**4.1**	**1.2**	**1.2**
Copper	55.6	55.6	31.6	149	**1.8**	**1.8**	<1	<1
Lead	282	282	35.8	128	**7.9**	**7.9**	**2.2**	**2.2**
Silver	2.0	2.0	1.0	3.7	**2.0**	**2.0**	<1	<1
Zinc	195	195	121	459	**1.6**	**1.6**	<1	<1

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.4
Sediment HQs for the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Arsenic	34.2	27.4	9.8	33	**3.5**	**2.8**	**1.04**	<1
Cadmium	12.9	11.1	0.99	4.98	**13.0**	**11.2**	**2.6**	**2.2**
Copper	399	339	31.6	149	**12.6**	**10.7**	**2.7**	**2.3**
Lead	1733	1508	35.8	128	**48.4**	**42.1**	**13.5**	**11.8**
Manganese	12566	10617	630	1,200	**19.9**	**16.9**	**10.5**	**8.8**
Mercury	0.09	0.07	0.18	1.06	<1	<1	<1	<1
Selenium	0.998	1.54	0.9	4.7	**1.1**	**1.7**	<1	<1
Silver	6.4	5.5	1.0	3.7	**6.4**	**5.5**	**1.7**	**1.5**
Zinc	4054	3172	121	459	**33.5**	**26.2**	**8.8**	**6.9**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.5
Sediment HQs for sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Aluminum	19,659	14,872	26,000	60,000	<1	<1	<1	<1
Arsenic	39.6	33.4	9.8	33	**4.0**	**3.4**	**1.2**	**1.01**
Cadmium	2.9	2.1	1.0	4.98	**2.9**	**2.1**	<1	<1
Copper	173	137	31.6	149	**5.5**	**4.3**	**1.2**	<1
Lead	581	478	35.8	128	**16.2**	**13.4**	**4.5**	**3.7**
Manganese	2,979	2,100	630	1,200	**4.7**	**3.3**	**2.5**	**1.8**
Nickel	5.9	5.1	22.7	48.6	<1	<1	<1	<1
Selenium	1.9	1.5	0.9	4.7	**2.1**	**1.7**	<1	<1
Silver	2.4	1.9	1.0	3.7	**2.4**	**1.9**	<1	<1
Zinc	819	651	121	459	**6.8**	**5.4**	**1.8**	**1.4**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.6
Sediment HQs for sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Aluminum	35,775	17,123	26,000	60,000	**1.4**	<1	<1	<1
Arsenic	33.8	27.9	9.8	33	**3.4**	**2.9**	**1.02**	<1
Cadmium	5.4	4.0	1.0	4.98	**5.5**	**4.1**	**1.1**	<1
Copper	284	199	31.6	149	**9.0**	**6.3**	**1.9**	**1.3**
Lead	729	513	35.8	128	**20.4**	**14.3**	**5.7**	**4.0**
Manganese	6,618	4,340	630	1,200	**10.5**	**6.9**	**5.5**	**3.6**
Nickel	7.2	6.4	22.7	48.6	<1	<1	<1	<1
Selenium	1.4	1.1	0.9	4.7	**1.6**	**1.2**	<1	<1
Silver	2.8	1.9	1.0	3.7	**2.8**	**1.9**	<1	<1
Zinc	1,393	1,049	121	459	**11.5**	**8.7**	**3.0**	**2.3**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.7
Sediment HQs for sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Aluminum	31,900	16,373	26,000	60,000	**1.2**	<1	<1	<1
Arsenic	39.4	29.9	9.8	33	**4.0**	**3.1**	**1.2**	<1
Cadmium	4.2	3.5	1.0	4.98	**4.3**	**3.5**	<1	<1
Copper	292	177	31.6	149	**9.2**	**5.6**	**2.0**	**1.2**
Lead	593	534	35.8	128	**16.6**	**14.9**	**4.6**	**4.2**
Manganese	4,340	3,143	630	1,200	**6.9**	**5.0**	**3.6**	**2.6**
Nickel	12.1	10.0	22.7	48.6	<1	<1	<1	<1
Selenium	2.9	2.9	0.9	4.7	**3.2**	**3.2**	<1	<1
Silver	3.1	2.0	1.0	3.7	**3.1**	**2.0**	<1	<1
Zinc	1,720	1,114	121	459	**14.2**	**9.2**	**3.7**	**2.4**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.8
Sediment HQs for sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Aluminum	27,525	15,428	26,000	60,000	**1.1**	<1	<1	<1
Arsenic	27.0	19.4	9.8	33	**2.8**	**2.0**	<1	<1
Cadmium	6.4	4.8	1.0	4.98	**6.5**	**4.9**	**1.3**	<1
Copper	212	147	31.6	149	**6.7**	**4.6**	**1.4**	<1
Lead	367	300	35.8	128	**10.3**	**8.4**	**2.9**	**2.3**
Manganese	6,390	4,348	630	1,200	**10.1**	**6.9**	**5.3**	**3.6**
Nickel	12.4	9.4	22.7	48.6	<1	<1	<1	<1
Selenium	1.4	1.2	0.9	4.7	**1.6**	**1.4**	<1	<1
Silver	1.4	1.1	1.0	3.7	**1.4**	**1.1**	<1	<1
Zinc	2,778	1,738	121	459	**23.0**	**14.4**	**6.1**	**3.8**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.9
Sediment HQs for sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Aluminum	48,600	20,820	26,000	60,000	**1.9**	<1	<1	<1
Arsenic	37.2	19.9	9.8	33	**3.8**	**2.0**	**1.1**	<1
Cadmium	10.5	5.0	1.0	4.98	**10.6**	**5.1**	**2.1**	**1.01**
Copper	413	188	31.6	149	**13.1**	**5.9**	**2.8**	**1.3**
Lead	435	296	35.8	128	**12.2**	**8.3**	**3.4**	**2.3**
Manganese	3,820	2,743	630	1,200	**6.1**	**4.4**	**3.2**	**2.3**
Nickel	16.5	9.7	22.7	48.6	<1	<1	<1	<1
Selenium	3.3	1.9	0.9	4.7	**3.7**	**2.1**	<1	<1
Silver	2.2	1.4	1.0	3.7	**2.2**	**1.4**	<1	<1
Zinc	5,320	2,190	121	459	**44.0**	**18.1**	**11.6**	**4.8**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.10
Sediment HQs for sampling location Bakers Bridge on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Aluminum	37,400	20,025	26,000	60,000	**1.4**	<1	<1	<1
Arsenic	29.7	21.9	9.8	33	**3.0**	**2.2**	<1	<1
Cadmium	18.6	10.1	1.0	4.98	**18.8**	**10.2**	**3.7**	**2.0**
Copper	332	191	31.6	149	**10.5**	**6.0**	**2.2**	**1.3**
Lead	376	300	35.8	128	**10.5**	**8.4**	**2.9**	**2.3**
Manganese	13,100	7,425	630	1,200	**20.8**	**11.8**	**10.9**	**6.2**
Nickel	31.0	18.3	22.7	48.6	**1.4**	<1	<1	<1
Selenium	3.1	2.1	0.9	4.7	**3.4**	**2.4**	<1	<1
Silver	1.7	1.3	1.0	3.7	**1.7**	**1.3**	<1	<1
Zinc	8,544	4,620	121	459	**70.6**	**38.2**	**18.6**	**10.1**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.11
Average and lower hardnesses for deriving hardness-sensitive surface water benchmarks to calculate chronic HQs for pore water
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Exposure Unit	Pore water hardness (mg/L)					
	n	95% UCL	average[a]	difference[b]	ave - diff[c]	minimum[d]
Mineral Creek	1	--	139	--	--	139
Cement Creek	0	--	--	--	--	--
Animas R. above Cement Cr.	11	594.2	296	298	-2	118
Animas R. between CC & MC	0	--	--	--	--	--
A71B (Animas R. below MC)	0	--	--	--	--	--
A72 (Animas R. below MC)	2	--	208	--	--	160
A73 (Animas R. below MC)	2	--	168	--	--	151
A73B (Animas R. below MC)	1	--	49	--	--	49
A75D (Animas R. below MC)	2	--	115.5			96
A75B (Animas R. below MC)	0	--	--	--	--	--
BBridge(Animas R. below MC)	2	--	198	--	--	125

Highlighted concentrations were retained to adjust the hardness-sensitive benchmarks used in calculating the pore water HQs

note: the higher of the "ave - diff" value or "minimum" value was used to represent the estimated lower bound for pore water hardness for a given period

[a] average = arithmetic mean pore water hardness concentration

[b] difference = 95% UCL - average concentration

[c] ave - diff = concentration obtained by subtracting "difference" from "average"

[d] minimum = lowest pore water hardness measured in the samples collected from an exposure unit during the period

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/5/15
reviewed by: ES (3/10/15)

Table 5.12
Pore water HQs for benthic community-level receptors in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Pore Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Beryllium	1.0	1.0	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Silver	0.25	0.25	--	**--**	**--**	139	139	0.13	0.13	**1.9**	**1.9**	**1.9**	**1.9**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.13
Pore water HQs for benthic community-level receptors in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Pore Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	4,514	1,259	87	**52**	**14**	--	--	--	--	--	--	--	--
Beryllium	10	2.2	0.66	**15**	**3.4**	--	--	--	--	--	--	--	--
Cadmium	93	24	--	**--**	**--**	118	296	0.48	0.95	**195**	**49**	**98**	**25**
Copper	2,242	224	--	**--**	**--**	118	296	10.3	22.6	**217**	**22**	**99**	**9.9**
Lead	19	14	--	**--**	**--**	118	296	3.0	8.0	**6.4**	**4.5**	**2.4**	**1.7**
Manganese	78,300	17,912	--	**--**	**--**	118	296	1,743	2,368	**45**	**10**	**33**	**7.6**
Selenium	5.0	1.6	4.6	**1.1**	<1	--	--	--	--	**--**	**--**	**--**	**--**
Silver	2.5	0.8	--	**--**	**--**	118	296	0.10	0.49	**25**	**7.9**	**5.1**	**1.6**
Zinc	19,367	5,735	--	**--**	**--**	118	296	141	325	**137**	**41**	**60**	**18**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.14
Pore water HQs for benthic community-level receptors at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Pore Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	517	282	87	**5.9**	**3.2**	--	--	--	--	--	--	--	--
Beryllium	1	1	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Cadmium	3.0	2.2	--	**--**	**--**	160	208	0.60	0.73	**5.0**	**3.6**	**4.1**	**3.0**
Iron	338	338	1,000	<1	<1	--	--	--	--	--	--	--	**--**
Manganese	995	722	--	**--**	**--**	160	208	1,929	2,105	<1	<1	<1	<1
Silver	0.25	0.25	4.6	**--**	**--**	160	208	0.17	0.26	**1.5**	**1.5**	<1	<1
Zinc	1,630	1,019	--	**--**	**--**	160	208	186	236	**8.8**	**5.5**	**6.9**	**4.3**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.15
Pore water HQs for benthic community-level receptors at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Pore Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	29	26	87	<1	<1	--	--	--	--	--	--	--	--
Beryllium	1.0	1.0	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Cadmium	2.0	1.2	--	**--**	**--**	151	168	0.58	0.62	**3.5**	**2.1**	**3.3**	**1.9**
Iron	341	341	1,000	<1	<1	--	--	--	--	**--**	**--**	**--**	**--**
Manganese	1,870	936	--	**--**	**--**	151	168	1,892	1,961	<1	<1	<1	<1
Silver	0.25	0.25	--	**--**	**--**	151	168	0.15	0.18	**1.6**	**1.6**	**1.4**	**1.4**
Zinc	709	536	--	**--**	**--**	151	168	176	194	**4.0**	**3.0**	**3.6**	**2.8**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.16
Pore water HQs for benthic community-level receptors at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Pore Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	10	10	87	<1	<1	--	--	--	--	--	--	--	--
Beryllium	1.0	1.0	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Cadmium	0.1	0.1	--	**--**	**--**	49	49	0.25	0.25	<1	<1	<1	<1
Iron	50	50	1,000	<1	<1	--	--	--	--	**--**	**--**	**--**	**--**
Manganese	3.4	3.4	--	**--**	**--**	49	49	1,301	1,301	<1	<1	<1	<1
Silver	0.25	0.25	--	**--**	**--**	49	49	0.02	0.02	**11**	**11**	**11**	**11**
Zinc	33	33	--	**--**	**--**	49	49	63	63	<1	<1	<1	<1

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.17
Pore water HQs for benthic community-level receptors at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Pore Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	40	34	87	<1	<1	--	--	--	--	--	--	--	--
Beryllium	1.0	1.0	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Cadmium	0.79	0.59	--	**--**	**--**	96	116	0.41	0.47	**1.9**	**1.4**	**1.7**	**1.2**
Iron	107	107	1,000	<1	<1	--	--	--	--	--	--	--	**--**
Manganese	290	238	--	**--**	**--**	96	116	1,627	1,731	<1	<1	<1	<1
Silver	0.25	0.25	--	**--**	**--**	96	116	0.07	0.10	**3.6**	**3.6**	**2.6**	**2.6**
Zinc	190	182	--	**--**	**--**	96	116	117	138	**1.6**	**1.6**	**1.4**	**1.3**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.18
Pore water HQs for benthic community-level receptors at sampling location Bakers Bridge on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Pore Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	47	41	87	<1	<1	--	--	--	--	--	--	--	--
Beryllium	1.0	1.0	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Cadmium	0.3	0.3	--	**--**	**--**	125	198	0.50	0.71	<1	<1	<1	<1
Iron	1,260	1,260	1,000	**1.3**	**1.3**	--	--	--	--	--	--	--	**--**
Manganese	5,870	3,098	--	**--**	**--**	125	198	1,777	2,071	**3.3**	**1.7**	**2.8**	**1.5**
Silver	0.25	0.25	--	**--**	**--**	125	198	0.11	0.24	**2.3**	**2.3**	**1.03**	**1.03**
Zinc	115	64	--	**--**	**--**	125	198	148	226	<1	<1	<1	<1

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.19
Average and lower hardnesses used for deriving hardness-sensitive surface water benchmarks needed to calculate chronic HQs
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Exposure Unit	Pre-Runoff Period Hardness (mg/L)						Runoff Period Hardness (mg/L)						Post-Runoff Period Hardness (mg/L)					
	n	95% UCL[a]	average[b]	difference[c]	ave - diff[d]	minimum[e]	n	95% UCL	average	difference	ave - diff	minimum	n	95% UCL	average	difference	ave - diff	minimum
Mineral Creek	4	342	253	89	164	150	7	80	68	12	56	49	13	188	161	27	135	65
Cement Creek	4	619	477	143	334	301	7	157	124	33	91	76	14	475	409	66	343	67
Animas R. above Cement Cr.	5	192	170	22	148	148	17	74	69	5.1	64	49	18	136	124	12	112	66
Animas R. between CC & MC	0	--	--	--	--	--	0	--	--	--	--	--	2	--	296	--	--	295
A71B (Animas R. below MC)	0	--	--	--	--	--	0	--	--	--	--	--	1	--	263	--	--	263
A72 (Animas R. below MC)	4	378	285	93	192	177	7	87	72	15	56	45	13	221	189	32	158	75
A73 (Animas R. below MC)	the 1 pre-runoff datapoint was combined with the 2 runoff datapoints						5	216	147	70	77	71	the 2 post-runoff datapoints were combined with the 2 runoff datapoints					
A73B (Animas R. below MC)	0	--	--	--	--	--	4	194	98	96	1.6	37	the 2 post-runoff datapoints were combined with the 2 runoff datapoints					
A75D (Animas R. below MC)	the 1 pre-runoff datapoint was combined with the 2 runoff datapoints						5	161	110	50	60	60	the 2 post-runoff datapoints were combined with the 2 runoff datapoints					
A75B (Animas R. below MC)	0	--	--	--	--	--	4	174	102	72	30	61	the 2 post-runoff datapoints were combined with the 2 runoff datapoints					
BBridge(Animas R. below MC)	the 1 pre-runoff datapoint was combined with the 2 runoff datapoints						5	155	108	47	61	58	the 2 post-runoff datapoints were combined with the 2 runoff datapoints					

Highlighted concentrations were retained to adjust the hardness-sensitive benchmarks used in calculating the surface water HQs

note: the higher of the "ave - diff" value or "minimum" value was used to represent the estimated lower bound for surface water hardness for a given period

[a] UCL = upper confidence limit for surface water hardness concentration (see Appendix X)

[b] average = arithmetic mean surface water hardness concentration

[c] difference = 95% UCL - average concentration

[d] ave - diff = concentration obtained by subtracting "difference" from "average"

[e] minimum = lowest surface water hardness concentration measured in the samples collected from an exposure unit during the period

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/5/15
reviewed by: BB (3/5/15)

Table 5.20
Surface water HQs for aquatic community-level receptors in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD													
Aluminum (total)	5,950	4,575	87	**68**	**53**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.9	1.3	--	--	--	164	253	0.61	0.85	**3.0**	**2.1**	**2.2**	**1.5**
Iron (total)	6,830	5,868	1,000	**6.8**	**5.9**	--	--	--	--	--	--	--	--
Silver (dissolved)	0.6	0.4	--	--	--	164	253	0.18	0.37	**3.4**	**2.3**	**1.6**	**1.1**
Zinc (dissolved)	470	358	--	--	--	164	253	190	282	**2.5**	**1.9**	**1.7**	**1.3**
RUNOFF PERIOD													
Aluminum (total)	1,910	1,353	87	**22**	**16**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	0.4	0.3	--	--	--	56	68	0.27	0.32	**1.5**	**1.01**	**1.3**	<1
Iron (total)	4,119	2,664	1,000	**4.1**	**2.7**	--	--	--	--	--	--	--	--
Silver (dissolved)	1.3	0.4	--	--	--	56	68	0.03	0.04	**46.9**	**14.4**	**33.6**	**10.3**
Zinc (dissolved)	104	83.9	--	--	--	56	68	72	85	**1.5**	**1.2**	**1.2**	<1
POST-RUNOFF PERIOD													
Aluminum (total)	2,826	2,267	87	**32**	**26**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	0.7	0.6	--	--	--	135	161	0.53	0.60	**1.4**	**1.1**	**1.2**	**1.0**
Iron (total)	4,316	3,339	1,000	**4.3**	**3.3**	--	--	--	--	--	--	--	--
Silver (dissolved)	1.3	0.3	--	--	--	135	161	0.13	0.17	**10.3**	**2.4**	**7.6**	**1.8**
Zinc (dissolved)	194	160	--	--	--	135	161	159	187	**1.2**	**1.002**	**1.04**	<1

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.21
Surface water HQs for aquatic community-level receptors in mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD													
Aluminum (total)	8,610	7,318	87	**99**	**84**	--	--	--	--	--	--	--	--
Beryllium (dissolved	1.3	1.2	0.7	**2.0**	**1.8**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	5.5	5.3	--	**--**	**--**	334	477	1.05	1.20[a]	**5.3**	**5.1**	**4.6**	**4.4**
Copper (dissolved)	119	107	--	**--**	**--**	334	477	25.1	29.3[a]	**4.7**	**4.3**	**4.1**	**3.7**
Iron (total)	21,700	17,150	1,000	**22**	**17**	--	--	--	--	--	--	--	--
Lead (dissolved)	15.1	14.2	--	**--**	**--**	334	477	9.1	10.9[a]	**1.7**	**1.6**	**1.4**	**1.3**
Manganese (dissolved)	5,290	4,618	--	**--**	**--**	334	477	2465	2618[a]	**2.1**	**1.9**	**2.0**	**1.8**
Zinc (dissolved)	2,670	2,303	--	**--**	**--**	334	477	363	428[a]	**7.4**	**6.3**	**6.2**	**5.4**
RUNOFF PERIOD													
Aluminum (total)	2,876	2,389	87	**33**	**27**	--	--	--	--	--	--	--	--
Beryllium (dissolved)	1.0	0.7	0.7	**1.5**	**1.1**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	3.3	2.8	--	**--**	**--**	91	124	0.39	0.50	**8.4**	**7.1**	**6.7**	**5.6**
Copper (dissolved)	78.1	68.6	--	**--**	**--**	91	124	8.3	10.8	**9.5**	**8.3**	**7.3**	**6.4**
Iron (total)	12,554	8,067	1,000	**13**	**8.1**	--	--	--	--	--	--	--	--
Lead (dissolved)	10.4	8.4	--	**--**	**--**	91	124	2.3	3.2	**4.6**	**3.7**	**3.3**	**2.6**
Manganese (dissolved)	1,620	1,268	--	**--**	**--**	91	124	1599	1772	**1.01**	<1	<1	<1
Zinc (dissolved)	1,144	929	--	**--**	**--**	91	124	111	147	**10**	**8.4**	**7.8**	**6.3**
POST-RUNOFF PERIOD													
Aluminum (total)	7,110	6,360	87	**82**	**73**	--	--	--	--	--	--	--	--
Beryllium (dissolved)	1.0	1.1	0.7	**1.5**	**1.7**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	6.1	5.6	--	**--**	**--**	343	409	1.07	1.20[a]	**5.7**	**5.3**	**5.1**	**4.7**
Copper (dissolved)	152	130	--	**--**	**--**	343	409	25.7	29.3[a]	**5.9**	**5.1**	**5.2**	**4.4**
Iron (total)	12,725	10,801	1,000	**13**	**11**	--	--	--	--	--	--	--	--
Lead (dissolved)	17.1	15.5	--	**--**	**--**	343	409	9.3	10.9[a]	**1.8**	**1.7**	**1.6**	**1.4**
Manganese (dissolved)	5,300	4,112	--	**--**	**--**	343	409	2487	2618[a]	**2.1**	**1.7**	**2.0**	**1.6**
Zinc (dissolved)	2,890	2,190	--	**--**	**--**	343	409	372	428[a]	**7.8**	**5.9**	**6.8**	**5.1**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

[a] = Average hardness was greater than the 400 mg/L limit for use in deriving hardness-based criteria. Therefore, respective hardness-based benchmarks were derived using a hardness value of 400 mg/L.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.22
Surface water HQs for aquatic community-level receptors in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD													
Aluminum (total)	401	305	87	**4.6**	**3.5**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	3.6	2.6	--	--	--	148	170	0.57	0.63	**6.3**	**4.7**	**5.7**	**4.2**
Copper (dissolved)	8.3	7.2	--	--	--	148	170	12.5	14.1	<1	<1	<1	<1
Iron (total)	309	259	1,000	<1	<1	--	--	--	--	--	--	--	--
Lead (dissolved)	0.5	0.4	--	--	--	148	170	3.8	4.5	<1	<1	<1	<1
Manganese (dissolved)	3,676	3,300	--	--	--	148	170	1880	1969	**2.0**	**1.8**	**1.9**	**1.7**
Zinc (dissolved)	1,012	840	--	--	--	148	170	173	196	**5.8**	**4.9**	**5.2**	**4.3**
RUNOFF PERIOD													
Aluminum (total)	566	480	87	**6.5**	**5.5**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.1	1.0	--	--	--	64	69	0.30	0.32	**3.8**	**3.5**	**3.6**	**3.3**
Copper (dissolved)	11.3	10.0	--	--	--	64	69	6.1	6.5	**1.8**	**1.6**	**1.7**	**1.5**
Iron (total)	556	469	1,000	<1	<1	--	--	--	--	--	--	--	--
Lead (dissolved)	1.1	1.0	--	--	--	64	69	1.5	1.7	<1	<1	<1	<1
Manganese (dissolved)	633	514	--	--	--	64	69	1422	1458	<1	<1	<1	<1
Zinc (dissolved)	381	344	--	--	--	64	69	81	86	**4.7**	**4.3**	**4.4**	**4.0**
POST-RUNOFF PERIOD													
Aluminum (total)	154	153	87	**1.8**	**1.8**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.2	1.1	--	--	--	112	124	0.46	0.50	**2.6**	**2.4**	**2.4**	**2.2**
Copper (dissolved)	3.2	3.2	--	--	--	112	124	9.9	10.8	<1	<1	<1	<1
Iron (total)	149	154	1,000	<1	<1	--	--	--	--	--	--	--	--
Lead (dissolved)	0.3	0.3	--	--	--	112	124	2.8	3.2	<1	<1	<1	<1
Manganese (dissolved)	1,247	1,031	--	--	--	112	124	1713	1772	<1	<1	<1	<1
Zinc (dissolved)	362	327	--	--	--	112	124	134	147	**2.7**	**2.4**	**2.5**	**2.2**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)

Table 5.23
Surface water HQs for aquatic community-level receptors in the Animas River between the mainstems of Cement Creek and Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
POST-RUNOFF PERIOD													
Aluminum (total)	2,520	2,490	87	**29**	**29**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	2.7	2.7	--	**--**	**--**	295	296	0.95	0.95	**2.8**	**2.8**	**2.8**	**2.8**
Copper (dissolved)	24.8	20.6	--	**--**	**--**	295	296	22.6	22.6	**1.1**	<1	**1.1**	<1
Iron (total)	5,100	4,995	1,000	**5.1**	**5.0**	--	--	--	--	--	--	--	--
Manganese (dissolved)	2,590	2,565	--	**--**	**--**	295	296	2365	2368	**1.1**	**1.1**	**1.1**	**1.1**
Zinc (dissolved)	1,160	1,160	--	**--**	**--**	295	296	324	325	**3.6**	**3.6**	**3.6**	**3.6**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.24
Surface water HQs for aquatic community-level receptors at sampling location A71B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
POST-RUNOFF PERIOD													
Aluminum (total)	2,780	2,780	87	**32**	**32**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.9	1.9	--	**--**	**--**	263	263	0.87	0.87	**2.2**	**2.2**	**2.2**	**2.2**
Copper (dissolved)	8.7	8.7	--	**--**	**--**	263	263	20.5	20.5	<1	<1	<1	<1
Iron (total)	4,640	4,640	1,000	**4.6**	**4.6**	--	--	--	--	--	--	--	--
Manganese (dissolved)	1,660	1,660	--	**--**	**--**	263	263	2276	2276	<1	<1	<1	<1
Zinc (dissolved)	743	743	--	**--**	**--**	263	263	292	292	**2.5**	**2.5**	**2.5**	**2.5**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.25
Surface water HQs for aquatic community-level receptors at sampling location A72 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD													
Aluminum (total)	4,440	3,455	87	**51**	**40**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	2.9	2.7	--	--	--	192	285	0.69	0.93	**4.2**	**3.9**	**3.1**	**2.9**
Copper (dissolved)	35.9	28.9	--	--	--	192	285	15.6	21.9	**2.3**	**1.8**	**1.6**	**1.3**
Iron (total)	7,710	6,018	1,000	**7.7**	**6.0**	--	--	--	--	--	--	--	--
Manganese (dissolved)	2,920	2,435	--	--	--	192	285	2050	2338	**1.4**	**1.2**	**1.2**	**1.04**
Zinc (dissolved)	1,230	1,044	--	--	--	192	285	219	314	**5.6**	**4.8**	**3.9**	**3.3**
RUNOFF PERIOD													
Aluminum (total)	2,065	1,359	87	**24**	**16**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.0	0.9	--	--	--	56	72	0.27	0.33	**3.7**	**3.2**	**3.0**	**2.7**
Copper (dissolved)	6.7	5.2	--	--	--	56	72	5.5	6.8	**1.2**	<1	<1	<1
Iron (total)	4,687	2,905	1,000	**4.7**	**2.9**	--	--	--	--	--	--	--	--
Manganese (dissolved)	578	427	--	--	--	56	72	1360	1479	<1	<1	<1	<1
Zinc (dissolved)	352	273	--	--	--	56	72	72	90	**4.9**	**3.8**	**3.9**	**3.0**
POST-RUNOFF PERIOD													
Aluminum (total)	2,129	1,777	87	**24**	**20**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.9	1.6	--	--	--	158	189	0.60	0.68	**3.1**	**2.7**	**2.7**	**2.3**
Copper (dissolved)	17	14	--	--	--	158	189	13.2	15.4	**1.3**	**1.1**	**1.1**	<1
Iron (total)	3,409	2,701	1,000	**3.4**	**2.7**	--	--	--	--	--	--	--	--
Manganese (dissolved)	1,514	1,242	--	--	--	158	189	1921	2039	<1	<1	<1	<1
Zinc (dissolved)	696	579	--	--	--	158	189	184	216	**3.8**	**3.2**	**3.2**	**2.7**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.26
Surface water HQs for aquatic community-level receptors at sampling location A73 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF (n=1) RUNOFF PERIOD (n = 2) and POST-RUNOFF PERIOD (n = 2) COMBINED													
Aluminum (total)	2,030	1,461	87	**23**	**17**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.7	1.3	--	**--**	**--**	77	147	0.35	0.56	**4.9**	**3.6**	**3.0**	**2.2**
Copper (dissolved)	5.0	3.7	--	**--**	**--**	77	147	7.2	12.4	<1	<1	<1	<1
Iron (total)	4,163	2,986	1,000	**4**	**3**	--	--	--	--	--	--	--	--
Manganese (dissolved)	1,592	1,009	--	**--**	**--**	77	147	1512	1875	**1.05**	<1	<1	<1
Zinc (dissolved)	666	463	--	**--**	**--**	77	147	96	172	**7.0**	**4.8**	**3.9**	**2.7**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.27
Surface water HQs for aquatic community-level receptors at sampling location A73B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
RUNOFF PERIOD (n = 2) and POST-RUNOFF PERIOD (n = 2) COMBINED													
Aluminum (total)	1,764	975	87	**20**	**11**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.3	0.7	--	--	--	37	98	0.20	0.42	**6.4**	**3.6**	**3.1**	**1.7**
Copper (dissolved)	3.8	2.6	--	--	--	37	98	3.8	8.8	**1.0**	<1	<1	<1
Iron (total)	2,649	1,570	1,000	**2.6**	**1.6**	--	--	--	--	--	--	--	--
Manganese (dissolved)	1,079	508	--	--	--	37	98	1185	1639	<1	<1	<1	<1
Zinc (dissolved)	500	250	--	--	--	37	98	49	119	**10**	**5.1**	**4.2**	**2.1**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.28
Surface water HQs for aquatic community-level receptors at sampling location A75D in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD (n=1) RUNOFF PERIOD (n = 2) and POST-RUNOFF PERIOD (n = 2) COMBINED													
Aluminum (total)	1,728	1,255	87	**20**	**14**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.0	0.8	--	**--**	**--**	60	110	0.29	0.45	**3.6**	**2.7**	**2.3**	**1.7**
Copper (dissolved)	3.9	2.5	--	**--**	**--**	60	110	5.8	9.7	<1	<1	<1	<1
Iron (total)	3,922	2,556	1,000	**3.9**	**2.6**	--	--	--	--	--	--	--	--
Manganese (dissolved)	935	590	--	**--**	**--**	60	110	1391	1703	<1	<1	<1	<1
Zinc (dissolved)	384	261	--	**--**	**--**	60	110	76	132	**5.0**	**3.4**	**2.9**	**2.0**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.29
Surface water HQs for aquatic community-level receptors at sampling location A75B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
RUNOFF PERIOD (n = 2) and POST-RUNOFF PERIOD (n = 2) COMBINED													
Aluminum (total)	1,565	1,021	87	**18**	**12**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.0	0.7	--	**--**	**--**	61	102	0.29	0.43	**3.5**	**2.4**	**2.4**	**1.6**
Copper (dissolved)	4.1	2.6	--	**--**	**--**	61	102	5.9	9.1	<1	<1	<1	<1
Iron (total)	4,454	2,224	1,000	**4.5**	**2.2**	61	--	--	--	--	--	--	--
Manganese (dissolved)	782	462	--	**--**	**--**	61	102	1399	1661	<1	<1	<1	<1
Zinc (dissolved)	402	235	--	**--**	**--**	61	102	77	123	**5.2**	**3.0**	**3.3**	**1.9**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.30
Surface water HQs for aquatic community-level receptors at Bakers Bridge sampling location in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD (n=1) RUNOFF PERIOD (n = 2) and POST-RUNOFF PERIOD (n = 2) COMBINED													
Aluminum (total)	1,103	704	87	**13**	**8.1**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	0.6	0.5	--	**--**	**--**	61	108	0.29	0.45	**2.1**	**1.6**	**1.4**	**1.03**
Copper (dissolved)	3.7	2.9	--	**--**	**--**	61	108	5.9	9.6	<1	<1	<1	<1
Iron (total)	2,742	1,717	1,000	**2.7**	**1.7**	--	--	--	--	--	--	--	--
Manganese (dissolved)	543	356	--	**--**	**--**	61	108	1399	1692	<1	<1	<1	<1
Zinc (dissolved)	204	136	--	**--**	**--**	61	108	77	130	**2.6**	**1.8**	**1.6**	**1.05**

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.31
HQs for the American dipper foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	1.20E+00	2.24	22.4	0.54	0.05	8.71E-01	2.24	22.4	0.39	0.04
Cadmium	1.12E+00	1.47	14.7	0.76	0.08	8.58E-01	1.47	14.7	0.58	0.06
Chromium	7.12E-01	2.66	26.6	0.27	0.03	6.58E-01	2.66	26.6	0.25	0.02
Copper	2.28E+01	4.05	12.1	**5.63**	**1.88**	2.09E+01	4.05	12.1	**5.17**	**1.73**
Lead	4.31E+01	1.63	3.26	**26.5**	**13.2**	3.74E+01	1.63	3.26	**23.0**	**11.5**
Mercury	2.13E-02	0.45	0.9	0.05	0.02	2.00E-02	0.45	0.9	0.04	0.02
Nickel	3.12E-01	6.71	67.1	0.05	0.00	2.90E-01	6.71	67.1	0.04	0.00
Selenium	2.13E-01	0.29	0.579	0.74	0.37	2.24E-01	0.29	0.579	0.77	0.39
Silver	1.87E-01	2.02	20.2	0.09	0.01	1.66E-01	2.02	20.2	0.08	0.01
Zinc	2.62E+02	66.1	661	**3.96**	0.40	1.95E+02	66.1	661	**2.95**	0.29

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/20/14
QC'd by: 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.32
HQs for the American dipper foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	9.19E-01	2.24	22.4	0.41	0.04	7.84E-01	2.24	22.4	0.35	0.04
Cadmium	2.11E-01	1.47	14.7	0.14	0.01	1.93E-01	1.47	14.7	0.13	0.01
Chromium	6.02E-01	2.66	26.6	0.23	0.02	5.70E-01	2.66	26.6	0.21	0.02
Copper	1.21E+01	4.05	12.1	**2.98**	0.99	1.13E+01	4.05	12.1	**2.79**	0.93
Lead	1.43E+01	1.63	3.26	**8.76**	**4.38**	1.20E+01	1.63	3.26	**7.38**	**3.69**
Mercury	2.48E-02	0.45	0.9	0.06	0.03	2.46E-02	0.45	0.9	0.05	0.03
Nickel	1.87E-01	6.71	67.1	0.03	0.003	1.69E-01	6.71	67.1	0.03	0.003
Selenium	1.57E-01	0.29	0.579	0.54	0.27	1.49E-01	0.29	0.579	0.51	0.26
Silver	1.10E-01	2.02	20.2	0.05	0.01	9.91E-02	2.02	20.2	0.05	0.005
Zinc	5.40E+01	66.1	661	0.82	0.08	5.03E+01	66.1	661	0.76	0.08

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.33
HQs for the American dipper foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	8.85E-01	2.24	22.4	0.40	0.04	7.57E-01	2.24	22.4	0.34	0.03
Cadmium	3.21E-01	1.47	14.7	0.22	0.02	2.91E-01	1.47	14.7	0.20	0.02
Chromium	5.59E-01	2.66	26.6	0.21	0.02	5.28E-01	2.66	26.6	0.20	0.02
Copper	1.34E+01	4.05	12.1	**3.31**	**1.11**	1.15E+01	4.05	12.1	**2.85**	0.95
Lead	1.73E+01	1.63	3.26	**10.6**	**5.31**	1.26E+01	1.63	3.26	**7.74**	**3.87**
Mercury	2.50E-02	0.45	0.9	0.06	0.03	2.48E-02	0.45	0.9	0.06	0.03
Nickel	2.82E-01	6.71	67.1	0.04	0.004	2.65E-01	6.71	67.1	0.04	0.004
Selenium	1.50E-01	0.29	0.579	0.52	0.26	1.43E-01	0.29	0.579	0.49	0.25
Silver	1.21E-01	2.02	20.2	0.06	0.01	1.01E-01	2.02	20.2	0.05	0.005
Zinc	7.33E+01	66.1	661	**1.11**	0.11	6.58E+01	66.1	661	0.99	0.10

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.34
HQs for the American dipper foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	2.63E+00	2.24	22.4	**1.17**	0.12	2.09E+00	2.24	22.4	0.93	0.09
Cadmium	3.12E-01	1.47	14.7	0.21	0.02	2.77E-01	1.47	14.7	0.19	0.02
Chromium	7.43E-01	2.66	26.6	0.28	0.03	7.08E-01	2.66	26.6	0.27	0.03
Copper	5.86E+01	4.05	12.1	**14.5**	**4.85**	3.55E+01	4.05	12.1	**8.78**	**2.94**
Lead	1.72E+01	1.63	3.26	**10.5**	**5.27**	1.56E+01	1.63	3.26	**9.58**	**4.79**
Mercury	2.52E-02	0.45	0.9	0.06	0.03	1.96E-02	0.45	0.9	0.04	0.02
Nickel	7.10E-01	6.71	67.1	0.11	0.01	6.09E-01	6.71	67.1	0.09	0.01
Selenium	6.93E-01	0.29	0.579	**2.39**	**1.20**	6.93E-01	0.29	0.579	**2.39**	**1.20**
Silver	1.89E-01	2.02	20.2	0.09	0.01	1.22E-01	2.02	20.2	0.06	0.01
Zinc	8.06E+01	66.1	661	**1.22**	0.12	6.51E+01	66.1	661	0.98	0.10

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.35
HQs for the American dipper foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	7.20E-01	2.24	22.4	0.32	0.03	5.55E-01	2.24	22.4	0.25	0.02
Cadmium	3.09E-01	1.47	14.7	0.21	0.02	2.75E-01	1.47	14.7	0.19	0.02
Chromium	8.14E-01	2.66	26.6	0.31	0.03	7.99E-01	2.66	26.6	0.30	0.03
Copper	7.88E+00	4.05	12.1	**1.95**	0.65	6.47E+00	4.05	12.1	**1.60**	0.53
Lead	8.48E+00	1.63	3.26	**5.20**	**2.60**	7.02E+00	1.63	3.26	**4.31**	**2.15**
Mercury	5.41E-02	0.45	0.9	0.12	0.06	5.41E-02	0.45	0.9	0.12	0.06
Nickel	4.03E-01	6.71	67.1	0.06	0.01	3.37E-01	6.71	67.1	0.05	0.01
Selenium	2.96E-01	0.29	0.579	**1.02**	0.51	2.92E-01	0.29	0.579	**1.01**	0.50
Silver	1.64E-01	2.02	20.2	0.08	0.01	1.57E-01	2.02	20.2	0.08	0.01
Zinc	1.01E+02	66.1	661	**1.53**	0.15	7.85E+01	66.1	661	**1.19**	0.12

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.36
HQs for the American dipper foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	2.50E+00	2.24	22.4	**1.12**	0.11	1.49E+00	2.24	22.4	0.67	0.07
Cadmium	5.81E-01	1.47	14.7	0.39	0.04	3.50E-01	1.47	14.7	0.24	0.02
Chromium	7.75E-01	2.66	26.6	0.29	0.03	7.55E-01	2.66	26.6	0.28	0.03
Copper	8.29E+01	4.05	12.1	**20.5**	**6.85**	3.77E+01	4.05	12.1	**9.32**	**3.12**
Lead	1.30E+01	1.63	3.26	**7.95**	**3.98**	9.16E+00	1.63	3.26	**5.62**	**2.81**
Mercury	1.96E-02	0.45	0.9	0.04	0.02	1.96E-02	0.45	0.9	0.04	0.02
Nickel	9.12E-01	6.71	67.1	0.14	0.01	5.93E-01	6.71	67.1	0.09	0.01
Selenium	7.89E-01	0.29	0.579	**2.72**	**1.36**	4.54E-01	0.29	0.579	**1.57**	0.78
Silver	1.34E-01	2.02	20.2	0.07	0.01	8.52E-02	2.02	20.2	0.04	0.00
Zinc	1.65E+02	66.1	661	**2.50**	0.25	9.21E+01	66.1	661	**1.39**	0.14

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.37
HQs for the American dipper foraging at the Bakers Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	6.96E-01	2.24	22.4	0.31	0.03	5.26E-01	2.24	22.4	0.23	0.02
Cadmium	7.50E-01	1.47	14.7	0.51	0.05	5.66E-01	1.47	14.7	0.38	0.04
Chromium	5.97E-01	2.66	26.6	0.22	0.02	5.62E-01	2.66	26.6	0.21	0.02
Copper	1.10E+01	4.05	12.1	**2.73**	0.91	7.97E+00	4.05	12.1	**1.97**	0.66
Lead	8.72E+00	1.63	3.26	**5.35**	**2.68**	7.07E+00	1.63	3.26	**4.34**	**2.17**
Mercury	2.15E-02	0.45	0.9	0.05	0.02	2.11E-02	0.45	0.9	0.05	0.02
Nickel	1.02E+00	6.71	67.1	0.15	0.02	7.43E-01	6.71	67.1	0.11	0.01
Selenium	1.68E-01	0.29	0.579	0.58	0.29	1.47E-01	0.29	0.579	0.51	0.25
Silver	8.71E-02	2.02	20.2	0.04	0.004	7.84E-02	2.02	20.2	0.04	0.004
Zinc	2.62E+02	66.1	661	**3.97**	0.40	1.77E+02	66.1	661	**2.68**	0.27

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.38
HQs for the mallard foraging on the Animas River above mainstem Cement Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	1.45E-01	2.24	22.4	0.06	0.01	9.43E-02	2.24	22.4	0.04	0.004
Cadmium	2.14E-01	1.47	14.7	0.15	0.01	1.59E-01	1.47	14.7	0.11	0.01
Chromium	1.49E-01	2.66	26.6	0.06	0.01	1.38E-01	2.66	26.6	0.05	0.01
Copper	3.79E+00	4.05	12.1	0.93	0.31	3.59E+00	4.05	12.1	0.89	0.30
Lead	3.11E+00	1.63	3.26	**1.91**	0.95	2.68E+00	1.63	3.26	**1.64**	0.82
Mercury	4.67E-03	0.45	0.9	0.01	0.01	4.48E-03	0.45	0.9	0.01	0.005
Nickel	3.63E-02	6.71	67.1	0.01	0.001	3.53E-02	6.71	67.1	0.01	0.001
Selenium	4.68E-02	0.29	0.579	0.16	0.08	4.73E-02	0.29	0.579	0.16	0.08
Silver	1.81E-02	2.02	20.2	0.01	0.001	1.67E-02	2.02	20.2	0.01	0.001
Zinc	4.57E+01	66.1	661	0.69	0.07	3.34E+01	66.1	661	0.51	0.05

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by: EC 3/01/15
QC'd by: RI 3/3/15

Table 5.39
HQs for mallards foraging at sampling location A72 on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	5.53E-02	2.24	22.4	0.02	0.002	4.88E-02	2.24	22.4	0.02	0.002
Cadmium	3.84E-02	1.47	14.7	0.03	0.003	3.75E-02	1.47	14.7	0.03	0.003
Chromium	1.18E-01	2.66	26.6	0.04	0.004	1.17E-01	2.66	26.6	0.04	0.004
Copper	2.17E+00	4.05	12.1	0.54	0.18	2.13E+00	4.05	12.1	0.53	0.18
Lead	9.98E-01	1.63	3.26	0.61	0.31	8.90E-01	1.63	3.26	0.55	0.27
Mercury	5.63E-03	0.45	0.9	0.01	0.01	5.62E-03	0.45	0.9	0.01	0.01
Nickel	2.01E-02	6.71	67.1	0.003	0.0003	1.94E-02	6.71	67.1	0.003	0.0003
Selenium	2.97E-02	0.29	0.579	0.10	0.05	2.93E-02	0.29	0.579	0.10	0.05
Silver	1.63E-02	2.02	20.2	0.01	0.001	1.58E-02	2.02	20.2	0.01	0.001
Zinc	9.52E+00	66.1	661	0.14	0.01	9.33E+00	66.1	661	0.14	0.01

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.40
HQs for mallards foraging at sampling location A73 on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	7.11E-02	2.24	22.4	0.03	0.003	6.50E-02	2.24	22.4	0.03	0.003
Cadmium	5.43E-02	1.47	14.7	0.04	0.004	5.28E-02	1.47	14.7	0.04	0.004
Chromium	1.11E-01	2.66	26.6	0.04	0.004	1.10E-01	2.66	26.6	0.04	0.004
Copper	2.02E+00	4.05	12.1	0.50	0.17	1.93E+00	4.05	12.1	0.48	0.16
Lead	1.11E+00	1.63	3.26	0.68	0.34	8.83E-01	1.63	3.26	0.54	0.27
Mercury	5.76E-03	0.45	0.9	0.01	0.01	5.75E-03	0.45	0.9	0.01	0.01
Nickel	3.76E-02	6.71	67.1	0.01	0.001	3.68E-02	6.71	67.1	0.01	0.001
Selenium	2.99E-02	0.29	0.579	0.10	0.05	2.96E-02	0.29	0.579	0.10	0.05
Silver	1.72E-02	2.02	20.2	0.01	0.001	1.62E-02	2.02	20.2	0.01	0.001
Zinc	1.17E+01	66.1	661	0.18	0.02	1.14E+01	66.1	661	0.17	0.02

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.41
HQs for mallards foraging at sampling location A73B on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	4.64E-01	2.24	22.4	0.21	0.02	3.75E-01	2.24	22.4	0.17	0.02
Cadmium	5.70E-02	1.47	14.7	0.04	0.004	5.16E-02	1.47	14.7	0.04	0.004
Chromium	1.57E-01	2.66	26.6	0.06	0.01	1.50E-01	2.66	26.6	0.06	0.01
Copper	1.28E+01	4.05	12.1	**3.16**	**1.06**	7.75E+00	4.05	12.1	**1.91**	0.64
Lead	1.64E+00	1.63	3.26	**1.01**	0.50	1.51E+00	1.63	3.26	0.93	0.46
Mercury	5.63E-03	0.45	0.9	0.01	0.01	4.38E-03	0.45	0.9	0.01	0.00
Nickel	1.19E-01	6.71	67.1	0.02	0.002	1.04E-01	6.71	67.1	0.02	0.002
Selenium	1.54E-01	0.29	0.579	0.53	0.27	1.54E-01	0.29	0.579	0.53	0.27
Silver	3.22E-02	2.02	20.2	0.02	0.002	2.08E-02	2.02	20.2	0.01	0.001
Zinc	1.21E+01	66.1	661	0.18	0.02	1.09E+01	66.1	661	0.17	0.02

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.42
HQs for mallards foraging at sampling location A75D on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	5.99E-02	2.24	22.4	0.03	0.003	5.20E-02	2.24	22.4	0.02	0.002
Cadmium	4.74E-02	1.47	14.7	0.03	0.003	4.57E-02	1.47	14.7	0.03	0.003
Chromium	1.74E-01	2.66	26.6	0.07	0.01	1.73E-01	2.66	26.6	0.07	0.01
Copper	1.00E+00	4.05	12.1	0.25	0.08	9.35E-01	4.05	12.1	0.23	0.08
Lead	5.02E-01	1.63	3.26	0.31	0.15	4.32E-01	1.63	3.26	0.26	0.13
Mercury	1.28E-02	0.45	0.9	0.03	0.01	1.28E-02	0.45	0.9	0.03	0.01
Nickel	4.47E-02	6.71	67.1	0.01	0.001	4.16E-02	6.71	67.1	0.01	0.001
Selenium	6.50E-02	0.29	0.579	0.22	0.11	6.48E-02	0.29	0.579	0.22	0.11
Silver	3.33E-02	2.02	20.2	0.02	0.002	3.30E-02	2.02	20.2	0.02	0.002
Zinc	1.26E+01	66.1	661	0.19	0.02	1.15E+01	66.1	661	0.17	0.02

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.43
HQs for mallards foraging at sampling location A75B on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD[1] (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD[1] (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	4.44E-01	2.24	22.4	0.20	0.02	2.73E-01	2.24	22.4	0.12	0.01
Cadmium	9.51E-02	1.47	14.7	0.06	0.01	6.28E-02	1.47	14.7	0.04	0.004
Chromium	1.62E-01	2.66	26.6	0.06	0.01	1.59E-01	2.66	26.6	0.06	0.01
Copper	1.81E+01	4.05	12.1	**4.47**	**1.50**	8.24E+00	4.05	12.1	**2.03**	0.68
Lead	1.29E+00	1.63	3.26	0.79	0.40	9.60E-01	1.63	3.26	0.59	0.29
Mercury	4.38E-03	0.45	0.9	0.01	0.005	4.38E-03	0.45	0.9	0.01	0.005
Nickel	1.49E-01	6.71	67.1	0.02	0.002	1.01E-01	6.71	67.1	0.02	0.002
Selenium	1.75E-01	0.29	0.579	0.60	0.30	1.01E-01	0.29	0.579	0.35	0.17
Silver	2.28E-02	2.02	20.2	0.01	0.001	1.45E-02	2.02	20.2	0.01	0.001
Zinc	1.74E+01	66.1	661	0.26	0.03	1.29E+01	66.1	661	0.20	0.02

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.44
HQs for mallards foraging at the Baker Bridge sampling location on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	4.29E-02	2.24	22.4	0.02	0.002	3.48E-02	2.24	22.4	0.02	0.002
Cadmium	1.02E-01	1.47	14.7	0.07	0.01	9.32E-02	1.47	14.7	0.06	0.01
Chromium	1.14E-01	2.66	26.6	0.04	0.00	1.12E-01	2.66	26.6	0.04	0.00
Copper	1.26E+00	4.05	12.1	0.31	0.10	1.11E+00	4.05	12.1	0.27	0.09
Lead	5.24E-01	1.63	3.26	0.32	0.16	4.44E-01	1.63	3.26	0.27	0.14
Mercury	4.89E-03	0.45	0.9	0.01	0.01	4.87E-03	0.45	0.9	0.01	0.01
Nickel	1.15E-01	6.71	67.1	0.02	0.002	1.01E-01	6.71	67.1	0.02	0.002
Selenium	2.74E-02	0.29	0.579	0.09	0.05	2.63E-02	0.29	0.579	0.09	0.05
Silver	1.38E-02	2.02	20.2	0.01	0.001	1.33E-02	2.02	20.2	0.01	0.001
Zinc	2.72E+01	66.1	661	0.41	0.04	2.31E+01	66.1	661	0.35	0.04

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.45
HQs for Mallard foraging on the Animas River above mainstem Cement Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	1.16E-01	2.24	22.4	0.05	0.01	8.43E-02	2.24	22.4	0.04	0.004
Cadmium	1.79E-01	1.47	14.7	0.12	0.01	1.45E-01	1.47	14.7	0.10	0.01
Chromium	8.26E-02	2.66	26.6	0.03	0.003	7.63E-02	2.66	26.6	0.03	0.003
Copper	2.64E+00	4.05	12.1	0.65	0.22	2.48E+00	4.05	12.1	0.61	0.20
Lead	2.91E+00	1.63	3.26	**1.78**	0.89	2.54E+00	1.63	3.26	**1.56**	0.78
Mercury	5.13E-03	0.45	0.9	0.01	0.01	4.53E-03	0.45	0.9	0.01	0.01
Nickel	3.77E-02	6.71	67.1	0.01	0.001	3.55E-02	6.71	67.1	0.01	0.001
Selenium	3.71E-02	0.29	0.579	0.13	0.06	4.51E-02	0.29	0.579	0.16	0.08
Silver	1.47E-02	2.02	20.2	0.01	0.001	1.32E-02	2.02	20.2	0.01	0.001
Zinc	3.76E+01	66.1	661	0.57	0.06	2.94E+01	66.1	661	0.44	0.04

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.46
HQs for mallards foraging at sampling location A72 on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	7.66E-02	2.24	22.4	0.03	0.003	6.75E-02	2.24	22.4	0.03	0.003
Cadmium	4.96E-02	1.47	14.7	0.03	0.003	4.41E-02	1.47	14.7	0.03	0.003
Chromium	6.89E-02	2.66	26.6	0.03	0.003	6.58E-02	2.66	26.6	0.02	0.002
Copper	1.56E+00	4.05	12.1	0.39	0.13	1.49E+00	4.05	12.1	0.37	0.12
Lead	1.05E+00	1.63	3.26	0.64	0.32	9.13E-01	1.63	3.26	0.56	0.28
Mercury	5.11E-03	0.45	0.9	0.01	0.01	4.91E-03	0.45	0.9	0.01	0.01
Nickel	2.38E-02	6.71	67.1	0.004	0.0004	2.20E-02	6.71	67.1	0.003	0.0003
Selenium	4.26E-02	0.29	0.579	0.15	0.07	3.60E-02	0.29	0.579	0.12	0.06
Silver	1.03E-02	2.02	20.2	0.01	0.001	9.57E-03	2.02	20.2	0.005	0.0005
Zinc	1.04E+01	66.1	661	0.16	0.02	9.59E+00	66.1	661	0.15	0.01

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.47
HQs for mallards foraging at sampling location A73 on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	7.89E-02	2.24	22.4	0.04	0.004	7.01E-02	2.24	22.4	0.03	0.003
Cadmium	7.05E-02	1.47	14.7	0.05	0.005	6.29E-02	1.47	14.7	0.04	0.004
Chromium	6.41E-02	2.66	26.6	0.02	0.002	6.11E-02	2.66	26.6	0.02	0.002
Copper	1.63E+00	4.05	12.1	0.40	0.13	1.48E+00	4.05	12.1	0.36	0.12
Lead	1.21E+00	1.63	3.26	0.74	0.37	9.37E-01	1.63	3.26	0.57	0.29
Mercury	4.79E-03	0.45	0.9	0.01	0.01	4.56E-03	0.45	0.9	0.01	0.01
Nickel	3.49E-02	6.71	67.1	0.01	0.001	3.31E-02	6.71	67.1	0.005	0.0005
Selenium	3.48E-02	0.29	0.579	0.12	0.06	3.00E-02	0.29	0.579	0.10	0.05
Silver	1.11E-02	2.02	20.2	0.01	0.001	9.80E-03	2.02	20.2	0.005	0.0005
Zinc	1.36E+01	66.1	661	0.21	0.02	1.22E+01	66.1	661	0.18	0.02

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.48
HQs for mallards foraging at sampling location A73B on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	2.81E-01	2.24	22.4	0.13	0.01	2.27E-01	2.24	22.4	0.10	0.01
Cadmium	6.60E-02	1.47	14.7	0.04	0.004	5.96E-02	1.47	14.7	0.04	0.004
Chromium	8.64E-02	2.66	26.6	0.03	0.003	8.25E-02	2.66	26.6	0.03	0.003
Copper	7.02E+00	4.05	12.1	**1.73**	0.58	4.36E+00	4.05	12.1	**1.08**	0.36
Lead	1.38E+00	1.63	3.26	0.84	0.42	1.27E+00	1.63	3.26	0.78	0.39
Mercury	5.45E-03	0.45	0.9	0.01	0.01	4.48E-03	0.45	0.9	0.01	0.00
Nickel	8.42E-02	6.71	67.1	0.01	0.001	7.30E-02	6.71	67.1	0.01	0.001
Selenium	1.21E-01	0.29	0.579	0.42	0.21	1.21E-01	0.29	0.579	0.42	0.21
Silver	1.88E-02	2.02	20.2	0.01	0.001	1.21E-02	2.02	20.2	0.01	0.001
Zinc	1.48E+01	66.1	661	0.22	0.02	1.22E+01	66.1	661	0.18	0.02

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
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QC'd by: RI 3/3/15

Table 5.49
HQs for mallards foraging at sampling location A75D on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	6.67E-02	2.24	22.4	0.03	0.003	5.49E-02	2.24	22.4	0.02	0.002
Cadmium	7.15E-02	1.47	14.7	0.05	0.005	6.33E-02	1.47	14.7	0.04	0.004
Chromium	9.48E-02	2.66	26.6	0.04	0.004	9.34E-02	2.66	26.6	0.04	0.004
Copper	1.03E+00	4.05	12.1	0.25	0.09	9.06E-01	4.05	12.1	0.22	0.07
Lead	6.31E-01	1.63	3.26	0.39	0.19	5.41E-01	1.63	3.26	0.33	0.17
Mercury	8.06E-03	0.45	0.9	0.02	0.01	8.06E-03	0.45	0.9	0.02	0.01
Nickel	4.73E-02	6.71	67.1	0.01	0.001	4.07E-02	6.71	67.1	0.01	0.001
Selenium	5.23E-02	0.29	0.579	0.18	0.09	4.91E-02	0.29	0.579	0.17	0.08
Silver	1.79E-02	2.02	20.2	0.01	0.001	1.75E-02	2.02	20.2	0.01	0.001
Zinc	1.80E+01	66.1	661	0.27	0.03	1.46E+01	66.1	661	0.22	0.02

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.50
HQs for mallards foraging at sampling location A75B on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD[1] (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD[1] (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	2.68E-01	2.24	22.4	0.12	0.01	1.66E-01	2.24	22.4	0.07	0.01
Cadmium	1.11E-01	1.47	14.7	0.08	0.01	7.28E-02	1.47	14.7	0.05	0.005
Chromium	8.98E-02	2.66	26.6	0.03	0.003	8.76E-02	2.66	26.6	0.03	0.003
Copper	9.81E+00	4.05	12.1	**2.42**	0.81	4.61E+00	4.05	12.1	**1.14**	0.38
Lead	1.08E+00	1.63	3.26	0.66	0.33	8.02E-01	1.63	3.26	0.49	0.25
Mercury	4.48E-03	0.45	0.9	0.01	0.005	4.48E-03	0.45	0.9	0.01	0.005
Nickel	1.06E-01	6.71	67.1	0.02	0.002	7.12E-02	6.71	67.1	0.01	0.001
Selenium	1.38E-01	0.29	0.579	0.48	0.24	7.80E-02	0.29	0.579	0.27	0.13
Silver	1.34E-02	2.02	20.2	0.01	0.001	8.50E-03	2.02	20.2	0.004	0.0004
Zinc	2.62E+01	66.1	661	0.40	0.04	1.66E+01	66.1	661	0.25	0.03

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.51
HQs for mallards foraging at the Bakers Bridge sampling location on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	6.09E-02	2.24	22.4	0.03	0.003	4.90E-02	2.24	22.4	0.02	0.002
Cadmium	1.40E-01	1.47	14.7	0.10	0.01	1.09E-01	1.47	14.7	0.07	0.01
Chromium	6.79E-02	2.66	26.6	0.03	0.003	6.45E-02	2.66	26.6	0.02	0.002
Copper	1.30E+00	4.05	12.1	0.32	0.11	1.06E+00	4.05	12.1	0.26	0.09
Lead	6.49E-01	1.63	3.26	0.40	0.20	5.47E-01	1.63	3.26	0.34	0.17
Mercury	4.55E-03	0.45	0.9	0.01	0.01	4.12E-03	0.45	0.9	0.01	0.005
Nickel	1.10E-01	6.71	67.1	0.02	0.002	8.49E-02	6.71	67.1	0.01	0.001
Selenium	6.12E-02	0.29	0.579	0.21	0.11	4.41E-02	0.29	0.579	0.15	0.08
Silver	8.38E-03	2.02	20.2	0.004	0.0004	7.82E-03	2.02	20.2	0.004	0.0004
Zinc	3.71E+01	66.1	661	0.56	0.06	2.75E+01	66.1	661	0.42	0.04

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.52
HQs for the belted kingfisher foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	4.34E-01	2.24	22.4	0.19	0.02	3.48E-01	2.24	22.4	0.16	0.02
Cadmium	2.06E-01	1.47	14.7	0.14	0.01	1.78E-01	1.47	14.7	0.12	0.01
Chromium	2.52E-02	2.66	26.6	0.01	0.001	2.37E-02	2.66	26.6	0.01	0.001
Copper	4.16E+00	4.05	12.1	**1.03**	0.34	3.54E+00	4.05	12.1	0.87	0.29
Lead	1.36E+01	1.63	3.26	**8.32**	**4.16**	1.18E+01	1.63	3.26	**7.24**	**3.62**
Mercury	2.84E-02	0.45	0.9	0.06	0.03	1.99E-02	0.45	0.9	0.04	0.02
Nickel	8.15E-01	6.71	67.1	0.12	0.01	7.27E-01	6.71	67.1	0.11	0.01
Selenium	8.85E-02	0.29	0.579	0.31	0.15	1.33E-01	0.29	0.579	0.46	0.23
Silver	5.67E-01	2.02	20.2	0.28	0.03	4.88E-01	2.02	20.2	0.24	0.02
Zinc	5.89E+01	66.1	661	0.89	0.09	4.61E+01	66.1	661	0.70	0.07

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.53
HQs for the belted kingfisher foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	5.03E-01	2.24	22.4	0.22	0.02	4.24E-01	2.24	22.4	0.19	0.02
Cadmium	4.66E-02	1.47	14.7	0.03	0.003	3.38E-02	1.47	14.7	0.02	0.002
Chromium	3.07E-02	2.66	26.6	0.01	0.001	2.32E-02	2.66	26.6	0.01	0.001
Copper	1.81E+00	4.05	12.1	0.45	0.15	1.43E+00	4.05	12.1	0.35	0.12
Lead	4.55E+00	1.63	3.26	**2.79**	**1.39**	3.74E+00	1.63	3.26	**2.29**	**1.15**
Mercury	1.99E-02	0.45	0.9	0.04	0.02	1.70E-02	0.45	0.9	0.04	0.02
Nickel	5.23E-01	6.71	67.1	0.08	0.01	4.53E-01	6.71	67.1	0.07	0.01
Selenium	1.68E-01	0.29	0.579	0.58	0.29	1.33E-01	0.29	0.579	0.46	0.23
Silver	2.13E-01	2.02	20.2	0.11	0.01	1.68E-01	2.02	20.2	0.08	0.01
Zinc	1.20E+01	66.1	661	0.18	0.02	9.51E+00	66.1	661	0.14	0.01

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.54
HQs for the belted kingfisher foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	4.29E-01	2.24	22.4	0.19	0.02	3.54E-01	2.24	22.4	0.16	0.02
Cadmium	8.66E-02	1.47	14.7	0.06	0.01	6.41E-02	1.47	14.7	0.04	0.004
Chromium	2.72E-02	2.66	26.6	0.01	0.001	2.02E-02	2.66	26.6	0.01	0.001
Copper	2.96E+00	4.05	12.1	0.73	0.24	2.08E+00	4.05	12.1	0.51	0.17
Lead	5.70E+00	1.63	3.26	**3.50**	**1.75**	4.01E+00	1.63	3.26	**2.46**	**1.23**
Mercury	1.42E-02	0.45	0.9	0.03	0.02	1.14E-02	0.45	0.9	0.03	0.01
Nickel	6.39E-01	6.71	67.1	0.10	0.01	5.68E-01	6.71	67.1	0.08	0.01
Selenium	1.24E-01	0.29	0.579	0.43	0.21	9.75E-02	0.29	0.579	0.34	0.17
Silver	2.48E-01	2.02	20.2	0.12	0.01	1.68E-01	2.02	20.2	0.08	0.01
Zinc	2.03E+01	66.1	661	0.31	0.03	1.53E+01	66.1	661	0.23	0.02

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.55
HQs for the belted kingfisher foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	5.00E-01	2.24	22.4	0.22	0.02	3.79E-01	2.24	22.4	0.17	0.02
Cadmium	6.73E-02	1.47	14.7	0.05	0.005	5.61E-02	1.47	14.7	0.04	0.004
Chromium	2.58E-02	2.66	26.6	0.01	0.001	2.33E-02	2.66	26.6	0.01	0.001
Copper	3.05E+00	4.05	12.1	0.75	0.25	1.85E+00	4.05	12.1	0.46	0.15
Lead	4.64E+00	1.63	3.26	**2.85**	**1.42**	4.18E+00	1.63	3.26	**2.56**	**1.28**
Mercury	2.56E-02	0.45	0.9	0.06	0.03	1.99E-02	0.45	0.9	0.04	0.02
Nickel	1.07E+00	6.71	67.1	0.16	0.02	8.87E-01	6.71	67.1	0.13	0.01
Selenium	2.57E-01	0.29	0.579	0.89	0.44	2.57E-01	0.29	0.579	0.89	0.44
Silver	2.75E-01	2.02	20.2	0.14	0.01	1.77E-01	2.02	20.2	0.09	0.01
Zinc	2.50E+01	66.1	661	0.38	0.04	1.62E+01	66.1	661	0.25	0.02

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.56
HQs for the belted kingfisher foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	3.43E-01	2.24	22.4	0.15	0.02	2.46E-01	2.24	22.4	0.11	0.01
Cadmium	1.02E-01	1.47	14.7	0.07	0.007	7.69E-02	1.47	14.7	0.05	0.01
Chromium	2.47E-02	2.66	26.6	0.01	0.001	2.12E-02	2.66	26.6	0.01	0.001
Copper	2.21E+00	4.05	12.1	0.55	0.18	1.53E+00	4.05	12.1	0.38	0.13
Lead	2.87E+00	1.63	3.26	**1.76**	0.88	2.35E+00	1.63	3.26	**1.44**	0.72
Mercury	1.14E-02	0.45	0.9	0.03	0.01	1.14E-02	0.45	0.9	0.03	0.01
Nickel	1.10E+00	6.71	67.1	0.16	0.02	8.33E-01	6.71	67.1	0.12	0.01
Selenium	1.24E-01	0.29	0.579	0.43	0.21	1.06E-01	0.29	0.579	0.37	0.18
Silver	1.24E-01	2.02	20.2	0.06	0.01	9.75E-02	2.02	20.2	0.05	0.005
Zinc	4.04E+01	66.1	661	0.61	0.06	2.53E+01	66.1	661	0.38	0.04

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.57
HQsfor the belted kingfisher foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	4.72E-01	2.24	22.4	0.21	0.02	2.52E-01	2.24	22.4	0.11	0.01
Cadmium	1.68E-01	1.47	14.7	0.11	0.01	8.00E-02	1.47	14.7	0.05	0.01
Chromium	2.77E-02	2.66	26.6	0.01	0.001	2.62E-02	2.66	26.6	0.01	0.001
Copper	4.31E+00	4.05	12.1	1.06	0.36	1.96E+00	4.05	12.1	0.48	0.16
Lead	3.41E+00	1.63	3.26	**2.09**	**1.04**	2.32E+00	1.63	3.26	**1.42**	0.71
Mercury	1.99E-02	0.45	0.9	0.04	0.02	1.99E-02	0.45	0.9	0.04	0.02
Nickel	1.46E+00	6.71	67.1	0.22	0.02	8.60E-01	6.71	67.1	0.13	0.01
Selenium	2.93E-01	0.29	0.579	1.01	0.51	1.68E-01	0.29	0.579	0.58	0.29
Silver	1.95E-01	2.02	20.2	0.10	0.01	1.24E-01	2.02	20.2	0.06	0.01
Zinc	7.73E+01	66.1	661	**1.17**	0.12	3.18E+01	66.1	661	0.48	0.05

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.58
HQs for the belted kingfisher foraging at the Baker Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	3.77E-01	2.24	22.4	0.17	0.02	2.78E-01	2.24	22.4	0.12	0.01
Cadmium	2.97E-01	1.47	14.7	0.20	0.02	1.62E-01	1.47	14.7	0.11	0.01
Chromium	3.53E-02	2.66	26.6	0.01	0.001	2.72E-02	2.66	26.6	0.01	0.001
Copper	3.46E+00	4.05	12.1	0.86	0.29	1.99E+00	4.05	12.1	0.49	0.16
Lead	2.94E+00	1.63	3.26	**1.81**	0.90	2.35E+00	1.63	3.26	**1.44**	0.72
Mercury	1.70E-02	0.45	0.9	0.04	0.02	1.14E-02	0.45	0.9	0.03	0.01
Nickel	2.75E+00	6.71	67.1	0.41	0.04	1.62E+00	6.71	67.1	0.24	0.02
Selenium	2.75E-01	0.29	0.579	0.95	0.47	1.86E-01	0.29	0.579	0.64	0.32
Silver	1.51E-01	2.02	20.2	0.07	0.01	1.15E-01	2.02	20.2	0.06	0.01
Zinc	1.24E+02	66.1	661	**1.88**	0.19	6.71E+01	66.1	661	**1.01**	0.10

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.59
HQs for the muskrat foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	3.71E-01	1.04	1.66	0.36	0.22	3.04E-01	1.04	1.66	0.29	0.18
Cadmium	3.19E-01	0.77	7.7	0.41	0.04	2.87E-01	0.77	7.7	0.37	0.04
Chromium	5.91E-02	2.4	24	0.02	0.002	5.56E-02	2.4	24	0.02	0.002
Copper	5.08E+00	5.6	9.34	0.91	0.54	4.47E+00	5.6	9.34	0.80	0.48
Lead	1.60E+01	4.7	8.9	**3.40**	**1.80**	1.40E+01	4.7	8.9	**2.98**	**1.57**
Mercury	9.69E-03	1.00	14.1	0.01	0.001	7.88E-03	1.00	14.1	0.01	0.001
Nickel	1.25E-01	1.70	3.4	0.07	0.04	1.13E-01	1.70	3.4	0.07	0.03
Selenium	5.09E-02	0.14	0.214	0.36	0.24	7.92E-02	0.14	0.214	0.57	0.37
Silver	6.12E-02	6.02	60.2	0.01	0.001	5.26E-02	6.02	60.2	0.01	0.001
Zinc	7.48E+01	75.4	754	0.99	0.10	6.22E+01	75.4	754	0.83	0.08

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by: EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.60
HQs for the muskrat foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	4.24E-01	1.04	1.66	0.41	0.26	3.64E-01	1.04	1.66	0.35	0.22
Cadmium	1.18E-01	0.77	7.7	0.15	0.02	9.59E-02	0.77	7.7	0.12	0.01
Chromium	7.22E-02	2.4	24	0.03	0.003	5.44E-02	2.4	24	0.02	0.002
Copper	2.70E+00	5.6	9.34	0.48	0.29	2.29E+00	5.6	9.34	0.41	0.25
Lead	5.67E+00	4.7	8.9	**1.21**	0.64	4.72E+00	4.7	8.9	**1.00**	0.53
Mercury	7.88E-03	1.00	14.1	0.01	0.001	7.21E-03	1.00	14.1	0.01	0.001
Nickel	8.41E-02	1.70	3.4	0.05	0.02	7.40E-02	1.70	3.4	0.04	0.02
Selenium	1.02E-01	0.14	0.214	0.73	0.48	7.92E-02	0.14	0.214	0.57	0.37
Silver	2.30E-02	6.02	60.2	0.004	0.0004	1.82E-02	6.02	60.2	0.003	0.0003
Zinc	2.37E+01	75.4	754	0.31	0.03	2.03E+01	75.4	754	0.27	0.03

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.61
HQs for the muskrat foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	3.67E-01	1.04	1.66	0.35	0.22	3.09E-01	1.04	1.66	0.30	0.19
Cadmium	1.76E-01	0.77	7.7	0.23	0.02	1.45E-01	0.77	7.7	0.19	0.02
Chromium	6.39E-02	2.4	24	0.03	0.003	4.73E-02	2.4	24	0.02	0.002
Copper	3.90E+00	5.6	9.34	0.70	0.42	2.99E+00	5.6	9.34	0.53	0.32
Lead	7.02E+00	4.7	8.9	**1.49**	0.79	5.04E+00	4.7	8.9	**1.07**	0.57
Mercury	6.49E-03	1.00	14.1	0.01	0.0005	5.71E-03	1.00	14.1	0.01	0.0004
Nickel	1.01E-01	1.70	3.4	0.06	0.03	9.05E-02	1.70	3.4	0.05	0.03
Selenium	7.35E-02	0.14	0.214	0.52	0.34	5.65E-02	0.14	0.214	0.40	0.26
Silver	2.68E-02	6.02	60.2	0.004	0.0004	1.82E-02	6.02	60.2	0.003	0.0003
Zinc	3.43E+01	75.4	754	0.45	0.05	2.81E+01	75.4	754	0.37	0.04

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.62
HQs for the muskrat foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	4.21E-01	1.04	1.66	0.41	0.25	3.29E-01	1.04	1.66	0.32	0.20
Cadmium	1.49E-01	0.77	7.7	0.19	0.02	1.33E-01	0.77	7.7	0.17	0.02
Chromium	5.97E-02	2.4	24	0.02	0.002	5.38E-02	2.4	24	0.02	0.002
Copper	3.98E+00	5.6	9.34	0.71	0.43	2.74E+00	5.6	9.34	0.49	0.29
Lead	5.78E+00	4.7	8.9	**1.23**	0.65	5.23E+00	4.7	8.9	**1.11**	0.59
Mercury	9.12E-03	1.00	14.1	0.01	0.001	7.88E-03	1.00	14.1	0.01	0.001
Nickel	1.60E-01	1.70	3.4	0.09	0.05	1.35E-01	1.70	3.4	0.08	0.04
Selenium	1.62E-01	0.14	0.214	**1.16**	0.76	1.62E-01	0.14	0.214	**1.16**	0.76
Silver	2.97E-02	6.02	60.2	0.005	0.0005	1.91E-02	6.02	60.2	0.003	0.0003
Zinc	3.98E+01	75.4	754	0.53	0.05	2.93E+01	75.4	754	0.39	0.04

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.63
HQs for the muskrat foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	3.00E-01	1.04	1.66	0.29	0.18	2.24E-01	1.04	1.66	0.22	0.13
Cadmium	1.97E-01	0.77	7.7	0.26	0.03	1.63E-01	0.77	7.7	0.21	0.02
Chromium	5.80E-02	2.4	24	0.02	0.002	4.97E-02	2.4	24	0.02	0.002
Copper	3.13E+00	5.6	9.34	0.56	0.34	2.40E+00	5.6	9.34	0.43	0.26
Lead	3.69E+00	4.7	8.9	0.79	0.41	3.06E+00	4.7	8.9	0.65	0.34
Mercury	5.71E-03	1.00	14.1	0.01	0.0004	5.71E-03	1.00	14.1	0.01	0.0004
Nickel	1.64E-01	1.70	3.4	0.10	0.05	1.27E-01	1.70	3.4	0.07	0.04
Selenium	7.35E-02	0.14	0.214	0.52	0.34	6.22E-02	0.14	0.214	0.44	0.29
Silver	1.34E-02	6.02	60.2	0.002	0.0002	1.05E-02	6.02	60.2	0.002	0.0002
Zinc	5.64E+01	75.4	754	0.75	0.07	4.01E+01	75.4	754	0.53	0.05

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.64
HQs for the muskrat foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	4.00E-01	1.04	1.66	0.38	0.24	2.29E-01	1.04	1.66	0.22	0.14
Cadmium	2.76E-01	0.77	7.7	0.36	0.04	1.68E-01	0.77	7.7	0.22	0.02
Chromium	6.51E-02	2.4	24	0.03	0.003	6.15E-02	2.4	24	0.03	0.003
Copper	5.23E+00	5.6	9.34	0.93	0.56	2.87E+00	5.6	9.34	0.51	0.31
Lead	4.32E+00	4.7	8.9	0.92	0.49	3.03E+00	4.7	8.9	0.64	0.34
Mercury	7.88E-03	1.00	14.1	0.01	0.001	7.88E-03	1.00	14.1	0.01	0.001
Nickel	2.12E-01	1.70	3.4	0.12	0.06	1.31E-01	1.70	3.4	0.08	0.04
Selenium	1.87E-01	0.14	0.214	**1.33**	0.87	1.02E-01	0.14	0.214	0.73	0.48
Silver	2.10E-02	6.02	60.2	0.003	0.0003	1.34E-02	6.02	60.2	0.002	0.0002
Zinc	9.21E+01	75.4	754	**1.22**	0.12	4.74E+01	75.4	754	0.63	0.06

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.65
HQs for the muskrat foraging at the Baker Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	3.27E-01	1.04	1.66	0.31	0.20	2.49E-01	1.04	1.66	0.24	0.15
Cadmium	4.13E-01	0.77	7.7	0.54	0.05	2.69E-01	0.77	7.7	0.35	0.03
Chromium	8.28E-02	2.4	24	0.03	0.003	6.39E-02	2.4	24	0.03	0.003
Copper	4.40E+00	5.6	9.34	0.79	0.47	2.90E+00	5.6	9.34	0.52	0.31
Lead	3.78E+00	4.7	8.9	0.80	0.42	3.06E+00	4.7	8.9	0.65	0.34
Mercury	7.21E-03	1.00	14.1	0.01	0.001	5.71E-03	1.00	14.1	0.01	0.0004
Nickel	3.79E-01	1.70	3.4	0.22	0.11	2.33E-01	1.70	3.4	0.14	0.07
Selenium	1.75E-01	0.14	0.214	**1.25**	0.82	1.14E-01	0.14	0.214	0.82	0.53
Silver	1.63E-02	6.02	60.2	0.003	0.0003	1.24E-02	6.02	60.2	0.002	0.0002
Zinc	1.33E+02	75.4	754	**1.77**	0.18	8.26E+01	75.4	754	**1.10**	0.11

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level (mg/kg bw-day)
LOAEL - Lowest Observable Adverse Effect Level (mg/kg bw-day)
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient (unit less)

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Appendix 1

pH, hardness, and total plus dissolved metal concentrations measured in surface water samples collected from the Animas River, mainstem Cement Creek, and mainstem Mineral Creek

Appendix 1.a: Field pH measurements in surface water samples collected between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD											
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Measurement	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**
Animas River upstream of mainstem Cement Creek																									
A56 ("upstream)											7.61	7.44												7.39	6.64
A60											7.66	7.44													6.48
A61											7.38	7.36													7.37
A64											7.54	7.35													6.26
A65											7.47	7.24													7.01
A66											7.45	7.15													6.99
A68	6.74	6.82	6.85	7.18		7.15	7.51	6.98	7.28	7.37	7.39	7.09	7.61	7.18	7.21	6.52	6.92	7.52	7.26	7.42	7.2	7.39	6.87	7.42	7.71
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								5.54	
A70B																								6.05	
Animas River downstream of mainstem Mineral Creek																									
A71B																								6.10	
A72	5.07	5.04	6.09	5.3		7.08	7.09	6.51	6.5	6.59	6.87	6.33	6.88	6.40	6.46	5.93	6.41	6.48	6.25	7.08	6.51	6.38	6.23	5.98	7.00
A73											7.25	7.19												6.54	7.24
A73B											7.26	7.24												6.74	7.24
A75D											7.49	7.44												7.21	6.93
A75B											7.42	7.29												7.02	6.89
Bakers Bridge											7.64	7.63												7.20	7.58
Mainstem Cement Creek																									
CC48	3.5	3.42	3.93	3.54		5.40	4.29	5.34	5.24	4.43	4.43	4.6	3.95	3.51	3.65	3.50	3.57	3.45	3.51	4.54	3.45	3.51	3.24	3.40	4.00
CC49																								3.43	
Mainstem Mineral Creek																									
M34	4.97	5.02	6.22	5.12		6.49	7.30	7.00	7.19	7.07	7.23	6.83	7.19	6.73	6.70	5.62	6.77	6.73	6.4	7.28	6.82	6.68	5.90	6.15	7.05

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

Appendix 1.b: Hardness measurements in surface water samples collected between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD											
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Measurement	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**	**hardness**
Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Animas River upstream of mainstem Cement Creek																									
A56 ("upstream")					131						65	79												168	114
A60											74	78													111
A61											78	80													111
A64											63	76													113
A65											65	80													117
A66											64	79													120
A68	202	179	148	172	151	49	65	50	53	71	66	87	85	135	141	167	97	144	154	66	111	140	138	174	114
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								297	
A70B																								295	
Animas River downstream of mainstem Mineral Creek																									
A71B																								263	
A72	352	337	177	273		45	78	54	55	86	82	103	109	211	199	296	136	245	232	75	161	210	183	261	144
A73					182						71	88												251	142
A73B											37	54												217	83
A75D					133						60	76												191	92
A75B											61	70												193	85
Bakers Bridge					127						58	73												183	99
Mainstem Cement Creek																									
CC48	571	541	301	493		81	189	88	76	177	129	126	293	467	470	495	345	509	517	191	398	474	435	515	67
CC49																								545	
Mainestem Mineral Creek																									
M34	309	308	150	247		52	72	49	53	77	79	92	91	186	156	238	114	199	219	65	144	188	155	220	118

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

Appendix 1.c: Total and Dissolved Aluminum Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD																							
Sampling Date	**Feb 2010**		**Mar 2010**		**Apr 2010**		**Mar 2011**		**April 2014**		**May 2009**		**Jun 2009**		**Jun 2010**		**Jun 2011**		**May 2012**		**May 2013**		**May 2014**		**Jul 2009**		**Aug 2009**		**Sep 2009**		**Nov 2009**		**Jul 2010**		**Sep 2010**		**Nov 2010**	
Metal-fraction	**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**	
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																																			
A56 ("upstream")									71.2												817		392														
A60																					370		452														
A61																					322		549														
A64																					343		514														
A65																					698		454														
A66																					653		547														
A68	269		177		368		275		438		1010		165		348		540		154		534		508		117		120		134		189		100	U	124		101	
Animas River between mainsteam Cement Creek and mainstem Mineral Creek																																			
A69A																																			
A70B																																			
Animas River downstream of confluence with mainstem Mineral Creek																																			
A71B																																			
A72	4440		4090		1980		3310				3060		679		585		1200		713		938		2340		812		2080		2080		2750		1090		2180		2540	
A73									1620												1280		1050														
A73B																					666		640														
A75D									1260												1630		1060														
A75B																					1650		1040														
Bakers Bridge									843												1310		734														
Mainstem Cement Creek																																			
CC48	8610		8100		5020		7540				1780		2920		1750		1610		2690		2690		3280		4120		7110		7050		7850		5270		7230		7930	
CC49																																			
Mainstem Mineral Creek																																			
M34	5950		5360		2160		4830				1130		773		665		2200		824		1270		2610		933		2630		2480		4590		1200		2960		3080	

	POST-RUNOFF PERIOD																																			
Sampling Date	**Sep 2010**		**Nov 2010**		**Jul 2011**		**Aug 2011**		**Sep 2011**		**Oct 2011**		**Oct 2012**		**Sept 2014**		**Feb 2010**		**Mar 2010**		**Apr 2010**		**Mar 2011**		**April 2014**		**May 2009**		**Jun 2009**		**Jun 2010**		**Jun 2011**		**May 2012**		**May 2013**	
Metal-fraction	**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-total**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**	
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**ug/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**ug/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																																				
A56 ("upstream")																									40.8	J									48.7	J
A60																																			49.8	J
A61																																			70.4	
A64																																			70.5	
A65																																			81.4	
A66																																			76.7	
A68	25.0	U	25.0	U	100	U	100	U	100	U	100	U	62.2		73		141		100	U	100	U	100		82.9		100	U	100	U	100	U	100	U	57.2		93.3	
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																				
A69A																																				
A70B																																				
Animas River downstream of confluence with mainstem Mineral Creek																																				
A71B																																				
A72																	3290		2740		212		1570				100	U	100	U	100	U	100	U	33.6	J	58.9	
A73																									32.2	J									73.1	
A73B																																			83.1	
A75D																									36.9	J									86.7	
A75B																																			84.2	
Bakers Bridge																									69.1										84.2	
Mainstem Cement Creek																																				
CC48																	8450		7820		4840		7660				751		2890		1050		798		2470		2290	
CC49																																				
Mainstem Mineral Creek																																				
M34																	4410		4700		160		3020				100	U	100	U	117		100	U	45.0	J	62.6	

	POST-RUNOFF PERIOD																																			
Sampling Date	**Jul 2009**		**Aug 2009**		**Sep 2009**		**Nov 2009**		**Jul 2010**		**Sep 2010**		**Nov 2010**		**Jul 2011**		**Aug 2011**		**Sep 2011**		**Oct 2011**		**Oct 2012**		**Sept 2014**											
Metal-fraction	**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**		**Al-diss**											
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**											
Animas River upstream of the confluence with mainstem Cement Creek																																				
A56 ("upstream")																									42.7	J	61.4										
A60																											43.3	J									
A61																											64.9										
A64																											63										
A65																											54.7										
A66																											59.9										
A68	100	U	100	U	100	U	103		100	U	25.0	U	25.0	U	100	U	100	U	100	U	100	U	62.2		73											
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																				
A69A																									603											
A70B																									1690											
Animas River downstream of confluence with mainstem Mineral Creek																																				
A71B																									309											
A72	100	U	131		171		959		100	U	25.0	U	193		100	U	100	U	117		103		342		38.9	J										
A73																									44.8	J	36.9	J								
A73B																									39.1	J	43.1	J								
A75D																									20	U	66.2									
A75B																									21.3	J	61.8									
Bakers Bridge																									26.2	J	76.9									
Mainstem Cement Creek																																				
CC48	4050		7050		6930		7850		5270		7440		7720		2410		6030		7290		6770		7480	D	938											
CC49																									7660	D										
Mainstem Mineral Creek																																				
M34	100	U	100	U	100	U	656		100	U	25.0	U	25.0	U	100	U	100	U	100	U	100	U	177	JD	46	J										

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by: Emily (2/10/15)

Appendix 1.d: Total and Dissolved Arsenic Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

| | PRE-RUNOFF PERIOD | | | | | | | | | | RUNOFF PERIOD | | | | | | | | | | | | | | | | | | | | | | POST-RUNOFF PERIOD | | | | | | | | | | | | | | | | | | |

Appendix 1.e: Total and Dissolved Beryllium Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

| | PRE-RUNOFF PERIOD | | | | | | | | | | RUNOFF PERIOD | | | | | | | | | | | | | | POST-RUNOFF PERIOD | | | | | | | | | | | | | |

Appendix 1.f: Total and Dissolved Cadmium Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**	**Cd-total**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					0.596 JD						1.6 D	1.33 D												1.0 D	0.99 JD
A60											1.3 D	1.17 D													0.93 JD
A61											1.2 D	1.83 D													0.99 JD
A64											1.3 D	1.49 D													0.93 JD
A65											1.3 D	1.37 D													0.94 JD
A66											1.4 D	1.5 D													1.0 D
A68	2.0	1.7	4.0	2.6	3.2 D	1.5	0.9	1.1	1.1	0.9 JD	1.5 D	1.52 D	0.8	1.0	1.3	1.6	0.8	1.3	1.3	0.8	1.0	1.1	1.2	1.3 D	1.1 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								3.0 D	
A70B																								2.7 D	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								2.0 D	
A72	2.5	2.8	2.9	2.7		1.2	0.8	0.9	0.9	0.9 JD	1.4 D	1.65 D	0.9	1.7	1.9	2.7	1.2	1.7	2.0	0.8	1.4	1.7	1.7	2.1 D	1.1 D
A73					2.18 D						1.0 JD	1.27 D												2.2 D	0.97 JD
A73B											0.5 U	0.5 U												1.5 D	0.58 JD
A75D					1.43 D						0.9 JD	0.924 JD												1.3 D	0.51 JD
A75B											1.0 D	0.896 JD												1.1 D	0.51 JD
Bakers Bridge					0.689 JD						0.7 JD	0.601 JD												0.8 JD	0.50 U
Mainstem Cement Creek																									
CC48	5.5	5.6	4.8	5.0		2.1	3.3	2.3	2.0	2.8 D	3.3 D	3.7 D	4.4	6.4	6.7	6.3	4.8	5.8	6.8	3.1	5.3	5.7	7.1	5.7 D	4.7 D
CC49																								5.5 D	
Maintstem Mineral Creek																									
M34	1.1	1.1	1.8	1.2		0.3	0.2	0.3	0.4	0.5 U	0.5 U	0.7 JD	0.4	0.7	0.7	0.9	0.4	0.7	0.7	0.3	0.5	0.7	0.6	0.7 D	5.0 U
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**	**Cd-diss**
Units	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					0.582						0.7	0.97												0.6	0.86
A60											0.7	1.01													0.99
A61											1.0	1.51													0.93
A64											0.9	1.35													1.0
A65											0.9	1.31													1.1
A66											0.9	1.4													1.1
A68	1.8	1.6	4.1	2.7	3.0	0.9	0.8	0.9	0.9	0.9	1.0	1.33	0.8	1.0	1.2	1.7	0.8	1.3	1.4	0.8	0.9	1.1	1.1	1.2	1.1
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								2.7	
A70B																								2.7	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								1.9	
A72	2.6	2.7	2.9	2.6		0.6	0.8	0.7	0.8	0.9	1.0 D	1.4	0.9	1.8	1.8	2.8	1.1	1.8	2.1	0.7	1.3	1.7	1.6	1.8	1.2
A73					1.79						0.7 JD	1.09												1.7	1.0
A73B											0.3	0.564												1.4	0.57
A75D					1.02						0.5	0.711												1.1	0.54
A75B											0.5	0.694												1.1	0.52
Bakers Bridge					0.533						0.3	0.422												0.7	0.35
Mainstem Cement Creek																									
CC48	5.5	5.3	4.9	5.3		2.1	3.4	2.2	2.0	2.9	3.2 D	3.8	4.6	6.6	6.6	6.4	4.4	5.7	6.7	3.1	5.6	5.9	7.0	5.1 D	5.1 D
CC49																								5.6 D	
Mainstem Mineral Creek																									
M34	1.1	1.0	2.0	1.1		0.3	0.2	0.2 U	0.2	0.3	0.5 U	0.6	0.3	0.7	0.7	1.0	0.4	0.7	0.8	0.2	0.5	0.7	0.6	0.9 JD	0.39

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by: Emily (2/10/15)

Appendix 1.g: Total and Dissolved Chromium Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

| | PRE-RUNOFF PERIOD | | | | | | | | | | RUNOFF PERIOD | | | | | | | | | | | | | | | | | | | | | | POST-RUNOFF PERIOD | | | | | | | | | | | | | | | | | | |

Appendix 1.h: Total and Dissolved Copper Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD																							
Sampling Date	**Feb 2010**		**Mar 2010**		**Apr 2010**		**Mar 2011**		**April 2014**		**May 2009**		**Jun 2009**		**Jun 2010**		**Jun 2011**		**May 2012**		**May 2013**		**May 2014**		**Jul 2009**		**Aug 2009**		**Sep 2009**		**Nov 2009**		**Jul 2010**		**Sep 2010**		**Nov 2010**	
Metal-fraction	**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**	
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																																				
A56 ("upstream")									3.3	JD											46.0	D	25.9	D												
A60																					33.1	D	27.1	D												
A61																					21.7	D	33.5	D												
A64																					20.1	D	29.2	D												
A65																					25.7	D	29.9	D												
A66																					24.9	D	30.3	D												
A68	6.2		7.7		22.3		14.7		20.5	D	21.2		5.8		10.0	U	10.9		5.9	D	28.9	D	27.2	D	4.0		3.9		4.0		5.1		10.0	U	4.0	U	4.0	U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																				
A69A																																				
A70B																																				
Animas River downstream of the confluence with mainstem Mineral Creek																																				
A71B																																				
A72	42.0		40.5		34.9		33.5				36.1		14.8		13.4		16.5		12.0	D	26.0	D	34.0	D	15.7		40.7		34.1		46.7		19.8		33.6		31.4	
A73									19.3	D											22.8	D	22.5	D												
A73B																					8.5	D	11.8	D												
A75D									13.5	D											20.6	D	17.9	D												
A75B																					21.5	D	17.9	D												
Bakers Bridge									7.9	D											16.3	D	11.0	D												
Mainstem Cement Creek																																				
CC48	122		116		110		90.9				64.3		94.6		78.0		61.3		61.5	D	80.1	D	80.4	D	115		224		192		159		126		174		141	
CC49																																				
Mainstem Mineral Creek																																				
M34	13.1		13.8		21.6		19.4				14.5		8.5		10.0	U	12.8		5.7	D	9.2	D	22.4	D	6.6		12.0		12.8		18.1		10.0	U	11.7		12.3	

	POST-RUNOFF PERIOD																																			
Sampling Date	**Jul 2010**		**Sep 2010**		**Nov 2010**		**Jul 2011**		**Aug 2011**		**Sep 2011**		**Oct 2011**		**Oct 2012**		**Sept 2014**	
Metal-fraction	**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**		**Cu-total**	
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																		
A56 ("upstream")															2.5	U	3.9	JD
A60																	4.1	JD
A61																	5.0	D
A64																	4.6	D
A65																	5.0	JD
A66																	5.1	D
A68	10.0	U	4.0	U	4.0	U	20.0	U	20.0	U	20.0	U	20.0	U	4.5	JD	4.7	JD
Animas River between mainstem Cement Creek and mainstem Mineral Creek																		
A69A															27.8	D		
A70B															27.1	D		
Animas River downstream of the confluence with mainstem Mineral Creek																		
A71B															18.1	D		
A72	19.8		33.6		31.4		20.0	U	22.2		28.8		24.2		18.0	D	10.3	D
A73															15.9	D	8.3	D
A73B															13.1	D	4.3	JD
A75D															12.6	D	4.4	JD
A75B															5.2	D	4.1	JD
Bakers Bridge															2.5	U	2.8	JD
Mainstem Cement Creek																		
CC48	126		174		141		82.8		147		156		136		73.7	D	76.1	D
CC49															66.9	D		
Mainstem Mineral Creek																		
M34	10.0	U	11.7		12.3		20.0	U	20.0	U	20.0	U	20.0	U	5.6	D	4.9	JD

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD																							
Sampling Date	**Feb 2010**		**Mar 2010**		**Apr 2010**		**Mar 2011**		**April 2014**		**May 2009**		**Jun 2009**		**Jun 2010**		**Jun 2011**		**May 2012**		**May 2013**		**May 2014**		**Jul 2009**		**Aug 2009**		**Sep 2009**		**Nov 2009**		**Jul 2010**		**Sep 2010**		**Nov 2010**	
Metal-fraction	**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**	
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																																				
A56 ("upstream")									2.1												8.4		13.4													
A60																					7.8		12.6													
A61																					9.6		16.5													
A64																					8.5		14.3													
A65																					8.9		14.1													
A66																					9.1		13.9													
A68	3.0	U	3.0	U	8.3		10.0	U	6.0		4.5		3.7		10.0	U	10.0	U	4.3		10.3		11.3		3.0	U	3.0	U	3.0	U	3.0	U	10.0	U	4.0	U	4.0	U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																				
A69A																																				
A70B																																				
Animas River downstream of the confluence with mainstem Mineral Creek																																				
A71B																																				
A72	35.9		35.2		19.2		25.2				3.6		4.5		10.0	U	10.0	U	4.1		7.6	D	6.4		4.8		17.4		14.7		36.9		10.0	U	13.0		14.5	
A73									2.5												5.0	D	4.9													
A73B																					2.0		3.8													
A75D									2.1												3.7		4.2													
A75B																					3.7		4.1													
Bakers Bridge									2.5												3.5		3.7													
Mainstem Cement Creek																																				
CC48	119		109		110		89.1				56.3		90.6		72.0		55.6		61.2		79.3	D	65.4		110		221		189		152		118		166		140	
CC49																																				
Mainstem Mineral Creek																																				
M34	10.3		11.2		12.3		16.2				3.9		3.0	U	10.0	U	10.0	U	1.7		2.5	U	3.1		3.0	U	3.4		3.7		9.5		10.0	U	4.0	U	4.0	U

	POST-RUNOFF PERIOD																																			
Sampling Date	**Jul 2011**		**Aug 2011**		**Sep 2011**		**Oct 2011**		**Oct 2012**		**Sept 2014**	
Metal-fraction	**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**		**Cu-diss**	
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek												
A56 ("upstream")									0.7	J	2.4	
A60											2.8	
A61											3.4	
A64											3.5	
A65											3.0	
A66											3.5	
A68	20.0	U	20.0	U	20.0	U	20.0	U	2.7		3.3	
Animas River between mainstem Cement Creek and mainstem Mineral Creek												
A69A									16.3			
A70B									24.8			
Animas River downstream of the confluence with mainstem Mineral Creek												
A71B									8.7			
A72	20.0	U	20.0	U	20.0	U	20.0	U	9.5		3.0	
A73									4.3		1.9	
A73B									3.1		1.4	
A75D									0.6	J	1.9	
A75B									0.7	J	2.0	
Bakers Bridge									0.5	U	1.9	
Mainstem Cement Creek												
CC48	76.6		145		148		139		74.4	D	65.3	JD
CC49									78.3	D		
Mainstem Mineral Creek												
M34	20.0	U	20.0	U	20.0	U	20.0	U	3.8	JD	1.5	

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by: Emily (2/10/15)

Appendix 1.i: Total and Dissolved Iron Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD																							
Sampling Date	**Feb 2010**		**Mar 2010**		**Apr 2010**		**Mar 2011**		**April 2014**		**May 2009**		**Jun 2009**		**Jun 2010**		**Jun 2011**		**May 2012**		**May 2013**		**41760**		**Jul 2009**		**Aug 2009**		**Sep 2009**		**Nov 2009**		**Jul 2010**		**Sep 2010**		**Nov 2010**	
Metal-fraction	**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**	
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																																				
A56 ("upstream")									142	J											635		413														
A60																					257		408														
A61																					218	J	427														
A64																					130	J	497														
A65																					699		420														
A66																					669		675														
A68	293		235		225		208		334		1100		100	U	376		544		111	J	437		536		100	U	115		151		234		100	U	129		169	
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																				
A69A																																				
A70B																																				
Animas River downstream of the confluence with mainstem Mineral Creek																																				
A71B																																				
A72	7710		7090		4190		5080				5300		948		986		1950		1270		2680		7200		1060		2990		3330		5490		1320		3230		4330	
A73									3850												4210		2580														
A73B																					1520		1400														
A75D									2730												4610		2530														
A75B																					4810		2440														
Bakers Bridge									1460												3560		1530														
Mainstem Cement Creek																																				
CC48	21700		19400		12700		14800				3950		4440		4160		3610		6510		17200		16600		6030		10800		13400		18600		5460		11500		14200	
CC49																																				
Mainstem Mineral Creek																																				
M34	6830		6380		4180		6080				2130		1060		1040		4200		1170		2720		6330		1340		3560		3500		8290		1780		4300		4870	

	POST-RUNOFF PERIOD																																			
Sampling Date	**Jul 2011**		**Aug 2011**		**Sep 2011**		**Oct 2011**		**Oct 2012**		**Sept 2014**																										
Metal-fraction	**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**		**Fe-total**																										
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**																										
Animas River upstream of the confluence with mainstem Cement Creek																																				
A56 ("upstream")									500	U	100	U																									
A60											100	U																									
A61											100	U																									
A64											100	U																									
A65											100	U																									
A66											111	J																									
A68	129		169		189		116		158		169		500	U	100	U																					
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																				
A69A									5100	D																											
A70B									4890	D																											
Animas River downstream of the confluence with mainstem Mineral Creek																																				
A71B									4640	D																											
A72	787		1750		2500		2740		4240	D	1340																										
A73									3210	D	1080																										
A73B									2790	D	569																										
A75D									2330	D	580																										
A75B									1060	JD	585																										
Bakers Bridge									500	U	317																										
Mainstem Cement Creek																																				
CC48	5230		7290		8630		11700		15100	D	8870	D																									
CC49									14400	D																											
Mainstem Mineral Creek																																				
M34	754		2430		3340		3100		4630	D	1510																										

	PRE-RUNOFF PERIOD										RUNOFF PERIOD														POST-RUNOFF PERIOD													
Sampling Date	**Feb 2010**		**Mar 2010**		**Apr 2010**		**Mar 2011**		**April 2014**		**May 2009**		**Jun 2009**		**Jun 2010**		**Jun 2011**		**May 2012**		**May 2013**		**41760**		**Jul 2009**		**Aug 2009**		**Sep 2009**		**Nov 2009**		**Jul 2010**		**Sep 2010**		**Nov 2010**	
Metal-fraction	**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**	
Units	**ug/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**ug/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																																				
A56 ("upstream")									<100	U											100	U	100	U													
A60																					100	U	100	U													
A61																					100	U	100	U													
A64																					100	U	100	U													
A65																					100	U	100	U													
A66																					100	U	100	U													
A68	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	10.0	U	10.0	U	100	U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																				
A69A																																				
A70B																																				
Animas River downstream of the confluence with mainstem Mineral Creek																																				
A71B																																				
A72	3250		2500		1940		1800				100	U	343		224		199		746		628		913		463		1340		1500		3020		556		1610		2160	
A73									557												249	J	284														
A73B																					120	J	157	J													
A75D									100	U											144	J	100	U													
A75B																					137	J	100	U													
Bakers Bridge									100	U											100	U	100	U													
Mainstem Cement Creek																																				
CC48	13300		9640		8610		10000				2000		3090		2300		2320		5360		4360		4590		3670		7750		9530		11600		4300		9010		11700	
CC49																																				
Mainstem Mineral Creek																																				
M34	2490		2470		1700		2390				139		374		173		100	U	512		554		545		764		2440		2050		4160		1190		3170		3900	

	POST-RUNOFF PERIOD																																			
Sampling Date	**Jul 2011**		**Aug 2011**		**Sep 2011**		**Oct 2011**		**Oct 2012**		**Sept 2014**																										
Metal-fraction	**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**		**Fe-diss**																										
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**																										
Animas River upstream of the confluence with mainstem Cement Creek																																				
A56 ("upstream")									100	U	100	U																									
A60											100	U																									
A61											100	U																									
A64											100	U																									
A65											100	U																									
A66											100	U																									
A68	100	U	100	U	100	U	100	U	100	U	100	U																									
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																				
A69A									2180																												
A70B									2270																												
Animas River downstream of the confluence with mainstem Mineral Creek																																				
A71B									2480																												
A72	280		703		1050		1300		2210		443																										
A73									1020		115	J																									
A73B									810		104	J																									
A75D									100	U	100	U																									
A75B									100	U	100	U																									
Bakers Bridge									100	U	100	U																									
Mainstem Cement Creek																																				
CC48	3600		5520		7110		8730		11300	D	1420																										
CC49									11500	D																											
Mainstem Mineral Creek																																				
M34	337		1740		2400		2400		3510	D	858																										

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)

Appendix 1.j: Total and Dissolved Lead Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

| | PRE-RUNOFF PERIOD | | | | | RUNOFF PERIOD | | | | | | | POST-RUNOFF PERIOD | | | | | | |

Appendix 1.k: Total and Dissolved Manganese Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD																			
Sampling Date	**Feb 2010**		**Mar 2010**		**Apr 2010**		**Mar 2011**		**April 2014**		**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**41760**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**		**Sept 2014**	
Metal-fraction	**Mn-total**		**Mn-total**		**Mn-total**		**Mn-total**		**Mn-total**		**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**		**Mn-total**	
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																																
A56 ("upstream")									187							567	287												189	D	482	
A60																348	302														424	
A61																477	917														481	
A64																412	756														576	
A65																578	771														630	
A66																635	944														862	
A68	3550		2830		3980		3200		3390		697	697	435	550	715	988	1300	676	1290	1580	2320	668	1280	1770	571	868	1120	1300	1350	D	835	
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																
A69A																													2640	D		
A70B																													2550	D		
Animas River downstream of the confluence with mainstem Mineral Creek																																
A71B																													1670	D		
A72	2710		3110		1850		2440				755	492	311	397	488	734	898	596	1380	1430	2470	734	1450	1690	439	923	1290	1220	1580	D	884	
A73									1860							609	689												1470	D	813	
A73B																230	333												1210	D	395	
A75D									1100							571	507												909	D	385	
A75B																592	493												839	D	381	
Bakers Bridge									638							468	327												561	D	272	
Mainstem Cement Creek																																
CC48	5120		5490		3190		4950				809	1810	865	739	1660	1510	1770	2850	4900	5100	5530	3190	4780	5140	1790	3780	4490	4700	5070	D	3590	D
CC49																													5140	D		
Mainstem Mineral Creek																																
M34	615		559		328		567				219	130	112	313	123	151	242	174	401	374	596	209	440	429	115	275	394	302	428	D	226	

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD																			
Sampling Date	**Feb 2010**		**Mar 2010**		**Apr 2010**		**Mar 2011**		**April 2014**		**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**41760**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**		**Sept 2014**	
Metal-fraction	**Mn-diss**		**Mn-diss**		**Mn-diss**		**Mn-diss**		**Mn-diss**		**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**		**Mn-diss**	
Units	**ug/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																																
A56 ("upstream")									172							140	196												184		469	
A60																153	189														416	
A61																328	786														464	
A64																240	639														569	
A65																304	655														614	
A66																343	805														860	
A68	3560		2710		3730		3160		3340		340	636	335	415	699	656	1220	668	1320	1540	2380	649	1310	1790	537	821	1140	1310	1340		826	
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																
A69A																													2590			
A70B																													2540			
Animas River downstream of the confluence with mainstem Mineral Creek																																
A71B																													1660			
A72	2710		2920		1770		2340				219	450	241	305	471	478	823	603	1420	1370	2490	736	1590	1690	405	923	1290	1180	1580		863	
A73									1830							341	624												1440		811	
A73B																109	294												1210		419	
A75D									1090							232	408												847		371	
A75B																233	394												856		363	
Bakers Bridge									584							149	246												546		254	
Mainstem Cement Creek																																
CC48	5290		5200		3040		4940				766	1770	811	731	1620	1440	1740	2830	4810	4920	5270	3280	5030	5220	1740	3890	4900	4620	5050	D	710	
CC49																													5300	D		
Mainstem Mineral Creek																																
M34	630		634		324		530				160	120	84.9	150	115	128	184	169	410	336	592	212	435	456	104	293	406	303	435	D	221	

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)

Appendix 1.I: Total and Dissolved Nickel Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD																							
Sampling Date	**Feb 2010**		**Mar 2010**		**Apr 2010**		**Mar 2011**		**April 2014**		**May 2009**		**Jun 2009**		**Jun 2010**		**Jun 2011**		**May 2012**		**May 2013**		**May 2014**		**Jul 2009**		**Aug 2009**		**Sep 2009**		**Nov 2009**		**Jul 2010**		**Sep 2010**		**Nov 2010**	
Metal-fraction	**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**	
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																																				
A56 ("upstream")									2.5	U											2.5	U	2.5	U													
A60																					2.5	U	2.5	U													
A61																					2.5	U	2.5	U													
A64																					2.5	U	2.5	U													
A65																					2.5	U	2.5	U													
A66																					2.5	U	2.5	U													
A68	2.0	U	2.0	U	2.0	U	4.0	U	2.5	U	2.0	U	2.0	U	4.0	U	4.0	U	2.5	U	2.5	U	2.5	U	2.0	U	2.0	U	2.0	U	2.0	U	4.0	U	0.7	U	0.7	U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																				
A69A																																				
A70B																																				
Animas River downstream of the confluence with mainstem Mineral Creek																																				
A71B																					2.5	U															
A72	7.0		7.0		2.0	U	5.2				2.0	U	2.0	U	4.0	U	4.0	U	2.5	U	2.5	U	2.5	U	2.0		3.9		3.3		6.3		4.0	U	0.7	U	5.4	
A73									2.5	U											2.5	U	2.5	U													
A73B																					2.5	U	2.5	U													
A75D									2.5	U											2.5	U	2.5	U													
A75B																					2.5	U	2.5	U													
Bakers Bridge									2.5	U											2.5	U	2.5	U													
Mainstem Cement Creek																																				
CC48	17.8		17.9		9.7		14.8				2.0		6.6		4.3		4.0	U	4.8	JD	5.0	U	3.5	JD	10		16.3		15.7		17.3		10		15.1		17.1	
CC49																																				
Mainstem Mineral Creek																																				
M34	4.0		3.2		2.0	U	4.0	U			2.0	U	2.0	U	4.0	U	4.0	U	2.5	U	2.5	U	<2.5	U	2.0	U	2.3		2.0	U	3.7		4.0	U	0.7	U	0.7	U

	POST-RUNOFF PERIOD																																			
Sampling Date	**Jul 2011**		**Aug 2011**		**Sep 2011**		**Oct 2011**		**Oct 2012**		**Sept 2014**		**Feb 2010**		**Mar 2010**		**Apr 2010**		**Mar 2011**		**April 2014**		**May 2009**		**Jun 2009**		**Jun 2010**		**Jun 2011**		**May 2012**		**May 2013**		**May 2014**	
Metal-fraction	**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-total**		**Ni-diss**		**Ni-diss**		**Ni-diss**		**Ni-diss**		**Ni-diss**		**Ni-diss**		**Ni-diss**		**Ni-diss**		**Ni-diss**		**Ni-diss**		**Ni-diss**		**Ni-diss**	
Units	**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																																				
A56 ("upstream")									2.5	U	2.5	U									0.5	U											0.5	U	0.5	U
A60											2.5	U																					0.5	U	0.5	U
A61											2.5	U																					0.5	U	0.5	U
A64											2.5	U																					0.5	U	0.5	U
A65											2.5	U																					0.5	U	0.5	U
A66											2.5	U																					0.5	U	0.5	U
A68	4.0	U	4.0	U	4.0	U	4.0	U	2.5	U	2.5	U	2.0	U	2.0	U	2.0	U	4.0	U	0.5	U	2.0	U	2.0	U	4.0	U	4.0	U	0.5	U	0.5	U	0.5	U	0.5	U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																																				
A69A									4.8																											
A70B									5.2																											
Animas River downstream of the confluence with mainstem Mineral Creek																																				
A71B									4.9																											
A72	4.0	U	4.0	U	4.0	U	4.0	U	5.9		1.1		8.2		6.4		3.4		5.8				2.0	U	2.0	U	4.0	U	4.0	U	0.9	J	2.5	U	0.606	J
A73									4.8		0.9	J									0.9	J											2.5	U	0.5	U
A73B									3.3		1.9																						1.4		0.8	J
A75D									2.3		1.0	J									0.8	J											0.6	J	0.5	U
A75B									2.4		1.0																						0.5	J	0.5	U
Bakers Bridge									0.6	J	0.7	J									0.5	U											0.5	U	0.5	U
Mainstem Cement Creek																																				
CC48	6.0		13.0		14.5		13.7		12.4	D	5.9	D	19.4		16.3		10.3		16.4				2.2		5.3		4.0	U	4.0	U	4.9		5.0	U	3.1	
CC49									13.5	D																										
Mainstem Mineral Creek																																				
M34	4.0	U	4.0	U	4.0	U	4.0	U	2.5	U	0.5	J	5.3		3.3		2.0	U	4.0				2.0	U	2.0	U	4.0	U	4.0	U	0.6	J	2.5	U	0.5	U

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by: Emily (2/10/15)

Appendix 1.m: Total and Dissolved Selenium Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

| | PRE-RUNOFF PERIOD | | | | | | | | | | RUNOFF PERIOD | | | | | | | | | | | | | | | | | | | | | | POST-RUNOFF PERIOD | | | | | | | | | | | | | | | | | | |

Appendix 1.n: Total and Dissolved Silver Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

| | PRE-RUNOFF PERIOD | | | | | | | | | | RUNOFF PERIOD | | | | | | | | | | | | | | | | POST-RUNOFF PERIOD | | | | | | | | | | | | | | | |

Appendix 1.o: Total and Dissolved Zinc Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD																	
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**		**Sept 2014**	
Metal-fraction	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**		**Zn-total**	
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																														
A56 ("upstream")					247						467	396												189	D	255				
A60											384	426														267				
A61											375	547														263				
A64											358	504														259				
A65											395	502														293				
A66											400	516														340				
A68	663	597	1180	874	1020	405	324	318	307	289	454	491	270	333	413	581	273	380	441	252	290	317	399	306	D	273				
Animas River between mainstem Cement Creek and mainstem Mineral Creek																														
A69A																								1170	D					
A70B																								1150	D					
Animas River downstream of the confluence with mainstem Mineral Creek																														
A71B																								731	D					
A72	1060	1320	966	1080		306	303	221	237	293	453	489	310	659	650	1140	393	717	786	251	469	573	600	726	D	391				
A73					768						352	426												685	D	372				
A73B											119	204												557	D	181				
A75D					483						288	306												545	D	181				
A75B											283	296												445	D	183				
Bakers Bridge					273						221	195												264	D	126				
Mainstem Cement Creek																														
CC48	2570	2730	1840	2430		641	1130	655	551	1070	1180	1270	1600	2580	2690	2890	1720	2710	2620	1100	1970	2160	2510	2560	D	2030	D			
CC49																								2590	D					
Mainstem Mineral Creek																														
M34	285	251	573	357		90	94.7	56.8	77.7	80.2	121	196	92	194	189	280	114	196	236	62.8	132	169	157	177	D	110				

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD																	
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**		**Sept 2014**	
Metal-fraction	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**		**Zn-diss**	
Units	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**		**µg/L**	
Animas River upstream of the confluence with mainstem Cement Creek																														
A56 ("upstream")					241						224	361												189		250				
A60											242	360														266				
A61											305	509														253				
A64											280	452														260				
A65											296	455														293				
A66											292	461														341				
A68	702	610	985	874	1030	295	270	286	274	281	347	446	268	332	407	567	261	410	436	237	282	311	393	300		270				
Animas River between mainstem Cement Creek and mainstem Mineral Creek																														
A69A																								1160						
A70B																								1160						
Animas River downstream of the confluence with mainstem Mineral Creek																														
A71B																								743						
A72	1110	1230	864	972		133	249	206	217	284	369	453	313	636	617	1120	392	762	754	228	467	590	549	733		362				
A73					701						242	364												682		327				
A73B											79.0	178												561		180				
A75D					367						140	217												427		152				
A75B											140	210												442		149				
Bakers Bridge					174						66.5	111												241		87.7				
Mainstem Cement Creek																														
CC48	2670	2600	1600	2340		611	1080	660	614		1070	1160	1310	1620	2650	2570	2650	1800	2730	2890	1090	2140	2430	2400	2590	D	394			
CC49																								2710	D					
Mainstem Mineral Creek																														
M34	328	292	499	312		48.1	72.5	68.6	50.0	U	68.2	100	146	88.7	180	175	317	106	196	242	54.4	131	170	142	173	D	98.8			

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by: Emily (2/10/15)

Appendix 2

Total metal concentrations measured in bulk sediment samples collected from the Animas River, mainstem Cement Creek, and mainstem Mineral Creek

Appendix 2.1
Total metals concentrations in sediment samples collected in May 2012
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	mg/kg dw														
A60	mg/kg dw														
A61	mg/kg dw														
A64	mg/kg dw														
A65	mg/kg dw														
A66	mg/kg dw														
A68	mg/kg dw	9050 D	25.9 D	<2.01 U	13.4 D	4.97 D	374 D	29100 D	1890 D	12200 D	0.081 D	8.95 D	1.29 D	7.09 D	3030 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	mg/kg dw														
A70B	mg/kg dw														
Animas River below mainstem Mineral Creek															
A71B	mg/kg dw														
A72	mg/kg dw	12200 D	40.6 D	<1.97 U	2.8 D	6.1 D	152 D	57500 D	581 D	2710 D	0.072 D	6.38 D	2.03 D	1.99 D	748 D
A73	mg/kg dw														
A73B	mg/kg dw														
A75D	mg/kg dw														
A75B	mg/kg dw														
Bakers Bridge	mg/kg dw														
mainstem Cement Creek															
CC48	mg/kg dw														
CC49	mg/kg dw														
mainstem Mineral Creek															
M34	mg/kg dw														

Lab Qualifiers:
U = undetected
D = diluted sample
< = less than

Appendix 2.2
Total metals concentrations in sediment samples collected in October 2012
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver
Animas River above mainstem Cement Creek														
A56 ("upstream")	mg/kg dw	10300 D	31.9 D	<2.01 U	4.66 D	7.47 D	250 D	35600 D	1490 D	3140 D	0.17 D	7.61 D	1.64 D	7.15 D
A60	mg/kg dw													
A61	mg/kg dw													
A64	mg/kg dw													
A65	mg/kg dw													
A66	mg/kg dw													
A68	mg/kg dw	15300 D	89.5 D	6.77 D	24.2 D	5.69 D	745 D	45300 D	3030 D	22300 D	0.19 D	16.5 D	2.86 D	13.3 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek														
A69A	mg/kg dw													
A70B	mg/kg dw													
Animas River below of mainstem Mineral Creek														
A71B	mg/kg dw													
A72	mg/kg dw	21500 D	36.3 D	<2.00 U	1.81 D	4.05 D	179 D	56900 D	542 D	1470 D	0.06 D	4.79 D	1.83 D	2.76 D
A73	mg/kg dw	11800 D	25.5 D	<1.97 U	3.64 D	4.02 D	223 D	51600 D	729 D	4140 D	0.05 D	6.84 D	1.43 D	2.32 D
A73B	mg/kg dw	31900 D	39.4 D	3.24 JD	4.24 D	5.02 D	292 D	70700 D	468 D	2610 D	0.09 D	12.1 D	2.89 D	3.09 D
A75D	mg/kg dw	15600 D	13.2 D	<1.97 U	4.87 D	3.73 D	152 D	33700 D	231 D	3010 D	0.04 D	9.09 D	1.4 D	0.724 JD
A75B	mg/kg dw	48600 D	37.2 D	5.98 D	10.5 D	5.16 D	413 D	84500 D	435 D	3820 D	0.07 D	16.5 D	3.26 D	2.18 D
Bakers Bridge	mg/kg dw	37400 D	29.7 D	4.85 JD	18.6 D	5.21 D	357 D	68400 D	378 D	10500 D	0.06 D	31.6 D	3.1 D	1.71 D
mainstem Cement Creek														
CC48	mg/kg dw													
CC49	mg/kg dw	5310 D	40.6 D	<1.99 U	0.595 D	4.62 D	55.6 D	143000 D	282 D	478 D	0.06 D	2.85 D	0.747 JD	2.0 D
mainstem Mineral Creek														
M34	mg/kg dw	22400 D	21.1 D	<1.98 U	0.888 D	3.44 D	53.8 D	46500 D	129 D	1430 D	0.02 D	4.64 D	1.74 D	0.651 JD

Lab Qualifiers:
U = undetected
D = diluted sample
J = estimated value
B = blank contamination
< = less than

Appendix 2.3
Total metals concentrations in sediment samples collected in May 2013
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	mg/kg dw	8250 D	20.3 D	<1.97 U	12.8 D	4.65 BD	267 JD	26100 D	1820 BD	9760 D		5.99 D	0.548 JD	7.06 D	2330 D
A60	mg/kg dw	9160 D	24.4 D	<2.01 U	14.7 D	4.86 BD	286 D	24400 D	2100 BD	12600 D		7.58 D	<0.502 U	4.05 D	3180 D
A61	mg/kg dw	10600 D	44.0 D	2.53 JD	11.3 D	4.71 BD	466 D	27500 D	2120 BD	11000 D		7.19 D	<0.505 U	7.34 D	2840 D
A64	mg/kg dw	10500 D	44.2 D	2.77 JD	11.9 D	4.42 BD	336 D	30000 D	1770 BD	9670 D		7.2 D	0.905 JD	7.14 D	3470 D
A65	mg/kg dw	9250 D	30.3 D	<2.02 U	10.3 D	4.76 BD	328 D	28800 D	1840 BD	12900 D		6.68 D	<0.504 U	5.53 D	2590 D
A66	mg/kg dw	8370 D	26.9 D	<1.99 U	8.44 D	5.68 BD	257 D	29600 D	1750 BD	7830 D		5.92 D	<0.497 U	5.06 D	1950 D
A68	mg/kg dw	7650 D	26.3 D	<2.01 U	13.7 D	5.21 BD	352 D	28800 D	2180 BD	10300 D		8.76 D	<0.501 U	9.22 D	2830 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	mg/kg dw														
A70B	mg/kg dw														
Animas River below of mainstem Mineral Creek															
A71B	mg/kg dw														
A72	mg/kg dw	11800 D	26.1 D	<1.97 U	1.15 D	6.41 BD	77.8 D	45800 D	299 BD	1210 D		4.88 D	1.04 D	1.3 D	386 D
A73	mg/kg dw	9220 D	31.9 D	<2.02 U	4.1 D	5.6 BD	176 D	55700 D	591 BD	3320 D		6.07 D	0.717 JD	2.78 D	998 D
A73B	mg/kg dw	10600 D	30.4 D	<2.00 U	3.56 D	4.72 BD	140 D	67100 D	593 BD	4340 D		9.78 D	<0.5 U	1.65 D	964 D
A75D	mg/kg dw	8550 D	18.2 D	<1.99 U	3.88 D	4.99 BD	108 D	34400 D	367 BD	3730 D		7.27 D	<0.498 U	1.37 D	1030 D
A75B	mg/kg dw	7220 D	13.3 D	<1.99 U	2.65 D	5.45 BD	82.7 D	26000 D	354 BD	2340 D		5.93 D	0.588 JD	1.51 D	672 D
Bakers Bridge	mg/kg dw	7360 D	15.9 D	<1.98 U	2.46 D	7.38 BD	116 D	28200 D	328 BD	2130 D		7.36 D	<0.496 U	1.08 D	2080 D
mainstem Cement Creek															
CC48	mg/kg dw														
CC49	mg/kg dw														
mainstem Mineral Creek															
M34	mg/kg dw														

Lab Qualifiers:
U = undetected B = blank contamination
D = diluted sample < = less than
J = estimated value

Appendix 2.4
Total metals concentrations in sediment samples collected in April 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample location	Units	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	mg/kg dw	15100 D	33.1 D	6.35 D	17.8 D	4.72 D	432 D	40700 D	1220 D	12700 D	0.171 D	9.92 D	1.62 JD	7.64 D	6200 D
A60	mg/kg dw	13400 D	16.4 D	<2.01 U	5.84 D	6.35 D	166 D	33500 D	554 D	3400 D	0.033 D	9.62 D	<1.0 U	3.48 D	1530 D
A61	mg/kg dw	13500 D	19.8 D	2.99 JD	9.02 D	5.28 D	638 D	32000 D	891 D	6400 D	0.091 D	8.56 D	1.1 JD	4.28 D	2530 D
A64	mg/kg dw	10700 D	18.8 D	<2.02 U	6.25 D	5.15 D	199 D	31400 D	1050 D	4920 D	0.053 D	7.44 D	<1.01 U	3.59 D	1950 D
A65	mg/kg dw	13100 D	21.8 D	2.16 JD	10.2 D	5.49 D	331 D	31600 D	900 D	10300 D	0.073 D	9.9 D	<1.01 U	3.87 D	2890 D
A66	mg/kg dw	11700 D	18.3 D	2.24 JD	18.3 D	4.07 D	378 D	31700 D	1230 D	20500 D	0.06 D	10.1 D	<1.0 U	4.13 D	4380 D
A68	mg/kg dw	13000 D	19.1 D	2.82 JD	15.7 D	4.21 D	390 D	32400 D	1080 D	19700 D	0.056 D	10.3 D	<0.998 U	4.35 D	4890 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	mg/kg dw														
A70B	mg/kg dw														
Animas River below mainstem Mineral Creek															
A71B	mg/kg dw														
A72	mg/kg dw	18900 D	37 D	<2.0 U	1.7 D	3.45 D	145 D	74600 D	470 D	1710 D	0.039 D	4.33 D	1.05 JD	1.68 D	616 D
A73	mg/kg dw	40700 D	33.8 D	4.2 JD	5.6 D	2.83 D	284 D	109000 D	297 D	7120 D	0.036 D	7.19 D	<1.0 U	1.35 D	1450 D
A73B	mg/kg dw														
A75D	mg/kg dw	29900 D	28.5 D	3.66 JD	6.75 D	4.39 D	223 D	67900 D	261 D	6900 D	0.038 D	13.1 D	1.06 JD	1.27 D	2910 D
A75B	mg/kg dw														
Bakers Bridge	mg/kg dw	27300 D	25.9 D	3.51 JD	14.6 D	4.28 D	199 D	62100 D	248 D	13100 D	0.043 D	22 D	1.16 JD	1.33 D	6030 D
mainstem Cement Creek															
CC48	mg/kg dw														
CC49	mg/kg dw														
mainstem Mineral Creek															
M34	mg/kg dw														

Lab Qualifiers:
U = undetected B = blank contamination
D = diluted sample < = less than
J = estimated value

Appendix 2.5
Total metals concentrations in sediment samples collected in September 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	mg/kg dw	9310 D	20.2 D	2.94 JD	11.6 D	3.6 D	244 D	21700 D	1180 D	9250 D	0.06 D	7.13 D	<1 U	3.62 D	3220 D
A60	mg/kg dw	7730 D	20.4 D	<2.03 U	9.55 D	3.88 D	262 D	23400 D	1610 D	7460 D	0.07 D	6.26 D	<1.02 U	5.96 D	2130 D
A61	mg/kg dw	9280 D	20.5 D	2.1 JD	4.95 D	3.55 D	286 D	22800 D	1400 D	8210 D	0.05 D	6.52 D	<0.995 U	5.23 D	2330 D
A64	mg/kg dw	9610 D	21.3 D	3.0 JD	7.93 D	3.55 D	264 D	24500 D	1120 D	6850 D	0.13 D	6.84 D	<1.01 U	4.88 D	2730 D
A65	mg/kg dw	8190 D	19.4 D	<1.99 U	6.82 D	3.76 D	271 D	25000 D	1220 D	8180 D	0.03 D	6.49 D	<0.997 U	3.61 D	1700 D
A66	mg/kg dw	9190 D	23.7 D	<2.03 U	9.17 D	3.7 D	243 D	25700 D	1190 D	8190 D	0.05 D	7.11 D	<1.01 U	4.81 D	2500 D
A68	mg/kg dw	7700 D	17.5 D	<1.97 U	10.8 D	3.73 D	216 D	24000 D	1240 D	9430 D	0.02 JD	6.56 D	<0.985 U	2.9 D	2480 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	mg/kg dw														
A70B	mg/kg dw														
Animas River below mainstem Mineral Creek															
A71B	mg/kg dw														
A72	mg/kg dw	9960 D	26.8 D	<2.03 U	3.03 D	3.01 D	133 D	42000 D	499 D	3400 D	0.05 D	5.33 D	<1.02 U	1.83 D	858 D
A73	mg/kg dw	6770 D	20.5 D	<2.04 U	2.7 D	3.5 D	113 D	36800 D	435 D	2780 D	0.02 JD	5.5 D	<1.02 U	1.24 D	749 D
A73B	mg/kg dw	6620 D	19.9 D	<2.03 U	2.72 D	3.68 D	98.8 D	35200 D	540 D	2480 D	0.04 D	8.16 D	<1.01 U	1.25 D	659 D
A75D	mg/kg dw	7660 D	17.5 D	<2.03 U	3.73 D	3.72 D	103 D	30800 D	339 D	3750 D	<0.02 U	8.2 BD	<1.02 U	0.948 JD	1080 D
A75B	mg/kg dw	6640 D	9.22 D	<1.99 U	1.99 D	5.01 D	67 D	20100 D	98 D	2070 D	<0.01 U	6.71 D	<0.994 U	0.512 JD	578 D
Bakers Bridge	mg/kg dw	8040 D	16.2 D	<1.99 U	4.63 D	4.74 D	92 D	27200 D	244 D	3970 D	0.02 JD	12.1 BD	<0.997 U	1.02 D	1700 D
mainstem Cement Creek															
CC48	mg/kg dw														
CC49	mg/kg dw														
mainstem Mineral Creek															
M34	mg/kg dw	29100 D	32.7 D	<2.01 U	1.87 D	2.79 D	127 D	89000 D	237 D	1160 D	0.05 D	5.93 BD	<1.01 U	0.896 JD	666 D

Lab Qualifiers:
U = undetected B = blank contamination
D = diluted sample < = less than
J = estimated value

Appendix 3

Hardness and dissolved metal concentrations measured in pore water samples collected in the field from the Animas River, mainstem Cement Creek, and mainstem Mineral Creek

Appendix 3.1: Dissolved Metals Concentrations in Pore Water Samples Collected in April 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Hardness (mg/L)	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	µg/L	136	23.8 J	<0.500 U	<2.00 U	0.232	<1.00 U	1.3	<100 U	0.964	4.87 J	<0.500 U	<1.00 U	<0.500 U	124
A60	µg/L	158	20.9 J	0.547 J	<2.00 U	0.809	<1.00 U	1.41	<100 U	<0.100 U	<2.00 U	<0.500 U	<1.00 U	<0.500 U	353
A61	µg/L	853D	6170 D	<5.00 U	<20.0 U	100 D	<10.0 U	2250 D	<1000 U	13.4 D	78300 D	77.5 D	<10.0 U	<5.00 U	29900 D
A64	µg/L	141	<20.0 U	<0.500 U	<2.00 U	0.279	<1.00 U	1.83	<100 U	<0.100 U	4.27 J	<0.500 U	<1.00 U	<0.500 U	264
A65	µg/L	349.5	671	<0.500 U	<2.00 U	22.4	0.8 J	53.8	<100 U	2.00	18450	11.3	<1.00 U	<0.500 U	6230
A66	µg/L	141	<20.0 U	<0.500 U	<2.00 U	0.546	1.83 J	1.4	<100 U	0.123 J	226	<0.500 U	<1.00 U	<0.500 U	307
A68	µg/L	149	42.2 J	<0.500 U	<2.00 U	1.67	<1.00 U	3.46	<100 U	<0.100 U	1540	<0.500 U	<1.00 U	<0.500 U	675
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	µg/L														
A70B	µg/L														
Animas River below mainstem Mineral Creek															
A71B															
A72	µg/L	256	517	<0.500 U	<2.00 U	2.98	<1.00 U	8.07	<100 U	0.453	448	1.95	<1.00 U	<0.500 U	1630
A73	µg/L	185	29.2 J	<0.500 U	<2.00 U	2.03	<1.00 U	2.28	341	<0.100 U	1870	1.19	<1.00 U	<0.500 U	709
A73B	µg/L														
A75D	µg/L	135	27.7 J	<0.500 U	<2.00 U	0.387	<1.00 U	1.67	<100 U	<0.100 U	185	<0.500 U	<1.00 U	<0.500 U	173
A75B	µg/L														
Bakers Bridge	µg/L	125	47 J	<0.500 U	<2.00 U	0.334	1.15 J	2.21	<100 U	<0.100 U	325	<0.500 U	<1.00 U	<0.500 U	115
mainstem Cement Creek															
CC48	µg/L														
CC49	µg/L														
mainsem Mineral Creek															
M34	µg/L														

Appendix 3.2: Dissolved Metals Concentrations in Pore Water Samples Collected in September 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Hardness (mg/L)	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	µg/L	129	28.4 J	<0.500 U	<2.00 U	1.16	<1.00 U	4.15	<100 U	0.523	689	<0.500 U	<1.00 U	<0.500 U	463
A60	µg/L	340	119	<2.50 U	<2.00 U	3.86 D	<5.00 U	2.67 JD	<100 U	<0.500 U	6.46	<2.50 U	<5.00 U	<2.50 U	1630
A61	µg/L	496.5	2604.5 D	<3.8 U	<11.0 U	106.5 D	<7.5 U	95.9 JD	<550 U	65.6 D	63800 D	37.8 D	<7.5 U	<3.8 U	18490 D
A64	µg/L														
A65	µg/L	389	401	<2.50 U	<2.00 U	22 D	<5.00 U	47.2 D	<100 U	0.579 JD	16200	13.4 D	<5.00 U	<2.50 U	4760
A66	µg/L	118	<20.0 U	<0.500 U	<2.00 U	0.296	<1.00 U	1.27	<100 U	<0.100 U	2.57 J	<0.500 U	<1.00 U	<0.500 U	179
A68	µg/L	121	42.8 J	<0.500 U	<2.00 U	1.06	<1.00 U	4.13	<100 U	0.258	590	<0.500 U	<1.00 U	<0.500 U	294
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	µg/L														
A70B	µg/L														
Animas River below mainstem Mineral Creek															
71B	µg/L														
A72	µg/L	160	46.9 J	<0.500 U	<2.00 U	1.40	<1.00 U	2.87	338	<0.100 U	995	1.31	<1.00 U	<0.500 U	407
A73	µg/L	151	23.3 J	<0.500 U	<2.00 U	0.374	<1.00 U	1.18	<100 U	<0.100 U	2.45 J	1.35	<1.00 U	<0.500 U	362
A73B	µg/L	49	<20.0 U	<0.500 U	<2.00 U	<0.100 U	<1.00 U	0.915 J	<100 U	<0.100 U	3.37 J	0.581 J	<1.00 U	<0.500 U	32.9
A75D	µg/L	96	40 J	<0.500 U	<2.00 U	0.786	<1.00 U	2.60	107 J	0.205	290	1.52	<1.00 U	<0.500 U	190
A75B	µg/L														
Bakers Bridge	µg/L	271	35.2 J	3.74	<2.00 U	<0.100 U	3.23	<0.500 U	1260	0.193 J	5870	0.85 J	<1.00 U	<0.500 U	13.3 J
mainstem Cement Creek															
CC48	µg/L														
CC49	µg/L														
mainstem Mineral Creek															
M34	µg/L	139	45.7 J	<0.500 U	<2.00 U	0.127 J	<1.00 U	1.18	<100 U	<0.100 U	27.6	<0.500 U	<1.00 U	<0.500 U	48.2

Appendix 4

Tissue residue data for benthic invertebrates collected from the Animas River in September 2014

Appendix 4: Tissue residue data for benthic invertebrates collected from the Animas River in September 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sampling location	Analysis	Aluminum mg/kg ww		Arsenic mg/kg ww		Beryllium mg/kg ww		Cadmium mg/kg ww		Chromium mg/kg ww		Copper mg/kg ww		Iron mg/kg ww		Lead mg/kg ww		Manganese mg/kg ww		Mercury mg/kg ww		Nickel mg/kg ww		Selenium mg/kg ww		Silver mg/kg ww		Zinc mg/kg ww	
A56	Total Recoverable Metals	91.8	D	0.141	JD	0.09	JD	0.347	D	0.44	D	5.79	D	57.9	D	2.63	D	31.2D	D	<0.025	U	0.0704	JD	0.256	D	<0.0614	U	99.8	D
A60	Total Recoverable Metals	120	D	0.13	JD	0.1	JD	0.545	D	0.703	D	19.5	D	73.4	D	5.25	D	25.6D	D	<0.049	U	<0.123	U	<0.246	U	<0.123	U	108	D
A68	Total Recoverable Metals	212	D	0.631	D	0.1	JD	1.16	D	0.834	D	18	D	986	D	7.57	D	60.5D	D	<0.053	U	0.155	JD	0.265	JD	<0.132	U	240	D
A72	Total Recoverable Metals	261	D	<0.16	U	<0.1	U	0.204	D	0.649	D	11.5	D	1190	D	2.27	D	17.3D	D	<0.064	U	<0.16	U	<0.321	U	<0.16	U	49.9	D
A73	Total Recoverable Metals	251	D	0.208	JD	<0.1	U	0.281	D	0.61	JD	9.98	D	847	D	2.02	D	32.6D	D	<0.066	U	0.173	JD	<0.33	U	<0.165	U	59.3	D
A75D	Total Recoverable Metals	78.4	D	<0.368	U	<0.3	U	0.235	D	0.978	JD	4.52	D	105	D	0.689	D	50.6D	D	<0.147	U	<0.368	U	<0.735	U	<0.368	U	56.2	D
Bakers Bridge	Total Recoverable Metals	114	D	<0.139	U	<0.1	U	0.478	D	0.615	D	5.28	D	156	D	0.761	D	76.6D	D	<0.056	U	0.477	D	<0.279	U	<0.139	U	106	D

Sampling location	Analysis	Aluminum mg/kg dw		Arsenic mg/kg dw		Beryllium mg/kg dw		Cadmium mg/kg dw		Chromium mg/kg dw		Copper mg/kg dw		Iron mg/kg dw		Lead mg/kg dw		Manganese mg/kg dw		Mercury mg/kg dw		Nickel mg/kg dw		Selenium mg/kg dw		Silver mg/kg dw		Zinc mg/kg dw	
A56	Total Recoverable Metals	303	D	0.47	JD	0.30	JD	1.15	D	1.45	D	19.1	D	191	D	8.7	D	103	D	0.041	U	0.23	JD	0.84	D	0.10	U	329	D
A60	Total Recoverable Metals	396	D	0.43	JD	0.33	JD	1.80	D	2.32	D	64.4	D	242	D	17.3	D	84	D	0.081	U	0.20	U	0.41	U	0.20	U	356	D
A68	Total Recoverable Metals	700	D	2.08	D	0.33	JD	3.83	D	2.75	D	59.4	D	3254	D	25.0	D	200	D	0.087	U	0.51	JD	0.87	JD	0.22	U	792	D
A72	Total Recoverable Metals	861	D	0.26	U	0.17	U	0.67	D	2.14	D	38.0	D	3927	D	7.5	D	57	D	0.106	U	0.26	U	0.53	U	0.26	U	165	D
A73	Total Recoverable Metals	828	D	0.69	JD	0.17	U	0.93	D	2.01	JD	32.9	D	2795	D	6.7	D	108	D	0.109	U	0.57	JD	0.54	U	0.27	U	196	D
A75D	Total Recoverable Metals	259	D	0.61	U	0.50	U	0.78	D	3.23	JD	14.9	D	347	D	2.3	D	167	D	0.243	U	0.61	U	1.21	U	0.61	U	185	D
Bakers Bridge	Total Recoverable Metals	376	D	0.23	U	0.17	U	1.58	D	2.03	D	17.4	D	515	D	2.5	D	253	D	0.092	U	1.57	D	0.46	U	0.23	U	350	D

D = diluted; J = estimated value; U = not detected; dw = dry weight; ww = wet weight

notes:

all non-detected values were divided by half before calculating the dry weight concentrations

The moisture content of the benthic invertebrates was not measured and was assumed to equal 70% (= 30% dry matter); hence, the ww values were multiplied by a factor of 3.3 to convert them to dw values

Appendix 5

Steps and background for developing trout-specific hardness-dependent acute toxicity thresholds (DRAFT)

Steps and Background for Developing Trout Specific Hardness-Dependent Toxicity Thresholds

1) **BACKGROUND:**

This project evaluates acute and chronic laboratory toxicity studies to provide evidence of a stressor-response relationship between water hardness and key metals (i.e., cadmium [Cd], copper [Cu], and zinc [Zn]) associated with past mining activities in Colorado. The literature search focused on four trout species (i.e. brook trout, brown trout, cutthroat trout, and rainbow trout) with the objective of establishing protective threshold metal concentrations in surface water to inform risk management decisions at mining sites.

Data sources used for this evaluation include existing surface water criteria documents, EPA's Ecotox database (http://cfpub.epa.gov/ecotox/), peer-reviewed journal articles, and high-quality secondary literature. Pertinent information from each study was captured in a database and included organism parameters (length, weight, life stage), water quality characteristics (pH, hardness, alkalinity, temperature), design specifications (exposure duration, exposure type, method of chemical analysis), and toxicity endpoints.

DRAFT

This trout sensitivity project evaluated trout-specific acute and chronic toxicity data from exposure to aluminum. EPA issued aluminum water quality standards (i.e. 750 µg/L for acute exposure; 87 µg/L for chronic exposure) in 1988, which are protective of aquatic life including trout (USEPA, 1988). In 2011, Colorado promulgated new aluminum standards which take into account the hardness and pH of the receiving water (CDPHE, 2013).[1] As part of the 2011 Colorado recalculation effort, several aquatic species (i.e., midge, perch, snail, amphipod, daphnid, and trout) were evaluated and ranked for sensitivity to aluminum. The project described here, however, is exclusively focused on trout, for which not enough data points are available (i.e., 4 acute rainbow trout and 3 chronic brook trout) to confidently derive new toxicity thresholds. A literature search for post-2011 aluminum toxicity data on trout also did not uncover new information. Therefore, trout-specific acute and chronic toxicity threshold values for aluminum could not be calculated. Instead, the current pH- and hardness-dependent Colorado aluminum standard is adopted as the default standard.

2) **SCREENING CRITERIA:**

Acute toxicity data were screened to retain only studies conducted using the most acceptable procedures (Stephan *et al*., 1985) (**Appendix A**).

a. Only results from 96-hr LC_{50} tests were retained. Exposure periods less than or greater than 96 hours were excluded.
b. Results from flow-through tests were retained. Static tests were excluded.
c. Only results from exposures with a pH within the defined range for aquatic life use ($6.5 < pH < 9$) were retained.
d. Results from tests in which the concentrations of the test material were measured were retained. Tests in which concentrations were estimated or unreported were not retained.
e. Only data from trout younger than 1 year (~10 grams) were retained because smaller/younger trout are, to a limit, known to be more sensitive than large/older fish.

[1] Aluminum water quality standards adopted in 2011, as cited in Regulation – 31 (effective as of January 31, 2013).

Early life stage fish, which are still in the yolk sac (i.e. 1 day post hatch (dph)), were excluded from the data evaluation, as were eggs.

f. Results of acute toxicity tests in which organisms were fed during the 96-hour exposure period were not retained.
g. Results of tests conducted in unusual dilution waters were not retained. Stephan *et al.* (1985) defines unusual dilution waters as those, for example, with total organic carbon (TOC) > 5 mg/L. Other examples include those dilution waters with excessively high relative concentrations of cations and anions, (e.g. Na^{+}, Cl^{-}, Mg^{+2})
h. Acute values that appeared to be questionable in comparison with other acute and chronic data for the same species were not retained.
i. Retained toxicity values were converted to dissolved values using EPA metal-specific conversion factors if total metal concentration was reported, or if it was not stated.
j. Toxicity values from studies where fish were acclimated, or pre-exposed to the metal toxicant, were excluded from the data evaluation.

3) **RATIONALE:**

Geometric means and natural logarithms were calculated and used throughout this analysis because the most-widely used relationship is between hardness and acute toxicity of metals in fresh water. In addition, a log-log relationship fits these data (Stephan *et al*., 1985).

4) **METHODOLOGY:**

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The literature search data were retained and entered in an Excel spreadsheet (Filename: TroutMetalDataEvaluation) for data evaluation. The data for Cd, Cu and Zn were entered in two separate tabs, namely Summary Metal and Metal Acute Trout. The pooled and species-specific trout slopes, species mean acute values (SMAV), Y-intercepts, and predicted toxicity thresholds (i.e. acute, chronic, LC50s) are outlined in Steps 5-13 below and cross-referenced in each of the Metal Acute Trout tabs in the Excel spreadsheets.

5) **DETERMINATION OF SPECIES-SPECIFIC SLOPE:**

The purpose of the species-specific slope is to decide whether the data for each species is useful, and the degree of agreement within, and between, species (Stephan *et al.*, 1985). This summary data is compiled in **Appendix A**.

A least-squares regression was developed in the Summary Metal tab for each species and each metal for which comparable 96-hour acute LC_{50} toxicity values were available for two or more different values of water quality characteristics (i.e. hardness). Regressions were plotted with the x-y graphing function in Excel. Slopes and R^2 values were determined for each trout species and each metal using the natural logarithms of acute toxicity values vs. the corresponding natural logarithms of the hardness values to calculate a species-specific slope for each metal. The species- and metal-specific information needed for data evaluation was entered in the Summary Metal tab, and includes the following information:

a. 96-hour LC_{50} (µg/L)
b. Hardness (mg/L $CaCO_3$)
c. Citation or source

6) **DETERMINATION OF POOLED SLOPE FOR SALMONIDS:**

The pooled slope of the regression line is the best estimate of the trout species relationship between toxicity and hardness, and required for Step 7.

Data is entered into the Metal Acute Trout tab for each metal, as follows:

a. Trout species
b. Metal of concern
c. Fish mass (grams)
d. Fish length (mm)
e. pH
f. Hardness (mg/L $CaCO_3$)
g. Alkalinity (mg/L $CaCO_3$)
h. Temperature (C°)
i. Reported or dissolved 96-hour toxicity endpoint value (µg/L), with a separate column indicating if the value is total ("T") or dissolved ("D"). This parameter is important as total values are converted to dissolved concentrations based on the methodology in Stephan *et al*., (1985).
j. Citation or source
k. Notes

A least-squares regression of the natural logarithms of acute toxicity values vs. the corresponding natural logarithms of the hardness was performed on all retained data cumulatively for all trout species to obtain a pooled salmonid slope (V) and R^2 for each metal (**Figures 1 to 3**). The pooled salmonid slope is calculated in the Metal Acute Trout tab and entered into cell K9.

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7) **DETERMINATION OF SPECIES MEAN ACUTE VALUE:**

The data are pooled and averaged using the geometric mean to provide the SMAV and required for Step 8. The following equation was used to calculate the SMAV for each trout species as per the methodology described in Stephan *et al*., (1985):

$$SMAV_{50} = e^{(\ln W) - V(\ln X - \ln 50)}$$

where:

$SMAV_{50}$	= species mean acute value at hardness of 50 mg/L $CaCO_3$
W	= geometric mean of dissolved acute toxicity values
V	= pooled acute slope
X	= geometric mean of hardness values
Ln	= natural logarithm
E	= exponent

8) **DETERMINATION OF Y-INTERCEPT FOR LC50 TOXICITY THRESHOLDS:**

The y-intercept for LC50 toxicity thresholds is a statistical term that is required to calculate the LC50 toxicity threshold in Step 9. The following equation was used to calculate species-specific y-intercepts for each metal (**Table 1**):

$$\text{Y-Intercept} = \ln(SMAV_{50}) - (V \times \ln 50)$$

where:

$SMAV_{50}$	= species mean acute value at hardness of 50 mg/L $CaCO_3$
V	= pooled acute slope

Ln = natural logarithm of 50 mg/L $CaCO_3$ hardness value

9) **DETERMINATION OF LC_{50} TOXICITY THRESHOLDS**:

The calculation of LC_{50} toxicity thresholds, as reported in **Table 1**, is the initial step for determining acute and chronic toxicity thresholds in Steps 11 and 13 below. Species-specific LC_{50} equations were defined for each metal using the following equation:

$$\text{Predicted } LC_{50} = e^{(V * \ln(\text{hardness}) + \text{Y-intercept})}$$

where:

V = pooled acute slope

Ln = natural logarithm of 50 mg/L $CaCO_3$ hardness value

10) **DETERMINATION OF Y- INTERCEPT FOR ACUTE TOXICITY THRESHOLDS:**

The y-intercept for acute toxicity thresholds **(Table 1)** is a statistical term that is required to calculate the predicted acute toxicity thresholds in Step 11. The y-intercept was calculated using a safety factor of 2 (i.e., $SMAV_{50}/2$) for each metal using the equation in Step 8.

11) **DETERMINATION OF ACUTE TOXICITY THRESHOLDS:**

The calculation of acute toxicity thresholds **(Table 1)** is the final step in the derivation process, if an acute/ chronic ratio (ACR) is unavailable. The predicted acute toxicity threshold equation (with a safety factor) was reported in the same manner as in Step 9, but with the intercept calculated in Step 10**.**

DRAFT

12) **DETERMINATION OF Y-INTERCEPT FOR CHRONIC TOXICITY THRESHOLDS:**

The y-intercept for chronic toxicity thresholds **(Table 1)** is a statistical term that is necessary for calculation of the predicted chronic toxicity thresholds in Step 13. The y-intercept was calculated for each metal using the equation in Step 8. The $SMAV_{50}$ was divided by the species-specific ACR (**Table 2**).

13) **DETERMINATION OF CHRONIC TOXICITY THRESHOLDS:**

The predicted species-specific chronic toxicity threshold equation (with appropriate ACR applied) is reported in the same manner as in Step 9, however, with the intercept calculated in Step 12 **(Table 1).**

14) **SELECTION OF METAL TOXICITY THRESHOLD VALUE:**

The lesser of two values calculated via Steps 11 and 13 was used as the species specific metal toxicity threshold values (**Table 1**).

15) **UNCERTAINTY:**

Professional judgment is needed to determine the uncertainty associated with information taken from scientific literature, and any extrapolations used in developing the trout toxicity thresholds. In order to standardize the data selection process and reduce the number of potential confounding factors, data points from 96-hour acute toxicity tests were screened

against the criteria outlined in Steps 2a-j. This screening process produces more "standardized" datasets, which reduces the overall level uncertainty of the data analysis, except as noted below.

The toxic action and bioavailability of the three target metals is influenced by the pH, hardness, and DOC of the surface water. Hardness is a critical data point as natural logarithms of the 96-hour toxicity values and water quality characteristics (i.e. hardness) are plotted to determine a species-specific slope. A weak statistical relationship between hardness and LC_{50} values is likely if the entire data set consists of a narrow range of hardness concentrations (e.g. 45 – 55 mg/L $CaCO_3$). Note that the reported brown trout correlation coefficient ($R^2 = 0.19$) for Cu and the brook trout species specific slope (i.e. 11.08) for Cu (**Tables 4b and 4c**, respectively) indicate a weak relationship based on the limited range of hardness values, and therefore, introduce some level of uncertainty into the data evaluation for this metal.

Much scientific literature is available to determine the effects of Zn exposure to trout in a wide range of hardness values (**Tables 3a – 3d**), and therefore, confidence is high when calculating the trout toxicity thresholds for this metal. No Cd data were available for brook trout that satisfied the flow-through criterion outlined in Step 2b. In the absence of flow-through data, static toxicity data points were incorporated into the data evaluation as outlined in Stephan *et al.* (1985). Therefore, the inclusion of static 96-hour Cd data points deviates from the accepted methodology, and introduces some degree of uncertainty.

The published data do not fully capture the sensitivity of all trout species to Cd. These missing data represent an uncertainty in the current evaluation. Future research efforts should concentrate on obtaining acute and chronic data endpoints (i.e. 96-hour LC50s, NOECs, LOECs, etc.) in both soft and hard dilution waters with special emphasis on cutthroat and brook trout species.

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References:

Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation No. 31. CDPHE Water Quality Commission. Basic standards and methodologies for surface water (5 CCR 1002-31). Aluminum standards adopted in 2011. Most recent Regulation – 31 version: January 21, 2013.

Stephan, C.E., D.I. Mount, D.J. Hansen, J.H. Gentile, G.A. Chapman, and W.A. Brungs. 1985. Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses. PB5-227049. Duluth, MN.

US Environmental Protection Agency (USEPA). 1988. Ambient water quality criteria for aluminum. Office of Water. EPA-440/5-88-008.

Figure 1: Zinc regression

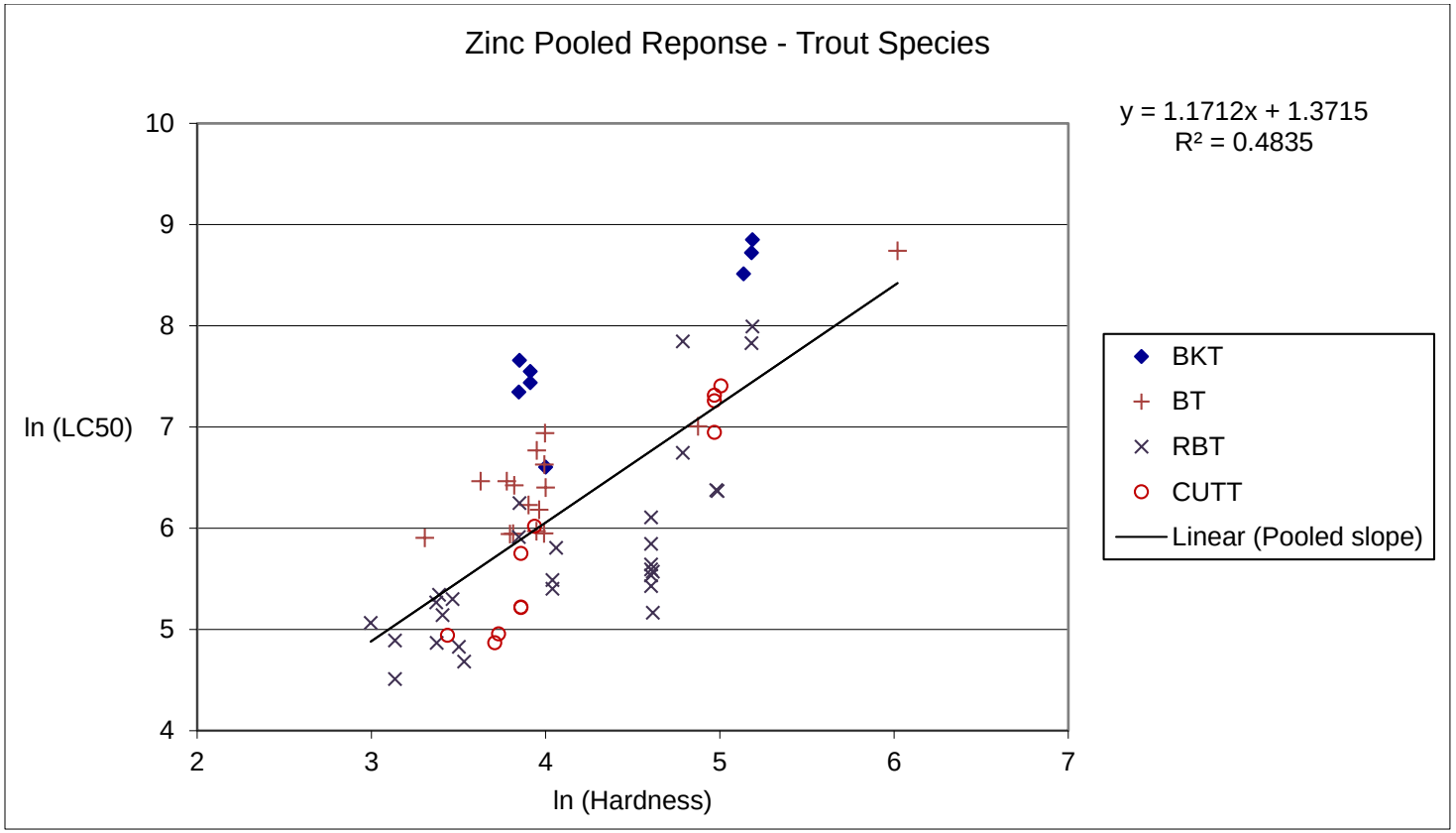


Figure 2: Copper regression

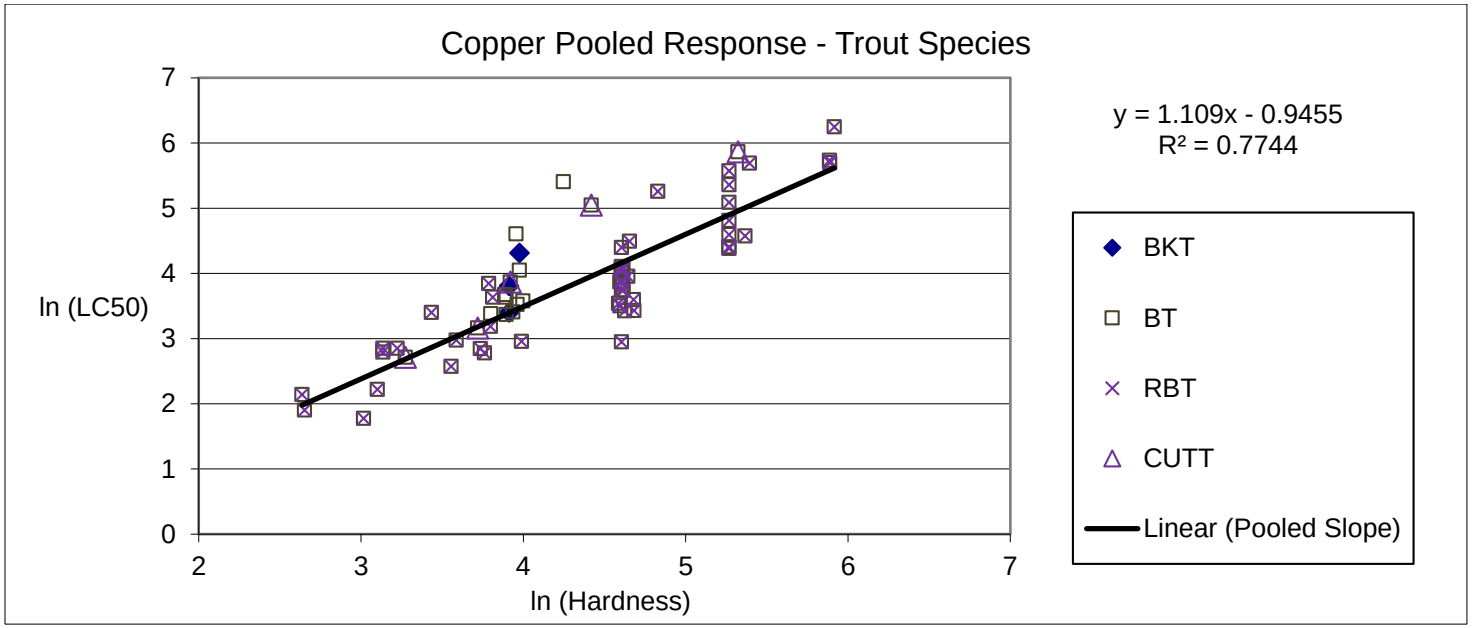


Figure 3: Cadmium regression

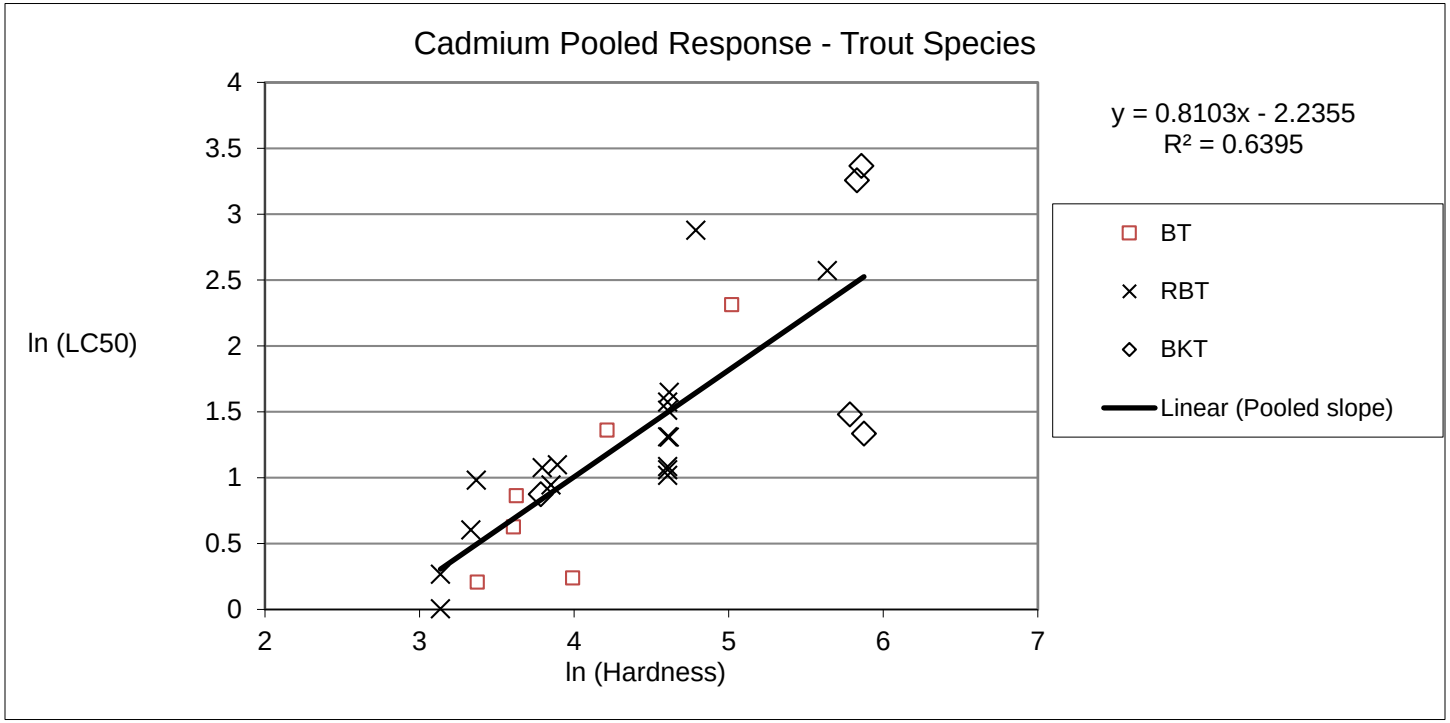


Table 1: Parameters for species-specific metal toxicity equations. Red values indicate an estimate of a protective species-specific threshold to be used at hardness 50 for individual metals of concern.

Species	*Metal*	*Geomean of Hardness Values (X)*	*Geomean of Acute Dissolved LC50s (W)*	*Acute Chronic Ratio (ACR) (a)*	*Pooled R^2 (b)*	*Pooled Slope (V) (b)*	Y-Intercepts			Calculated Values at Hardness of 50 mg/L $CaCO_3$		
							LC50 Toxicity Thresholds (c)	*Acute Toxicity Thresholds (d)*	*Chronic Toxicity Thresholds (e)*	*LC50 Toxicity Thresholds (f)*	*Acute Toxicity Thresholds (g)*	*Chronic Toxicity Thresholds (h)*
Brown Trout	Cadmium	53.11	2.55	2.44	0.64	0.8103	-2.283978729	-2.97712591	-3.177000834	2.43	1.21	0.99
Rainbow Trout	Cadmium	68.25	3.43	2.06	0.64	0.8103	-2.189457258	-2.882604439	-2.910608635	2.67	1.33	1.30
Brook Trout	Cadmium	227.23	7.87	*ACR (i)*	0.64	0.8103	-2.333165987	-3.026313167	*ACR (a)*	2.31	1.15	*ACR (i)*
Brook Trout	Copper	51.08	46.53	*ACR (i)*	0.77	1.109	-0.522060013	-1.215207193	*ACR (a)*	45.44	22.72	*ACR (i)*
Brown Trout	Copper	50.72	36.67	2.17	0.77	1.109	-0.752304666	-1.445451847	-1.5282753	36.09	18.05	16.61
Cutthroat Trout	Copper	62.22	62.21	*ACR (i)*	0.77	1.109	-0.450493193	-1.143640373	*ACR (a)*	48.81	24.41	*ACR (i)*
Rainbow Trout	Copper	83.27	47.04	2.48	0.77	1.109	-1.053054191	-1.746201372	-1.960465618	26.72	13.36	10.78
Brook Trout	Zinc	79.69	2528.70	2.34	0.48	1.1712	2.707789444	2.014642264	1.859649082	1464.91	732.46	627.29
Brown Trout	Zinc	57.31	663.90	1.63	0.48	1.1712	1.756526041	1.063378861	1.266107227	565.83	282.91	346.50
Cutthroat Trout	Zinc	67.33	399.50	*2.633 (j)*	0.48	1.1712	1.059889126	0.366741946	0.091765246	281.93	140.96	107.07
Rainbow Trout	Zinc	62.49	314.76	1.87	0.48	1.1712	0.908783827	0.215636646	0.283915487	242.39	121.19	129.76

Notes:

Values in red under *Calculated Values at Hardness of 50 mg/L $CaCO_3$* indicate an estimate of a protective, species-specific, dissolved toxicity applicable to waters of hardness values of 50 for individual metals of concern.

Refer to pages 3-5, steps 6-13, Steps and Background for Developing Trout Specific Hardness-Dependent Toxicity Thresholds

(a) See Table 2: Derivation of Acute to Chronic Ratios

(b) Step 6 - methodology for determining pooled slope and R^2

(c) Step 8 - equation and methodology for determining the y-intercept for LC50 toxicity thresholds

(d) Step 10 - methodology for determining the y-intercept for acute toxicity thresholds

(e) Step 12 - methodology for determining the y-intercept for chronic toxicity thresholds

(f) Step 9 - methodology and equation for calculating LC50 toxicity thresholds

(g) Step 11 - methodology for calculating acute toxicity thresholds

(h) Step 13 - methodology for calculating chronic toxicity thresholds

(i) ACR is unavailable

(j) Zinc Acute-to-Chronic Ratio for Cutthroat Trout was pre-populated for calculation of chronic endpoint.

Table 2: Derivation of Acute to Chronic Ratios (ACRs)

Metal	Species	Hardness	Acute	Chronic	Ratio	ACR	Reference
Cadmium	Brown Trout	37.6	2.4	0.4	5.9250	2.4425	Davies and Brinkman 1994a
	Brown Trout	29.0	1.2	1.0	1.2059		Brinkman and Hansen 2004
	Brown Trout	68.0	3.9	1.8	2.1311		Brinkman and Hansen 2004
	Brown Trout	151.0	10.1	6.5	1.5443		Brinkman and Hansen 2004
	Brown Trout	39.8	1.9	1.3	1.4060		Davies and Brinkman 1994b
	Rainbow Trout	47.0	2.6	1.5	1.7959	2.0568	Davies, Gorman, Carlson and Brinkman 1993
	Rainbow Trout	49.0	3.1	1.5	2.0952		Davies, Gorman, Carlson and Brinkman 1993
	Rainbow Trout	281.0	13.1	9.2	1.4317		Davies and Brinkman 1994c
	Rainbow Trout	29.0	2.7	1.3	2.1190		Davies and Brinkman 1994c
	Rainbow Trout	101.0	5.4	1.9	2.8421		Besser et al 2007
Copper	Brown Trout	50.0	30.2	13.9	2.1727	2.1727	Davies et al 2002
	Rainbow Trout	120.0	80.0	27.8	2.8808	2.4779	Seim et al 1984
	Rainbow Trout	101.0	83.0	40.0	2.0750		Besser et al 2007
Zinc	Brook Trout	45.9	1996.0	854.7	2.3353	2.3353	Holcombe and Andrew 1978
	Brown Trout	50.0	392.0	194.0	2.0206	1.6331	Davies and Brinkman 1999
	Brown Trout	39.0	550.0	457.0	1.2035		Davies and Brinkman 1994
	Brown Trout	27.3	367.0	251.0	1.4622		Davies et al 2003
	Brown Trout	131.0	1104.0	598.0	1.8462		Davies et al 2003
	Rainbow Trout	33.2	125.0	74.0	1.6892	1.8681	Brinkman and Hansen 2004
	Rainbow Trout	145.4	588.0	325.0	1.8092		Brinkman and Hansen 2004
	Rainbow Trout	25.5	430.0	276.7	1.5540		Sinley et al 1974
	Rainbow Trout	101.0	530.0	219.0	2.4201		Besser et al 2007

APPENDIX A

Summary of the calculation of Zn, Cu, and Cd thresholds of four salmonid species

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Table 3a: Reported values of acute Zn toxicity (and corresponding test hardness) to rainbow trout. These studies remain from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

	Dissolved LC50	ln LC50	hardness	ln hardness	Source
Rainbow Trout	850	6.75	120.0	4.79	1
Oncorhynchus	158	5.06	20.0	3.00	1
mykiss	2257	7.72	120.0	4.79	2
	175	5.16	101.0	4.62	8
	263	5.57	101.0	4.62	8
	125	4.83	33.2	3.50	13
Slope= 0.9874	588	6.38	145.4	4.98	13
R^2 = 0.5691	222	5.40	56.8	4.04	14
	242	5.49	56.8	4.04	14
	228	5.43	100.0	4.61	26
	253	5.53	100.0	4.61	26
	269	5.59	100.0	4.61	26
	282	5.64	100.0	4.61	26
	346	5.85	100.0	4.61	26
	449	6.11	100.0	4.61	26
	91	4.51	23.0	3.14	29
	133	4.89	23.0	3.14	29
	200	5.30	32.0	3.47	35
	130	4.87	29.2	3.37	46
	171	5.14	30.2	3.41	46
	194	5.27	29.1	3.37	46
	209	5.34	29.6	3.39	46
	370	5.91	46.8	3.85	57
	517	6.25	47.0	3.85	57
	2510	7.83	178.0	5.18	57
	2960	7.99	179.0	5.19	57
	333	5.81	58.0	4.06	80
	108	4.68	34.2	3.53	86
	583	6.37	146.4	4.99	86
Geometric mean	313		62.5		

Table 3b: Reported values of acute Zn toxicity (and corresponding test hardness) to brown trout. These studies remain from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

	Dissolved LC50	ln LC50	hardness	ln hardness	Source
Brown Trout	642	6.46	43.7	3.78	14
Salmo trutta	381	5.94	44.5	3.80	14
	617	6.42	45.6	3.82	14
	757	6.63	54.2	3.99	14
	392	5.97	54.1	3.99	18
	642	6.46	37.6	3.63	37
Slope = 1.0158	392	5.97	51.8	3.95	40
R^2 = 0.7931	871	6.77	51.9	3.95	40
	1033	6.94	54.4	4.00	41
	484	6.18	52.6	3.96	42
	603	6.40	54.6	4.00	42
	382	5.95	45.3	3.81	43
	508	6.23	49.5	3.90	43
	367	5.91	27.3	3.31	45
	1104	7.01	131.0	4.88	45
	6259	8.74	411.4	6.02	45
Geometric mean	665		57.3		

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Table 3c: Reported values of acute Zn toxicity (and corresponding test hardness) to brook trout. These studies remain from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

	Dissolved LC50	ln LC50	hardness	ln hardness	Source
Brook Trout	1700	7.44	50.0	3.91	23
Salvelinus fontinalis	1900	7.55	50.0	3.91	23
	738	6.60	54.6	4.00	42
	1550	7.35	46.8	3.85	57
Slope= 1.0568	2120	7.66	47.0	3.85	57
R^2 = 0.7822	4980	8.51	170.0	5.14	57
	6140	8.72	178.0	5.18	57
	6980	8.85	179.0	5.19	57
Geometric mean	2529		79.7		

Table 3d: Reported values of acute Zn toxicity (and corresponding test hardness) to cutthroat trout. These studies remain from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

	Dissolved LC50	ln LC50	hardness	ln hardness	Source
Cutthroat trout	140	4.94	31.1	3.44	13
Oncorhynchus	1645	7.41	149.4	5.01	13
clarkii	185	5.22	47.4	3.86	17
	1420	7.26	144.0	4.97	17
Slope = 1.6229	314	5.75	47.4	3.86	17
R^2 = 0.9347	1500	7.31	144.0	4.97	17
	184	5.21	47.4	3.86	17
	142	4.96	41.7	3.73	17
	1040	6.95	144.0	4.97	17
	130	4.87	40.8	3.71	42
	411	6.02	51.3	3.94	42
Geometric mean	400		67.3		

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Table 3e: Values of acute Zn toxicity (and corresponding test hardness) to trout eliminated through screening of a larger dataset with 5 criteria known to influence Zn toxicity.

Excluded studies

Species	Hardness	LC50	Rationale	Source
RBT	10	101	c	2
RBT	33.0	170	a,e	4
RBT	33.0	177	e	4
RBT	33.0	187	e	4
RBT	33.0	200	e	4
RBT	33.0	207	e	4
RBT	33.0	221	e	4
RBT	33.0	241	e	4
RBT	33.0	245	e	4
RBT	33.0	265	e	4
RBT	33.0	290	e	4
RBT	33.0	336	e	4
RBT	33.0	459	e	4
RBT	33.0	93	e	4
RBT	33.0	105	e	4
RBT	33.0	129	e	4
RBT	33.0	138	e	4
BKT	170.0	1900	a	7
BKT	181.0	5400	a	7
RBT	97.5	1120	b,e	9
RBT	30.9	4530	a	10
RBT	30.2	170	a	10
RBT	31.2	190	a	10
RBT	31.3	110	a	10
RBT	31.4	880	a	10
RBT	387.0	4460	a	10
RBT	389.0	11100	a	10
RBT	389.0	5160	a	10
RBT	394.0	9950	a	10
RBT	390.0	7260	a	11
RBT	390.0	4850	a	11
RBT	390.0	4200	a	11
RBT	390.0	3960	a	11
RBT	390.0	5210	a	11
BT	54.1	871	g	18
RBT	5.6	40	b,e	19
RBT	41.3	169	b,e	20
RBT	41.3	2170	b,e	20
RBT	100.0	571	f	26
RBT	23.0	651	d	29
RBT	23.0	815	d	29
RBT	83.0	1755	d	30
RBT	9.2	65	e	32
RBT	9.2	95	e	32

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BT	54.0	690	c	40
BT	206.7	2267	c	40
BKT	52.6	1178	d	42
RBT	330.8	730	c	46
RBT	30.0	441	c	46
RBT	105.6	1170	c	46
RBT	190.0	1470	c	46
RBT	399.0	2560	c	46
RBT	102.3	904	c	46
RBT	396.3	2280	c	46
RBT	45.1	153	c	46
RBT	139.0	214	c	46
RBT	228.3	283	c	46
RBT	332.3	483	c	46
RBT	29.1	1510	c	46
RBT	28.7	548	c	46
RBT	28.4	610	c	46
RBT	20.0	90	b,e	49
RBT	30.0	810	d,e	51
RBT	30.0	410	d,e	51
RBT	30.0	430	d,e	51
RBT	314.0	7210	d,e	54
RBT	312.0	4520	d,e	54
RBT	23.0	560	d,e	54
RBT	30.0	830	d,e	54
RBT	102.0	1000	d,e	54
RBT	312.0	1164	d,e	54
RBT	22.0	235	d,e	54
RBT	28.5	26.8	a	55
RBT	29.1	33.3	a	55
RBT	29.6	124	a	55
RBT	30.8	109	a	55
RBT	30.9	23.9	a	55
RBT	31.3	53.3	a	55
RBT	87.1	184	a	55
RBT	90.0	257	a	55
RBT	44.4	756	d	57
RBT	170.0	1910	d	57
BKT	44.4	2420	d	57
RBT	250.0	5300	b,e	60
RBT	250.0	1600	b,e	60
RBT	250.0	590	b,e	60
RBT	5.0	280	b,e	66
RBT	16.0	117	b	67
RBT	24.0	130	b	67
RBT	137.0	2600	b	68
RBT	143.0	2400	b	68
RBT	504.0	4760	a	81
RBT	14.0	560	b	83
RBT	14.0	670	b	83

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a	Exposure longer than 96 h or unspecified
b	Static or static renewal exposure
c	Unusual dilution waters
d	Fish too large, too old
e	Water chemistry estimated or unreported
f	Fish too young, still in yolk sac
g	Fish pre-exposed to metals

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Table 4a: Reported values of acute Cu toxicity (and corresponding test hardness) to rainbow trout. These studies remain from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

	Dissolved LC50	ln LC50	hardness	ln hardness	Source
Rainbow Trout	192	5.26	125.0	4.83	5
Oncorhynchus mykiss	58	4.06	101.0	4.62	8
	42	3.74	101.0	4.62	8
Slope= 1.131	6	1.77	20.4	3.02	22
R^2 = 0.8196	17	2.84	41.9	3.74	22
	38	3.63	45.2	3.81	22
	47	3.84	44.1	3.79	22
	24	3.19	44.6	3.80	22
	20	2.98	36.1	3.59	22
	19.1	2.95	100.0	4.61	26
	56.6	4.04	100.0	4.61	26
	59.9	4.09	100.0	4.61	26
	59	4.08	100.0	4.61	26
	42.4	3.75	100.0	4.61	26
	60.6	4.10	100.0	4.61	26
	162	5.09	194.0	5.27	28
	82	4.41	194.0	5.27	28
	80	4.38	194.0	5.27	28
	99	4.59	194.0	5.27	28
	263	5.57	194.0	5.27	28
	123	4.81	194.0	5.27	28
	212	5.36	194.0	5.27	28
	16	2.79	23.0	3.14	30
	17.28	2.85	23.0	3.14	30
	52.224	3.96	104.0	4.64	56
	296	5.69	220.0	5.39	56
	34	3.54	98.2	4.59	56
	97	4.57	214.0	5.37	56
	89	4.49	105.0	4.65	56
	33	3.50	99.0	4.60	59
	31	3.42	102.0	4.62	59
	309	5.73	360.0	5.89	59
	30	3.40	31.0	3.43	59
	48	3.87	100.0	4.61	59
	46	3.84	101.0	4.62	59
	48	3.87	99.0	4.60	59

	516	6.25	371.0	5.92	59
	298	5.70	361.0	5.89	59
	81	4.40	100.0	4.61	59
	39	3.67	107.7	4.68	61
	30	3.41	107.7	4.68	61
	17	2.85	25.1	3.22	63
	9	2.22	22.2	3.10	71
	9	2.14	14.0	2.64	71
	7	1.90	14.2	2.65	71
	19	2.95	54.0	3.99	80
	13	2.57	35.0	3.56	90
	16	2.78	43.0	3.76	90
Geometric mean	47		83.3		

Table 4b: Reported values of acute Cu toxicity (and corresponding test hardness) to brown trout. These studies remain from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

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	Dissolved LC50	ln LC50	hardness	ln hardness	Source
Brown Trout	39.4	3.67	57.1	4.04	18
Salmo trutta	33.9	3.52	52.6	3.96	42
	57.3	4.05	53.3	3.98	42
	29.4	3.38	44.7	3.80	42
	39.4	3.67	48.7	3.89	42
	30.2	3.41	51.2	3.94	42
	35.8	3.58	54.5	4.00	42
Geometric mean	37		50.7		

Slope =	1.2413
R^2 =	0.1973

Table 4c: Reported values of acute Cu toxicity (and corresponding test hardness) to brook trout. These studies remain from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

		Dissolved LC50	ln LC50	hardness	ln hardness	Source
Brook Trout		74.6	4.31	53.3	3.98	42
Salvelinus fontinalis		45	3.81	50.0	3.91	23
Slope=	11.08	30	3.40	50.0	3.91	23
R^2 =	0.8027					
Geometric mean		46.5		51.1		

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Table 4d: Reported values of acute Cu toxicity (and corresponding test hardness) to cutthroat trout. These studies remain from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

		Dissolved LC50	ln LC50	Hardness	ln hardness	Source
Cutthroat trout		15.072	2.71	26.4	3.27336	28
Oncorhynchus		155.52	5.05	83	4.41884	28
clarkii		352.32	5.86	205	5.32301	28
Slope=	1.6308	23.6	3.16	41.2	3.71844	42
R^2 =	0.9507	47.8	3.87	50.4	3.91999	42
Geometric mean		62.2		62.2		

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Table 4e: Values of acute Cu toxicity (and corresponding test hardness) to trout eliminated through screening of a larger dataset with 5 criteria known to influence Cu toxicity.

Excluded studies Species	Hardness	LC50	Source	Rationale
RBT	33.0	7	4	e
RBT	125	190	5	d
RBT	125	210	5	d
BKT	170.0	64	7	a
BKT	181.0	38	7	a
RBT	97.5	110	9	b,e
BT	57.1	30.2	18	g
RBT	41.3	13.8	20	b,e
RBT	41.3	36	20	b,e
RBT	36.2	12.9	22	c
RBT	45.4	25.1	22	c
RBT	300	890	24	d
RBT	52.2	62.9	26	f
CUTT	222.72	69.9	28	c
RBT	194.0	165	28	d
RBT	194.0	197	28	d
RBT	194.0	514	28	d
RBT	194.0	243	28	d
RBT	23	29	29	d
RBT	23	28	29	d
RBT	42.0	57	30	e
RBT	132.5	120	31	b
RBT	9.2	2.8	32	e
RBT	9.2	4.2	32	e
RBT	112.0	160	33	e
BKT	52.6	48.2	42	d
RBT	169.0	110	47	b,e
RBT	169.0	100	47	b,e
RBT	169.0	50	47	b,e
RBT	169.0	60	47	b,e
RBT	362.5	102	48	d
RBT	33.0	400	50	b
RBT	36.0	52	54	e
RBT	100.0	56	54	e

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RBT	350.0	150	54	e
RBT	98.0	85.9	59	c
RBT	101.0	176	59	c
RBT	370.0	232	59	c
RBT	364.0	111	59	c
RBT	366.0	70	59	c
RBT	32.0	22.4	59	c
RBT	371.0	82.2	59	c
RBT	31.0	28.9	59	c
RBT	101.0	40	59	c
RBT	30.0	30	59	c
RBT	30.0	19.9	59	c
RBT	250.0	930	60	b,e
RBT	250.0	1150	60	b,e
RBT	250.0	430	60	b,e
RBT	120.0	11.3	62	b,e
RBT	120.0	11.3	62	b,e
RBT	120.0	14.3	62	b,e
RBT	120.0	15.9	62	b,e
RBT	120.0	23.9	62	b,e
RBT	44.0	135	64	b,e
BKT	45.4	105.6	65	d
BKT	45.4	86.4	65	d
RBT	18.3	94	69	e
RBT	23.7	93	69	e
RBT	24.4	89	69	e
RBT	31.0	90	69	e
RBT	172.0	67.9	70	b
RBT	176.0	35.5	70	b
RBT	176.0	18.1	70	b
RBT	176.0	52.5	70	b
RBT	176.0	18.1	70	b
RBT	177.0	27.7	70	b
RBT	178.0	53.9	70	b
RBT	178.0	30.7	70	b
RBT	179.0	37.3	70	b
RBT	180.0	46.2	70	b
RBT	180.0	17.9	70	b
RBT	180.0	21.2	70	b
RBT	13.0	19.4	71	c
RBT	12.2	5.9	71	c

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RBT	170.0	80	75	b,e
RBT	52.2	100	78	a
RBT	120	80	77	d
RBT	284.0	650	84	e
RBT	120.0	66.7	85	e
RBT	57.0	40	87	b
RBT	57.0	21	87	b
RBT	57.0	22	87	b
RBT	57.0	24	87	b
RBT	39.0	8.1	89	b
RBT	42.0	3.4	89	b
RBT	90.0	17.2	89	b
RBT	90.0	32	89	b
RBT	38.0	21	90	b
RBT	45.0	17.2	90	b

a	Exposure longer than 96 h or unspecified
b	Static or static renewal exposure
c	Unusual dilution waters
d	Fish too large or too old
e	Water chemistry estimated or unreported
f	Fish too young, still in yolk sac
g	Fish pre-exposed to metals

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Table 5a: Reported values of acute Cd toxicity (and corresponding test hardness) to rainbow trout. These studies remain from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

	Dissolved LC50	ln LC50	hardness	ln hardness	Source
Rainbow Trout	3.70	1.31	101.0	4.62	8
Oncorhynchus mykiss	5.20	1.65	101.0	4.62	8
	2.77	1.02	100.0	4.61	26
Slope= 0.8249	2.89	1.06	100.0	4.61	26
R^2 = 0.6659	4.83	1.57	100.0	4.61	26
	3.71	1.31	100.0	4.61	26
	4.54	1.51	100.0	4.61	26
	2.96	1.09	100.0	4.61	26
	1.31	0.27	23.0	3.14	29
	1.01	0.01	23.0	3.14	29
	1.83	0.60	28.0	3.33	39
	2.67	0.98	29.0	3.37	39
	13.10	2.57	281.0	5.64	39
	2.58	0.95	47.0	3.85	36
	3.00	1.10	49.0	3.89	36
	17.79	2.88	120.0	4.79	72
	2.93	1.08	44.4	3.79	74
Geometric mean	3.43		68.2		

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Table 5b: Reported values of acute Cd toxicity (and corresponding test hardness) to brown trout. These studies remain from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

	Dissolved LC50	ln LC50	hardness	ln hardness	Source
Brown Trout	1.23	0.21	29.2	3.37	13
Salmo trutta	3.90	1.36	67.6	4.21	13
Slope = 1.2018	10.10	2.31	151.4	5.02	13
R^2 = 0.9755	1.17	0.16	54.1	3.99	18
	1.87	0.63	36.9	3.61	38
	2.37	0.86	37.6	3.63	37
Geometric mean	2.51		53.1		

Table 5c: Reported values of acute Cd toxicity (and corresponding test hardness) to brook trout. This study remains from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

	Dissolved LC50	ln LC50	hardness	ln hardness	Source
Brook trout	1.5	0.41	42	3.74	27
Salvenius fontinalis	2.4	0.88	44	3.78	27
	26	3.26	340	5.83	27
Slope = 0.8336	29	3.37	350	5.86	27
R^2 = 0.5189	3.8	1.34	356	5.87	27
	4.4	1.48	325	5.78	27
Geometric mean	5.97		171.5		

Table 5d: Reported values of acute Cd toxicity (and corresponding test hardness) to cutthroat trout. This study remains from the screening of a larger dataset with 5 criteria known to influence metal toxicity.

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	Dissolved LC50	ln LC50	hardness	ln hardness	Source
Cutthroat Trout *Oncorhynchus clarkii* No slope	2.40	0.88	44.9	3.80	12
Geometric mean	2.4		44.9		

Table 5e: Values of acute Cd toxicity (and corresponding test hardness) to trout eliminated through screening of a larger dataset with 5 criteria known to influence Cu toxicity.

Excluded studies Species	Hardness	LC50	Source	Rationale
RBT	33.0	7	4	e
RBT	125	190	5	d
RBT	125	210	5	d
BKT	170.0	64	7	a
BKT	181.0	38	7	a
RBT	97.5	110	9	b,e
BT	57.1	30.2	18	g
RBT	41.3	13.8	20	b,e
RBT	41.3	36	20	b,e
RBT	36.2	12.9	22	c
RBT	45.4	25.1	22	c
RBT	300	890	24	d
RBT	52.2	62.9	26	f
CUTT	222.72	69.9	28	c
RBT	194.0	165	28	d
RBT	194.0	197	28	d
RBT	194.0	514	28	d
RBT	194.0	243	28	d
RBT	23	29	29	d
RBT	23	28	29	d
RBT	42.0	57	30	e
RBT	132.5	120	31	b
RBT	9.2	2.8	32	e
RBT	9.2	4.2	32	e
RBT	112.0	160	33	e
BKT	52.6	48.2	42	d
RBT	169.0	110	47	b,e
RBT	169.0	100	47	b,e
RBT	169.0	50	47	b,e
RBT	169.0	60	47	b,e
RBT	362.5	102	48	d
RBT	33.0	400	50	b
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RBT	100.0	56	54	e

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RBT	350.0	150	54	e
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RBT	371.0	82.2	59	c
RBT	31.0	28.9	59	c
RBT	101.0	40	59	c
RBT	30.0	30	59	c
RBT	30.0	19.9	59	c
RBT	250.0	930	60	b,e
RBT	250.0	1150	60	b,e
RBT	250.0	430	60	b,e
RBT	120.0	11.3	62	b,e
RBT	120.0	11.3	62	b,e
RBT	120.0	14.3	62	b,e
RBT	120.0	15.9	62	b,e
RBT	120.0	23.9	62	b,e
RBT	44.0	135	64	b,e
BKT	45.4	105.6	65	d
BKT	45.4	86.4	65	d
RBT	18.3	94	69	e
RBT	23.7	93	69	e
RBT	24.4	89	69	e
RBT	31.0	90	69	e
RBT	172.0	67.9	70	b
RBT	176.0	35.5	70	b
RBT	176.0	18.1	70	b
RBT	176.0	52.5	70	b
RBT	176.0	18.1	70	b
RBT	177.0	27.7	70	b
RBT	178.0	53.9	70	b
RBT	178.0	30.7	70	b
RBT	179.0	37.3	70	b
RBT	180.0	46.2	70	b
RBT	180.0	17.9	70	b
RBT	180.0	21.2	70	b
RBT	13.0	19.4	71	c
RBT	12.2	5.9	71	c

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RBT	170.0	80	75	b,e
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RBT	57.0	24	87	b
RBT	39.0	8.1	89	b
RBT	42.0	3.4	89	b
RBT	90.0	17.2	89	b
RBT	90.0	32	89	b
RBT	38.0	21	90	b
RBT	45.0	17.2	90	b

a	Exposure longer than 96h or unspecified
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c	Unusual dilution waters
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e	Water chemistry estimated or unreported
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g	Fish pre-exposed to metals

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Appendix 5a

Normalizing dissolved metals concentrations to a standard surface water hardness of 50 mg/L

Appendix 5a: Normalizing dissolved metal concentrations to a standard surface water hardness of 50 mg/L

1.0 INTRODUCTION

Surface water hardness affects the toxicity of several metals, including cadmium (Cd), copper (Cu), and zinc (Zn) (CDPHE, 2013). The toxicity of these metals to aquatic receptors changes with water hardness at a rate which is non-linear and metal-specific.

EPA has collected surface water samples from the Upper Animas River for several years in support of the Upper Animas River Baseline Ecological Risk Assessment (BERA). Of special interest to EPA is determining to what extent exposures to dissolved Cd, Cu, and Zn in the stretch of river evaluated in the BERA may result in chronic toxicity to four trout species of interest, namely brook trout, brown trout, rainbow trout, and cutthroat trout.

Appendix 5 of the BERA presents species-specific Cd, Cu and Zn Chronic Toxicity Thresholds (CTTs) which are standardized to a surface water hardness of 50 mg/L calcium carbonate. It would be inaccurate to directly compare the dissolved metals levels measured in Upper Animas River surface water samples (each one of which has a different hardness) to these CTTs without first standardizing the surface water concentrations to a standard hardness of 50 mg/L.

This appendix describes the approach used for normalizing the dissolved Cd, Cu and Zn concentrations to a standard hardness of 50 mg/L. This hardness value was retained because it represents the hardness used to derive the CTTs presented in Appendix 5.

2.0 NORMALIZATION APPROACH

The following steps are used to normalize the dissolved Cd, Cu and Zn data from the Upper Animas River to a standard hardness of 50 mg/L for comparison to the CTTs.

2.1 Step 1: Obtain the equations to calculate hardness-specific water quality benchmarks

CDPHE (2013) provides the equations to calculate chronic water quality benchmarks for Cd, Cu and Zn applicable to any surface water hardness up to 400 mg/L. These equations are as follows:

- Cd benchmark = $(1.101672 - [\ln(\text{hardness}) * 0.041838]) * \exp^{0.7998 * \ln(\text{hardness}) - 4.4451}$
- Cu benchmark = $\exp^{0.8545 * \ln(\text{hardness}) - 1.7428}$
- Zn benchmark = $0.986 * \exp^{0.9094 * \ln(\text{hardness}) + 0.6235}$

2.2 Step 2: Calculate hardness-specific benchmarks

The equations provided in Step 1 are used to calculate metal-specific chronic surface water benchmarks for hardness ranging between 10 and 400 mg/L. **Attachment 1** provides the results of these calculations for Cd, Cu and Zn.

2.3 Step 3: Calculate metal-specific chronic hardness multipliers

The Chronic Hardness Multipliers (CHMs) are obtained by dividing the chronic metal-specific benchmarks at a hardness of 50 mg/L (the standard hardness selected for this project) by the equivalent metal-specific chronic benchmark at the other hardnesses between 10 and 400 mg/L shown in **Attachment 1**.

As an example, the chronic benchmark for dissolved Cu equals 4.95 µg/L at a hardness of 50 mg/L, but 2.74 µg/L at a hardness of 25 mg/L (see **Attachment 1**). The CHM for dissolved Cu at a hardness of 25 mg/L equals 1.81 (4.95/2.74). This value indicates that dissolved Cu at a hardness of 25 mg/L has 1.81 times the chronic toxicity, all else being equal, than the dissolved Cu at a hardness of 50 mg/L. This difference is hardness- and metal-specific.

Attachment 2 provides the results of the calculations to obtain the CHMs for Cd, Cu and Zn.

2.4 Step 4: Derive metal-specific, hardness-multiplier regression equations

The last step in the process consists of regressing the surface water hardness (the "x variable") for Cd, Cu and Zn against their corresponding CHMs calculated in Step 2.3 (the "y variable"). The goal is to obtain a regression equation for Cd, Cu and Zn to help derive an exposure- and metal-specific hardness multiplier at any hardness between 10 and 400 mg/L.

The figures in **Attachments 3 to 5** provide the data graphs for Cd, Cu and Zn, respectively. The metal-specific CHM regression equations are as follows:

- Cd $= 19.058 * \text{hardness}^{-0.753}$ (equation 1)
- Cu $= 28.299 * \text{hardness}^{-0.854}$ (equation 2)
- Zn $= 35.079 * \text{hardness}^{-0.909}$ (equation 3)

3.0 NORMALIZING DISSOLVED METALS TO A STANDARD HARDNESS

The regression equations provided in Step 4 are used to normalize all of the dissolved Cd, Cu and Zn data collected in support of the Upper Animas River BERA to a standard hardness of 50 mg/L for comparison against the CTTs developed for brook

trout, brown trout, rainbow trout, and cutthroat trout as presented in Appendix 5 of the BERA.

Table 1 provides a hypothetical example on how to normalize dissolved Cu concentrations to a standard hardness of 50 mg/L using the CHM regression equation for Cu. The calculations proceed as follows:

- Enter the hardness in equation 2 of Section 2.4 above to calculate the CHM for a particular sample.
- Multiply the measured Cu concentration by the CHM to obtain the Cu concentration normalized to a hardness of 50 mg/L.

Table 1: Hypothetical example for normalizing dissolved Cu using the CHMs

Surface water hardness (mg/L)	Measured Cu conc. (µg/L)	CHM for Cu (for normalizing to 50 mg/L hardness)	Hardness-Normalized Cu Conc. (µg/L)
27	39.5	1.696	67.0
40	27.0	1.212	32.7
52	15.0	0.969	14.5
84	9.0	0.643	5.8
179	10.9	0.337	3.7
247	94	0.256	24.1
381	179	0.177	31.7

The same general approach applies to Cd and Zn. The hardness-normalized concentrations are then divided by the species-specific CTTs presented in Appendix 5 of the Animas River BERA to obtain the Hazard Quotients (HQs) used in the surface water HQ scatter plots for Cd, Cu and Zn.

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Appendix 6

Known or likely vertebrate species occurrence in San Juan County, CO

La Plata county

Known or Likely Species Occurrence

Group	Common Name	Scientific Name	Occurence	Abundance
Amphibians	Boreal Toad	Bufo boreas	Likely to occur	Unknown
Amphibians	Bullfrog	Rana catesbeiana	Known to occur	Locally Common
Amphibians	Canyon Treefrog	Hyla arenicolor	Likely to occur	Unknown
Amphibians	New Mexico Spadefoot	Spea multiplicata	Known to occur	Unknown
Amphibians	Northern Leopard Frog	Rana pipiens	Known to occur	Locally Common
Amphibians	Red-spotted Toad	Bufo punctatus	Known to occur	Rare
Amphibians	Tiger Salamander	Ambystoma tigrinum	Known to occur	Locally Common
Amphibians	Western Chorus Frog	Pseudacris triseriata	Known to occur	Common
Amphibians	Woodhouse's Toad	Bufo woodhousii	Known to occur	Common
Birds	Acorn Woodpecker	Melanerpes formicivorus	Known to occur	Casual/Accidental
Birds	American Avocet	Recurvirostra americana	Known to occur	Unknown
Birds	American Bittern	Botaurus lentiginosus	Known to occur	Unknown
Birds	American Coot	Fulica americana	Known to occur	Fairly Common
Birds	American Crow	Corvus brachyrhynchos	Known to occur	Fairly Common
Birds	American Dipper	Cinclus mexicanus	Known to occur	Uncommon
Birds	American Goldfinch	Carduelis tristis	Known to occur	Uncommon
Birds	American Kestrel	Falco sparverius	Known to occur	Fairly Common
Birds	American Peregrine Falcon	Falco peregrinus anatum	Known to occur	Rare
Birds	American Pipit	Anthus rubescens	Known to occur	Uncommon
Birds	American Redstart	Setophaga ruticilla	Known to occur	Unknown
Birds	American Robin	Turdus migratorius	Known to occur	Common
Birds	American Tree Sparrow	Spizella arborea	Known to occur	Unknown
Birds	American White Pelican	Pelecanus erythrorhynchos	Known to occur	Unknown
Birds	American Wigeon	Anas americana	Known to occur	Unknown
Birds	Ash-throated Flycatcher	Myiarchus cinerascens	Known to occur	Fairly Common
Birds	Baird's Sandpiper	Calidris bairdii	Known to occur	Unknown
Birds	Bald Eagle	Haliaeetus leucocephalus	Known to occur	Unknown
Birds	Band-tailed Pigeon	Columba fasciata	Known to occur	Uncommon
Birds	Bank Swallow	Riparia riparia	Known to occur	Common
Birds	Barn Owl	Tyto alba	Known to occur	Unknown
Birds	Barn Swallow	Hirundo rustica	Known to occur	Common
Birds	Barrow's Goldeneye	Bucephala islandica	Known to occur	Unknown
Birds	Belted Kingfisher	Ceryle alcyon	Known to occur	Fairly Common

Birds	Bewick's Wren	Thryomanes bewickii	Known to occur	Fairly Common
Birds	Black Phoebe	Sayornis nigricans	Known to occur	Unknown
Birds	Black Rosy Finch	Leucosticte atrata	Known to occur	Unknown
Birds	Black Swift	Cypseloides niger	Known to occur	Uncommon
Birds	Black Tern	Chlidonias niger	Known to occur	Unknown
Birds	Black-billed Magpie	Pica pica	Known to occur	Common
Birds	Black-capped Chickadee	Poecile atricapillus	Known to occur	Fairly Common
Birds	Black-chinned Hummingbird	Archilochus alexandri	Known to occur	Common
Birds	Black-crowned Night-Heron	Nycticorax nycticorax	Known to occur	Unknown
Birds	Black-headed Grosbeak	Pheucticus melanocephalus	Known to occur	Fairly Common
Birds	Black-necked Stilt	Himantopus mexicanus	Known to occur	Unknown
Birds	Black-throated Gray Warbler	Dendroica nigrescens	Known to occur	Fairly Common
Birds	Black-throated Sparrow	Amphispiza bilineata	Known to occur	Rare
Birds	Blue Grosbeak	Guiraca caerulea	Known to occur	Fairly Common
Birds	Blue Grouse	Dendragapus obscurus	Known to occur	Uncommon
Birds	Blue Jay	Cyanocitta cristata	Known to occur	Unknown
Birds	Blue-gray Gnatcatcher	Polioptila caerulea	Known to occur	Common
Birds	Blue-winged Teal	Anas discors	Known to occur	Unknown
Birds	Bobolink	Dolichonyx oryzivorus	Known to occur	Unknown
Birds	Bonaparte's Gull	Larus philadelphia	Likely to occur	No Occurrence
Birds	Boreal Owl	Aegolius funereus	Known to occur	Rare
Birds	Brewer's Blackbird	Euphagus cyanocephalus	Known to occur	Common
Birds	Brewer's Sparrow	Spizella breweri	Known to occur	Fairly Common
Birds	Broad-tailed Hummingbird	Selasphorus platycercus	Known to occur	Common
Birds	Brown Creeper	Certhia americana	Known to occur	Uncommon
Birds	Brown Thrasher	Toxostoma rufum	Known to occur	Unknown
Birds	Brown-capped Rosy Finch	Leucosticte australis	Known to occur	Uncommon
Birds	Brown-headed Cowbird	Molothrus ater	Known to occur	Common
Birds	Bufflehead	Bucephala albeola	Known to occur	Unknown
Birds	Bullock's Oriole	Icterus bullockii	Known to occur	Fairly Common
Birds	Bushtit	Psaltriparus minimus	Known to occur	Fairly Common
Birds	California Gull	Larus californicus	Known to occur	Unknown
Birds	Calliope Hummingbird	Stellula calliope	Known to occur	Unknown
Birds	Canada Goose	Branta canadensis	Known to occur	Fairly Common
Birds	Canvasback	Aythya valisineria	Known to occur	Unknown
Birds	Canyon Wren	Catherpes mexicanus	Known to occur	Uncommon
Birds	Cassin's Finch	Carpodacus cassinii	Known to occur	Uncommon

Birds	Cassin's Kingbird	Tyrannus vociferans	Known to occur	Fairly Common
Birds	Cattle Egret	Bubulcus ibis	Known to occur	Unknown
Birds	Cedar Waxwing	Bombycilla cedrorum	Known to occur	Rare
Birds	Chimney Swift	Chaetura pelagica	Known to occur	Unknown
Birds	Chipping Sparrow	Spizella passerina	Known to occur	Common
Birds	Cinnamon Teal	Anas cyanoptera	Known to occur	Uncommon
Birds	Clark's Grebe	Aechmophorus clarkii	Known to occur	Unknown
Birds	Clark's Nutcracker	Nucifraga columbiana	Known to occur	Fairly Common
Birds	Clay-colored Sparrow	Spizella pallida	Likely to occur	No Occurrence
Birds	Cliff Swallow	Petrochelidon pyrrhonota	Known to occur	Abundant
Birds	Common Goldeneye	Bucephala clangula	Known to occur	Unknown
Birds	Common Grackle	Quiscalus quiscula	Known to occur	Uncommon
Birds	Common Loon	Gavia immer	Known to occur	Unknown
Birds	Common Merganser	Mergus merganser	Known to occur	Rare
Birds	Common Nighthawk	Chordeiles minor	Known to occur	Common
Birds	Common Poorwill	Phalaenoptilus nuttallii	Known to occur	Uncommon
Birds	Common Raven	Corvus corax	Known to occur	Fairly Common
Birds	Common Redpoll	Carduelis flammea	Likely to occur	No Occurrence
Birds	Common Snipe	Gallinago gallinago	Known to occur	Uncommon
Birds	Common Yellowthroat	Geothlypis trichas	Known to occur	Fairly Common
Birds	Cooper's Hawk	Accipiter cooperii	Known to occur	Uncommon
Birds	Cordilleran Flycatcher	Empidonax occidentalis	Known to occur	Fairly Common
Birds	Dark-eyed Junco	Junco hyemalis	Known to occur	Common
Birds	Double-crested Cormorant	Phalacrocorax auritus	Known to occur	Unknown
Birds	Downy Woodpecker	Picoides pubescens	Known to occur	Uncommon
Birds	Dusky Flycatcher	Empidonax oberholseri	Known to occur	Fairly Common
Birds	Eared Grebe	Podiceps nigricollis	Known to occur	Unknown
Birds	Eastern Kingbird	Tyrannus tyrannus	Known to occur	Rare
Birds	Eastern Phoebe	Sayornis phoebe	Known to occur	Unknown
Birds	European Starling	Sturnus vulgaris	Known to occur	Abundant
Birds	Evening Grosbeak	Coccothraustes vespertinus	Known to occur	Fairly Common
Birds	Ferruginous Hawk	Buteo regalis	Known to occur	Unknown
Birds	Flammulated Owl	Otus flammeolus	Known to occur	Uncommon
Birds	Forster's Tern	Sterna forsteri	Known to occur	Unknown
Birds	Fox Sparrow	Passerella iliaca	Known to occur	Unknown
Birds	Franklin's Gull	Larus pipixcan	Likely to occur	No Occurrence
Birds	Gadwall	Anas strepera	Known to occur	Unknown

Birds	Gambel's Quail	Callipepla gambelii	Known to occur	Uncommon
Birds	Golden Eagle	Aquila chrysaetos	Known to occur	Uncommon
Birds	Golden-crowned Kinglet	Regulus satrapa	Known to occur	Uncommon
Birds	Grace's Warbler	Dendroica graciae	Known to occur	Uncommon
Birds	Gray Catbird	Dumetella carolinensis	Known to occur	Rare
Birds	Gray Flycatcher	Empidonax wrightii	Known to occur	Uncommon
Birds	Gray Jay	Perisoreus canadensis	Known to occur	Uncommon
Birds	Gray Vireo	Vireo vicinior	Known to occur	Rare
Birds	Gray-crowned Rosy Finch	Leucosticte tephrocotis	Known to occur	Unknown
Birds	Great Blue Heron	Ardea herodias	Known to occur	Rare
Birds	Great Egret	Ardea alba	Known to occur	Unknown
Birds	Great Horned Owl	Bubo virginianus	Known to occur	Uncommon
Birds	Greater Roadrunner	Geococcyx californianus	Known to occur	Very Rare
Birds	Greater Sandhill Crane	Grus canadensis tabida	Known to occur	Unknown
Birds	Great-tailed Grackle	Quiscalus mexicanus	Known to occur	Uncommon
Birds	Green Heron	Butorides virescens	Known to occur	Unknown
Birds	Green-tailed Towhee	Pipilo chlorurus	Known to occur	Common
Birds	Green-winged Teal	Anas crecca	Known to occur	Uncommon
Birds	Gunnison Sage Grouse	Centrocercus minimus	Known to occur	Casual/Accidental
Birds	Hairy Woodpecker	Picoides villosus	Known to occur	Uncommon
Birds	Hammond's Flycatcher	Empidonax hammondii	Known to occur	Uncommon
Birds	Harris' Sparrow	Zonotrichia querula	Likely to occur	No Occurrence
Birds	Hermit Thrush	Catharus guttatus	Known to occur	Common
Birds	Hooded Merganser	Lophodytes cucullatus	Known to occur	Unknown
Birds	Horned Grebe	Podiceps auritus	Likely to occur	No Occurrence
Birds	Horned Lark	Eremophila alpestris	Known to occur	Uncommon
Birds	House Finch	Carpodacus mexicanus	Known to occur	Common
Birds	House Sparrow	Passer domesticus	Known to occur	Abundant
Birds	House Wren	Troglodytes aedon	Known to occur	Common
Birds	Indigo Bunting	Passerina cyanea	Known to occur	Rare
Birds	Juniper Titmouse	Baeolophus griseus	Known to occur	Fairly Common
Birds	Killdeer	Charadrius vociferus	Known to occur	Fairly Common
Birds	Lapland Longspur	Calcarius lapponicus	Known to occur	Unknown
Birds	Lark Bunting	Calamospiza melanocorys	Known to occur	Casual/Accidental
Birds	Lark Sparrow	Chondestes grammacus	Known to occur	Fairly Common
Birds	Lazuli Bunting	Passerina amoena	Known to occur	Fairly Common
Birds	Least Sandpiper	Calidris minutilla	Likely to occur	No Occurrence

Birds	Lesser Goldfinch	Carduelis psaltria	Known to occur	Fairly Common
Birds	Lesser Scaup	Aythya affinis	Known to occur	Unknown
Birds	Lewis' Woodpecker	Melanerpes lewis	Known to occur	Uncommon
Birds	Lincoln's Sparrow	Melospiza lincolnii	Known to occur	Fairly Common
Birds	Loggerhead Shrike	Lanius ludovicianus	Known to occur	Unknown
Birds	Long-billed Curlew	Numenius americanus	Known to occur	Unknown
Birds	Long-eared Owl	Asio otus	Known to occur	Uncommon
Birds	MacGillivray's Warbler	Oporornis tolmiei	Known to occur	Uncommon
Birds	Mallard	Anas platyrhynchos	Known to occur	Common
Birds	Marsh Wren	Cistothorus palustris	Known to occur	Unknown
Birds	Mexican Spotted Owl	Strix occidentalis lucida	Known to occur	Unknown
Birds	Mountain Bluebird	Sialia currucoides	Known to occur	Fairly Common
Birds	Mountain Chickadee	Poecile gambeli	Known to occur	Common
Birds	Mourning Dove	Zenaida macroura	Known to occur	Common
Birds	Nashville Warbler	Vermivora ruficapilla	Known to occur	Unknown
Birds	Northern Flicker	Colaptes auratus	Known to occur	Fairly Common
Birds	Northern Goshawk	Accipiter gentilis	Known to occur	Rare
Birds	Northern Harrier	Circus cyaneus	Known to occur	Rare
Birds	Northern Mockingbird	Mimus polyglottos	Known to occur	Rare
Birds	Northern Pintail	Anas acuta	Known to occur	Unknown
Birds	Northern Pygmy-Owl	Glaucidium gnoma	Known to occur	Rare
Birds	Northern Rough-winged Swallow	Stelgidopteryx serripennis	Known to occur	Fairly Common
Birds	Northern Saw-whet Owl	Aegolius acadicus	Known to occur	Uncommon
Birds	Northern Shoveler	Anas clypeata	Known to occur	Unknown
Birds	Northern Waterthrush	Seiurus noveboracensis	Known to occur	Unknown
Birds	Olive-sided Flycatcher	Contopus cooperi	Known to occur	Uncommon
Birds	Orange-crowned Warbler	Vermivora celata	Known to occur	Fairly Common
Birds	Osprey	Pandion haliaetus	Known to occur	Rare
Birds	Pacific Loon	Gavia pacifica	Likely to occur	No Occurrence
Birds	Peregrine Falcon	Falco peregrinus	Known to occur	Rare
Birds	Pied-billed Grebe	Podilymbus podiceps	Known to occur	Uncommon
Birds	Pine Grosbeak	Pinicola enucleator	Known to occur	Uncommon
Birds	Pine Siskin	Carduelis pinus	Known to occur	Common
Birds	Pinyon Jay	Gymnorhinus cyanocephalus	Known to occur	Fairly Common
Birds	Plumbeous Vireo	Vireo plumbeus	Known to occur	Fairly Common
Birds	Prairie Falcon	Falco mexicanus	Known to occur	Uncommon
Birds	Purple Martin	Progne subis	Known to occur	Rare

Birds	Pygmy Nuthatch	Sitta pygmaea	Known to occur	Fairly Common
Birds	Red Crossbill	Loxia curvirostra	Known to occur	Uncommon
Birds	Red-breasted Nuthatch	Sitta canadensis	Known to occur	Fairly Common
Birds	Red-eyed Vireo	Vireo olivaceus	Known to occur	Unknown
Birds	Redhead	Aythya americana	Known to occur	Unknown
Birds	Red-headed Woodpecker	Melanerpes erythrocephalus	Known to occur	Unknown
Birds	Red-naped Sapsucker	Sphyrapicus nuchalis	Known to occur	Uncommon
Birds	Red-necked Phalarope	Phalaropus lobatus	Likely to occur	No Occurrence
Birds	Red-tailed Hawk	Buteo jamaicensis	Known to occur	Fairly Common
Birds	Red-winged Blackbird	Agelaius phoeniceus	Known to occur	Abundant
Birds	Ring-billed Gull	Larus delawarensis	Known to occur	Unknown
Birds	Ring-necked Duck	Aythya collaris	Known to occur	Unknown
Birds	Ring-necked Pheasant	Phasianus colchicus	Known to occur	Uncommon
Birds	Rock Dove	Columba livia	Known to occur	Common
Birds	Rock Wren	Salpinctes obsoletus	Known to occur	Fairly Common
Birds	Rose-breasted Grosbeak	Pheucticus ludovicianus	Known to occur	Unknown
Birds	Rough-legged Hawk	Buteo lagopus	Known to occur	Unknown
Birds	Ruby-crowned Kinglet	Regulus calendula	Known to occur	Common
Birds	Ruddy Duck	Oxyura jamaicensis	Known to occur	Rare
Birds	Rufous Hummingbird	Selasphorus rufus	Known to occur	Unknown
Birds	Sabine's Gull	Xema sabini	Likely to occur	No Occurrence
Birds	Sage Grouse	Centrocercus urophasianus	Known to occur	Unknown
Birds	Sage Sparrow	Amphispiza belli	Known to occur	Casual/Accidental
Birds	Sage Thrasher	Oreoscoptes montanus	Known to occur	Rare
Birds	Sandhill Crane	Grus canadensis	Known to occur	Unknown
Birds	Savannah Sparrow	Passerculus sandwichensis	Known to occur	Unknown
Birds	Say's Phoebe	Sayornis saya	Known to occur	Fairly Common
Birds	Scissor-tailed Flycatcher	Tyrannus forficatus	Known to occur	Unknown
Birds	Semipalmated Sandpiper	Calidris pusilla	Likely to occur	No Occurrence
Birds	Sharp-shinned Hawk	Accipiter striatus	Known to occur	Uncommon
Birds	Short-eared Owl	Asio flammeus	Known to occur	Unknown
Birds	Snowy Egret	Egretta thula	Known to occur	Unknown
Birds	Snowy Plover	Charadrius alexandrinus	Known to occur	Unknown
Birds	Solitary Sandpiper	Tringa solitaria	Known to occur	Unknown
Birds	Song Sparrow	Melospiza melodia	Known to occur	Fairly Common
Birds	Sora	Porzana carolina	Known to occur	Uncommon
Birds	Southwestern Willow Flycatcher	Empidonax traillii extimus	Known to occur	Uncommon

Birds	Spotted Owl	Strix occidentalis	Known to occur	Unknown
Birds	Spotted Sandpiper	Actitis macularia	Known to occur	Fairly Common
Birds	Spotted Towhee	Pipilo maculatus	Known to occur	Common
Birds	Steller's Jay	Cyanocitta stelleri	Known to occur	Fairly Common
Birds	Summer Tanager	Piranga rubra	Likely to occur	No Occurrence
Birds	Swainson's Hawk	Buteo swainsoni	Known to occur	Rare
Birds	Swainson's Thrush	Catharus ustulatus	Known to occur	Rare
Birds	Three-toed Woodpecker	Picoides tridactylus	Known to occur	Uncommon
Birds	Townsend's Solitaire	Myadestes townsendi	Known to occur	Uncommon
Birds	Townsend's Warbler	Dendroica townsendi	Likely to occur	No Occurrence
Birds	Tree Swallow	Tachycineta bicolor	Known to occur	Common
Birds	Tundra Swan	Cygnus columbianus	Likely to occur	No Occurrence
Birds	Turkey Vulture	Cathartes aura	Known to occur	Common
Birds	Vermilion Flycatcher	Pyrocephalus rubinus	Known to occur	Unknown
Birds	Vesper Sparrow	Pooecetes gramineus	Known to occur	Common
Birds	Violet-green Swallow	Tachycineta thalassina	Known to occur	Common
Birds	Virginia Rail	Rallus limicola	Known to occur	Uncommon
Birds	Virginia's Warbler	Vermivora virginiae	Known to occur	Fairly Common
Birds	Warbling Vireo	Vireo gilvus	Known to occur	Common
Birds	Western Bluebird	Sialia mexicana	Known to occur	Fairly Common
Birds	Western Burrowing Owl	Athene cunicularia	Known to occur	Casual/Accidental
Birds	Western Grebe	Aechmophorus occidentalis	Known to occur	Unknown
Birds	Western Kingbird	Tyrannus verticalis	Known to occur	Fairly Common
Birds	Western Meadowlark	Sturnella neglecta	Known to occur	Abundant
Birds	Western Sandpiper	Calidris mauri	Likely to occur	No Occurrence
Birds	Western Screech-Owl	Otus kennicottii	Known to occur	Rare
Birds	Western Scrub Jay	Aphelocoma californica	Known to occur	Fairly Common
Birds	Western Snowy Plover	Charadrius alexandrinus nivosus	Known to occur	Unknown
Birds	Western Tanager	Piranga ludoviciana	Known to occur	Fairly Common
Birds	Western Wood-Pewee	Contopus sordidulus	Known to occur	Fairly Common
Birds	White-breasted Nuthatch	Sitta carolinensis	Known to occur	Fairly Common
Birds	White-crowned Sparrow	Zonotrichia leucophrys	Known to occur	Common
Birds	White-faced Ibis	Plegadis chihi	Known to occur	Unknown
Birds	White-rumped Sandpiper	Calidris fuscicollis	Likely to occur	No Occurrence
Birds	White-tailed Ptarmigan	Lagopus leucurus	Known to occur	Rare
Birds	White-throated Sparrow	Zonotrichia albicollis	Likely to occur	No Occurrence
Birds	White-throated Swift	Aeronautes saxatalis	Known to occur	Fairly Common

Birds	Wild Turkey	Meleagris gallopavo	Known to occur	Uncommon
Birds	Willet	Catoptrophorus semipalmatus	Known to occur	Unknown
Birds	Williamson's Sapsucker	Sphyrapicus thyroideus	Known to occur	Uncommon
Birds	Willow Flycatcher	Empidonax traillii	Known to occur	Uncommon
Birds	Wilson's Phalarope	Phalaropus tricolor	Known to occur	Rare
Birds	Wilson's Warbler	Wilsonia pusilla	Known to occur	Fairly Common
Birds	Wood Duck	Aix sponsa	Known to occur	Unknown
Birds	Yellow Warbler	Dendroica petechia	Known to occur	Fairly Common
Birds	Yellow-billed Cuckoo	Coccyzus americanus	Known to occur	Very Rare
Birds	Yellow-breasted Chat	Icteria virens	Known to occur	Fairly Common
Birds	Yellow-headed Blackbird	Xanthocephalus xanthocephalus	Known to occur	Common
Birds	Yellow-rumped Warbler	Dendroica coronata	Known to occur	Common
Mammals	Abert's Squirrel	Sciurus aberti	Known to occur	Fairly Common
Mammals	American Badger	Taxidea taxus	Known to occur	Uncommon
Mammals	American Beaver	Castor canadensis	Known to occur	Fairly Common
Mammals	American Elk	Cervus elaphus	Known to occur	Abundant
Mammals	American Marten	Martes americana	Known to occur	Uncommon
Mammals	American Pika	Ochotona princeps	Known to occur	Fairly Common
Mammals	Big Brown Bat	Eptesicus fuscus	Known to occur	Abundant
Mammals	Big Free-tailed Bat	Nyctinomops macrotis	Likely to occur	Unknown
Mammals	Bighorn Sheep	Ovis canadensis	Known to occur	Fairly Common
Mammals	Black Bear	Ursus americanus	Known to occur	Common
Mammals	Black-footed Ferret	Mustela nigripes	Known to occur	Extirpated
Mammals	Black-tailed Jackrabbit	Lepus californicus	Known to occur	Uncommon
Mammals	Bobcat	Lynx rufus	Known to occur	Uncommon
Mammals	Botta's Pocket Gopher	Thomomys bottae	Known to occur	Fairly Common
Mammals	Brazilian Free-tailed Bat	Tadarida brasiliensis	Known to occur	Unknown
Mammals	Brush Mouse	Peromyscus boylii	Known to occur	Fairly Common
Mammals	Bushy-tailed Woodrat	Neotoma cinerea	Known to occur	Fairly Common
Mammals	California Myotis	Myotis californicus	Known to occur	Fairly Common
Mammals	Colorado Chipmunk	Tamias quadrivittatus	Known to occur	Fairly Common
Mammals	Common Muskrat	Ondatra zibethicus	Known to occur	Common
Mammals	Common Porcupine	Erethizon dorsatum	Known to occur	Uncommon
Mammals	Coyote	Canis latrans	Known to occur	Common
Mammals	Deer Mouse	Peromyscus maniculatus	Known to occur	Abundant
Mammals	Desert Cottontail	Sylvilagus audubonii	Known to occur	Fairly Common
Mammals	Dwarf Shrew	Sorex nanus	Known to occur	Rare

Mammals	Ermine	Mustela erminea	Known to occur	Uncommon
Mammals	Fringed Myotis	Myotis thysanodes	Known to occur	Rare
Mammals	Golden-mantled Ground Squirrel	Spermophilus lateralis	Known to occur	Fairly Common
Mammals	Gray Fox	Urocyon cinereoargenteus	Known to occur	Uncommon
Mammals	Gunnison's Prairie Dog	Cynomys gunnisoni	Known to occur	Fairly Common
Mammals	Hoary Bat	Lasiurus cinereus	Known to occur	Common
Mammals	House Mouse	Mus musculus	Known to occur	Abundant
Mammals	Least Chipmunk	Tamias minimus	Known to occur	Common
Mammals	Little Brown Myotis	Myotis lucifugus	Known to occur	Abundant
Mammals	Long-eared Myotis	Myotis evotis	Known to occur	Fairly Common
Mammals	Long-legged Myotis	Myotis volans	Known to occur	Common
Mammals	Long-tailed Vole	Microtus longicaudus	Known to occur	Fairly Common
Mammals	Long-tailed Weasel	Mustela frenata	Known to occur	Uncommon
Mammals	Lynx	Lynx canadensis	Known to occur	Very Rare
Mammals	Masked Shrew	Sorex cinereus	Likely to occur	Unknown
Mammals	Mexican Woodrat	Neotoma mexicana	Known to occur	Fairly Common
Mammals	Mink	Mustela vison	Known to occur	Uncommon
Mammals	Montane Vole	Microtus montanus	Known to occur	Common
Mammals	Moose	Alces alces	Known to occur	Rare
Mammals	Mountain Cottontail	Sylvilagus nuttallii	Known to occur	Fairly Common
Mammals	Mountain Lion	Felis concolor	Known to occur	Uncommon
Mammals	Mule Deer	Odocoileus hemionus	Known to occur	Abundant
Mammals	Northern Pocket Gopher	Thomomys talpoides	Known to occur	Common
Mammals	Northern River Otter	Lutra canadensis	Known to occur	Rare
Mammals	Pallid Bat	Antrozous pallidus	Likely to occur	Unknown
Mammals	Pine Squirrel	Tamiasciurus hudsonicus	Likely to occur	Unknown
Mammals	Pinyon Mouse	Peromyscus truei	Known to occur	Common
Mammals	Plains Pocket Mouse	Perognathus flavescens	Known to occur	Unknown
Mammals	Raccoon	Procyon lotor	Known to occur	Fairly Common
Mammals	Red Fox	Vulpes vulpes	Known to occur	Fairly Common
Mammals	Ringtail	Bassariscus astutus	Known to occur	Rare
Mammals	Rock Squirrel	Spermophilus variegatus	Known to occur	Fairly Common
Mammals	Silver-haired Bat	Lasionycteris noctivagans	Known to occur	Common
Mammals	Snowshoe Hare	Lepus americanus	Known to occur	Fairly Common
Mammals	Southern Red-backed Vole	Clethrionomys gapperi	Known to occur	Fairly Common
Mammals	Striped Skunk	Mephitis mephitis	Known to occur	Fairly Common
Mammals	Townsend's Big-eared Bat	Plecotus townsendii	Known to occur	Uncommon

Mammals	Water Shrew	Sorex palustris	Known to occur	Uncommon
Mammals	Western Harvest Mouse	Reithrodontomys megalotis	Known to occur	Fairly Common
Mammals	Western Jumping Mouse	Zapus princeps	Known to occur	Fairly Common
Mammals	Western Pipistrelle	Pipistrellus hesperus	Known to occur	Fairly Common
Mammals	Western Small-footed Myotis	Myotis ciliolabrum	Known to occur	Common
Mammals	White-tailed Jackrabbit	Lepus townsendii	Known to occur	Fairly Common
Mammals	White-throated Woodrat	Neotoma albigula	Known to occur	Fairly Common
Mammals	Wolverine	Gulo gulo	Known to occur	Extirpated
Mammals	Yuma Myotis	Myotis yumanensis	Known to occur	Fairly Common
Reptiles	Blackneck Garter Snake	Thamnophis cyrtopsis	Known to occur	Rare
Reptiles	Collared Lizard	Crotaphytus collaris	Known to occur	Uncommon
Reptiles	Fence Lizard	Sceloporus undulatus	Known to occur	Common
Reptiles	Gopher Snake	Pituophis catenifer	Known to occur	Uncommon
Reptiles	Many-lined Skink	Eumeces multivirgatus	Known to occur	Fairly Common
Reptiles	Midget Faded Rattlesnake	Crotalus viridis concolor	Known to occur	Uncommon
Reptiles	Milk Snake	Lampropeltis triangulum	Known to occur	Rare
Reptiles	Painted Turtle	Chrysemys picta	Known to occur	Fairly Common
Reptiles	Plateau Striped Whiptail	Cnemidophorus velox	Known to occur	Common
Reptiles	Racer	Coluber constrictor	Known to occur	Rare
Reptiles	Sagebrush Lizard	Sceloporus graciosus	Known to occur	Common
Reptiles	Short-horned Lizard	Phrynosoma hernandesi	Known to occur	Fairly Common
Reptiles	Side-blotched Lizard	Uta stansburiana	Likely to occur	Unknown
Reptiles	Smooth Green Snake	Liochlorophis vernalis	Known to occur	Uncommon
Reptiles	Striped Whipsnake	Masticophis taeniatus	Known to occur	Uncommon
Reptiles	Tree Lizard	Urosaurus ornatus	Known to occur	Uncommon
Reptiles	Variable Skink	Eumeces gaigeae	Known to occur	Fairly Common
Reptiles	Western Rattlesnake	Crotalus viridis	Known to occur	Uncommon
Reptiles	Western Terrestrial Garter Snake	Thamnophis elegans	Known to occur	Fairly Common
Reptiles	Western Whiptail	Cnemidophorus tigris	Likely to occur	Unknown

San Juan county

Known or Likely Species Occurrence

Group	Common Name	Scientific Name	Occurence	Abundance
Amphibians	Boreal Toad	Bufo boreas	Likely to occur	Unknown
Amphibians	Bullfrog	Rana catesbeiana	Likely to occur	Unknown
Amphibians	Northern Leopard Frog	Rana pipiens	Known to occur	Unknown
Amphibians	Tiger Salamander	Ambystoma tigrinum	Known to occur	Locally Common
Amphibians	Western Chorus Frog	Pseudacris triseriata	Known to occur	Common
Amphibians	Woodhouse's Toad	Bufo woodhousii	Likely to occur	Unknown
Birds	American Coot	Fulica americana	Known to occur	Uncommon
Birds	American Crow	Corvus brachyrhynchos	Known to occur	Uncommon
Birds	American Dipper	Cinclus mexicanus	Known to occur	Uncommon
Birds	American Goldfinch	Carduelis tristis	Known to occur	Unknown
Birds	American Kestrel	Falco sparverius	Known to occur	Rare
Birds	American Peregrine Falcon	Falco peregrinus anatum	Known to occur	Unknown
Birds	American Pipit	Anthus rubescens	Known to occur	Fairly Common
Birds	American Robin	Turdus migratorius	Known to occur	Common
Birds	American Tree Sparrow	Spizella arborea	Known to occur	Unknown
Birds	Baird's Sandpiper	Calidris bairdii	Likely to occur	No Occurrence
Birds	Band-tailed Pigeon	Columba fasciata	Known to occur	Unknown
Birds	Belted Kingfisher	Ceryle alcyon	Known to occur	Uncommon
Birds	Black Rosy Finch	Leucosticte atrata	Known to occur	Unknown
Birds	Black Swift	Cypseloides niger	Known to occur	Uncommon
Birds	Black-billed Magpie	Pica pica	Known to occur	Fairly Common
Birds	Black-capped Chickadee	Poecile atricapillus	Known to occur	Fairly Common
Birds	Black-crowned Night-Heron	Nycticorax nycticorax	Known to occur	Unknown
Birds	Black-headed Grosbeak	Pheucticus melanocephalus	Known to occur	Fairly Common
Birds	Blue Grouse	Dendragapus obscurus	Known to occur	Uncommon
Birds	Bonaparte's Gull	Larus philadelphia	Known to occur	Unknown
Birds	Boreal Owl	Aegolius funereus	Known to occur	Rare
Birds	Brewer's Blackbird	Euphagus cyanocephalus	Known to occur	Fairly Common
Birds	Brewer's Sparrow	Spizella breweri	Known to occur	Uncommon
Birds	Broad-tailed Hummingbird	Selasphorus platycercus	Known to occur	Common
Birds	Brown Creeper	Certhia americana	Known to occur	Uncommon
Birds	Brown-capped Rosy Finch	Leucosticte australis	Known to occur	Fairly Common
Birds	Brown-headed Cowbird	Molothrus ater	Known to occur	Common

Birds	Bullock's Oriole	Icterus bullockii	Known to occur	Unknown
Birds	Calliope Hummingbird	Stellula calliope	Likely to occur	No Occurrence
Birds	Canada Goose	Branta canadensis	Known to occur	Unknown
Birds	Cassin's Finch	Carpodacus cassinii	Known to occur	Fairly Common
Birds	Cedar Waxwing	Bombycilla cedrorum	Known to occur	Unknown
Birds	Chipping Sparrow	Spizella passerina	Known to occur	Common
Birds	Clark's Nutcracker	Nucifraga columbiana	Known to occur	Fairly Common
Birds	Clay-colored Sparrow	Spizella pallida	Likely to occur	No Occurrence
Birds	Cliff Swallow	Petrochelidon pyrrhonota	Known to occur	Abundant
Birds	Common Goldeneye	Bucephala clangula	Known to occur	Unknown
Birds	Common Loon	Gavia immer	Known to occur	Unknown
Birds	Common Merganser	Mergus merganser	Known to occur	Unknown
Birds	Common Nighthawk	Chordeiles minor	Known to occur	Unknown
Birds	Common Raven	Corvus corax	Known to occur	Fairly Common
Birds	Common Redpoll	Carduelis flammea	Likely to occur	No Occurrence
Birds	Common Snipe	Gallinago gallinago	Known to occur	Unknown
Birds	Cooper's Hawk	Accipiter cooperii	Known to occur	Rare
Birds	Cordilleran Flycatcher	Empidonax occidentalis	Known to occur	Fairly Common
Birds	Dark-eyed Junco	Junco hyemalis	Known to occur	Common
Birds	Downy Woodpecker	Picoides pubescens	Known to occur	Uncommon
Birds	Dusky Flycatcher	Empidonax oberholseri	Known to occur	Fairly Common
Birds	Eared Grebe	Podiceps nigricollis	Known to occur	Unknown
Birds	European Starling	Sturnus vulgaris	Known to occur	Uncommon
Birds	Evening Grosbeak	Coccothraustes vespertinus	Known to occur	Fairly Common
Birds	Flammulated Owl	Otus flammeolus	Known to occur	Unknown
Birds	Fox Sparrow	Passerella iliaca	Known to occur	Uncommon
Birds	Franklin's Gull	Larus pipixcan	Likely to occur	No Occurrence
Birds	Golden Eagle	Aquila chrysaetos	Known to occur	Rare
Birds	Golden-crowned Kinglet	Regulus satrapa	Known to occur	Uncommon
Birds	Gray Catbird	Dumetella carolinensis	Known to occur	Unknown
Birds	Gray Jay	Perisoreus canadensis	Known to occur	Uncommon
Birds	Gray-crowned Rosy Finch	Leucosticte tephrocotis	Likely to occur	No Occurrence
Birds	Great Blue Heron	Ardea herodias	Known to occur	Unknown
Birds	Great Horned Owl	Bubo virginianus	Known to occur	Uncommon
Birds	Greater Scaup	Aythya marila	Known to occur	Unknown
Birds	Green-winged Teal	Anas crecca	Known to occur	Uncommon
Birds	Hairy Woodpecker	Picoides villosus	Known to occur	Uncommon

Birds	Hammond's Flycatcher	Empidonax hammondii	Known to occur	Uncommon
Birds	Harris' Sparrow	Zonotrichia querula	Likely to occur	No Occurrence
Birds	Hermit Thrush	Catharus guttatus	Known to occur	Common
Birds	Horned Grebe	Podiceps auritus	Likely to occur	No Occurrence
Birds	Horned Lark	Eremophila alpestris	Known to occur	Uncommon
Birds	House Finch	Carpodacus mexicanus	Known to occur	Uncommon
Birds	House Sparrow	Passer domesticus	Known to occur	Uncommon
Birds	House Wren	Troglodytes aedon	Known to occur	Common
Birds	Juniper Titmouse	Baeolophus griseus	Known to occur	Unknown
Birds	Killdeer	Charadrius vociferus	Known to occur	Fairly Common
Birds	Lazuli Bunting	Passerina amoena	Known to occur	Rare
Birds	Least Sandpiper	Calidris minutilla	Likely to occur	No Occurrence
Birds	Lesser Goldfinch	Carduelis psaltria	Known to occur	Unknown
Birds	Lincoln's Sparrow	Melospiza lincolnii	Known to occur	Common
Birds	Loggerhead Shrike	Lanius ludovicianus	Known to occur	Unknown
Birds	Long-eared Owl	Asio otus	Known to occur	Unknown
Birds	MacGillivray's Warbler	Oporornis tolmiei	Known to occur	Uncommon
Birds	Mallard	Anas platyrhynchos	Known to occur	Common
Birds	Marsh Wren	Cistothorus palustris	Known to occur	Unknown
Birds	Mountain Bluebird	Sialia currucoides	Known to occur	Fairly Common
Birds	Mountain Chickadee	Poecile gambeli	Known to occur	Common
Birds	Mourning Dove	Zenaida macroura	Known to occur	Uncommon
Birds	Northern Flicker	Colaptes auratus	Known to occur	Fairly Common
Birds	Northern Goshawk	Accipiter gentilis	Known to occur	Rare
Birds	Northern Harrier	Circus cyaneus	Known to occur	Unknown
Birds	Northern Pintail	Anas acuta	Known to occur	Unknown
Birds	Northern Rough-winged Swallow	Stelgidopteryx serripennis	Known to occur	Rare
Birds	Northern Saw-whet Owl	Aegolius acadicus	Known to occur	Unknown
Birds	Olive-sided Flycatcher	Contopus cooperi	Known to occur	Uncommon
Birds	Orange-crowned Warbler	Vermivora celata	Known to occur	Fairly Common
Birds	Pacific Loon	Gavia pacifica	Likely to occur	No Occurrence
Birds	Peregrine Falcon	Falco peregrinus	Known to occur	Unknown
Birds	Pied-billed Grebe	Podilymbus podiceps	Known to occur	Unknown
Birds	Pine Grosbeak	Pinicola enucleator	Known to occur	Fairly Common
Birds	Pine Siskin	Carduelis pinus	Known to occur	Common
Birds	Pinyon Jay	Gymnorhinus cyanocephalus	Known to occur	Unknown
Birds	Plumbeous Vireo	Vireo plumbeus	Known to occur	Rare

Birds	Prairie Falcon	Falco mexicanus	Known to occur	Uncommon
Birds	Pygmy Nuthatch	Sitta pygmaea	Known to occur	Uncommon
Birds	Red Crossbill	Loxia curvirostra	Known to occur	Uncommon
Birds	Red-breasted Nuthatch	Sitta canadensis	Known to occur	Uncommon
Birds	Red-naped Sapsucker	Sphyrapicus nuchalis	Known to occur	Uncommon
Birds	Red-necked Phalarope	Phalaropus lobatus	Likely to occur	No Occurrence
Birds	Red-tailed Hawk	Buteo jamaicensis	Known to occur	Uncommon
Birds	Red-winged Blackbird	Agelaius phoeniceus	Known to occur	Common
Birds	Ring-billed Gull	Larus delawarensis	Known to occur	Unknown
Birds	Ring-necked Duck	Aythya collaris	Known to occur	Rare
Birds	Rock Dove	Columba livia	Known to occur	Unknown
Birds	Rock Wren	Salpinctes obsoletus	Known to occur	Rare
Birds	Rough-legged Hawk	Buteo lagopus	Known to occur	Unknown
Birds	Ruby-crowned Kinglet	Regulus calendula	Known to occur	Common
Birds	Ruddy Duck	Oxyura jamaicensis	Known to occur	Unknown
Birds	Rufous Hummingbird	Selasphorus rufus	Known to occur	Unknown
Birds	Sabine's Gull	Xema sabini	Likely to occur	No Occurrence
Birds	Sage Thrasher	Oreoscoptes montanus	Known to occur	Unknown
Birds	Semipalmated Sandpiper	Calidris pusilla	Likely to occur	No Occurrence
Birds	Sharp-shinned Hawk	Accipiter striatus	Known to occur	Uncommon
Birds	Solitary Sandpiper	Tringa solitaria	Likely to occur	No Occurrence
Birds	Song Sparrow	Melospiza melodia	Known to occur	Fairly Common
Birds	Sora	Porzana carolina	Known to occur	Unknown
Birds	Southwestern Willow Flycatcher	Empidonax traillii extimus	Known to occur	Uncommon
Birds	Spotted Sandpiper	Actitis macularia	Known to occur	Uncommon
Birds	Steller's Jay	Cyanocitta stelleri	Known to occur	Fairly Common
Birds	Swainson's Thrush	Catharus ustulatus	Known to occur	Rare
Birds	Three-toed Woodpecker	Picoides tridactylus	Known to occur	Uncommon
Birds	Townsend's Solitaire	Myadestes townsendi	Known to occur	Uncommon
Birds	Tree Swallow	Tachycineta bicolor	Known to occur	Common
Birds	Tundra Swan	Cygnus columbianus	Likely to occur	No Occurrence
Birds	Turkey Vulture	Cathartes aura	Known to occur	Rare
Birds	Varied Thrush	Ixoreus naevius	Likely to occur	No Occurrence
Birds	Vesper Sparrow	Pooecetes gramineus	Known to occur	Unknown
Birds	Violet-green Swallow	Tachycineta thalassina	Known to occur	Common
Birds	Virginia's Warbler	Vermivora virginiae	Known to occur	Uncommon
Birds	Warbling Vireo	Vireo gilvus	Known to occur	Common

Birds	Western Bluebird	Sialia mexicana	Known to occur	Rare
Birds	Western Meadowlark	Sturnella neglecta	Known to occur	Unknown
Birds	Western Sandpiper	Calidris mauri	Likely to occur	No Occurrence
Birds	Western Tanager	Piranga ludoviciana	Known to occur	Uncommon
Birds	Western Wood-Pewee	Contopus sordidulus	Known to occur	Fairly Common
Birds	White-breasted Nuthatch	Sitta carolinensis	Known to occur	Uncommon
Birds	White-crowned Sparrow	Zonotrichia leucophrys	Known to occur	Common
Birds	White-faced Ibis	Plegadis chihi	Known to occur	Unknown
Birds	White-tailed Ptarmigan	Lagopus leucurus	Known to occur	Uncommon
Birds	White-throated Sparrow	Zonotrichia albicollis	Likely to occur	No Occurrence
Birds	White-throated Swift	Aeronautes saxatalis	Known to occur	Common
Birds	White-winged Crossbill	Loxia leucoptera	Known to occur	Unknown
Birds	Williamson's Sapsucker	Sphyrapicus thyroideus	Known to occur	Uncommon
Birds	Willow Flycatcher	Empidonax traillii	Known to occur	Uncommon
Birds	Wilson's Warbler	Wilsonia pusilla	Known to occur	Common
Birds	Wood Thrush	Hylocichla mustelina	Likely to occur	No Occurrence
Birds	Yellow Warbler	Dendroica petechia	Known to occur	Unknown
Birds	Yellow-rumped Warbler	Dendroica coronata	Known to occur	Common
Mammals	American Badger	Taxidea taxus	Known to occur	Uncommon
Mammals	American Beaver	Castor canadensis	Known to occur	Fairly Common
Mammals	American Elk	Cervus elaphus	Known to occur	Abundant
Mammals	American Marten	Martes americana	Known to occur	Uncommon
Mammals	American Pika	Ochotona princeps	Known to occur	Common
Mammals	Big Brown Bat	Eptesicus fuscus	Likely to occur	Unknown
Mammals	Bighorn Sheep	Ovis canadensis	Known to occur	Fairly Common
Mammals	Black Bear	Ursus americanus	Known to occur	Common
Mammals	Bobcat	Lynx rufus	Known to occur	Uncommon
Mammals	Bushy-tailed Woodrat	Neotoma cinerea	Known to occur	Fairly Common
Mammals	Colorado Chipmunk	Tamias quadrivittatus	Known to occur	Fairly Common
Mammals	Common Muskrat	Ondatra zibethicus	Known to occur	Common
Mammals	Common Porcupine	Erethizon dorsatum	Known to occur	Uncommon
Mammals	Coyote	Canis latrans	Known to occur	Fairly Common
Mammals	Deer Mouse	Peromyscus maniculatus	Known to occur	Abundant
Mammals	Ermine	Mustela erminea	Known to occur	Uncommon
Mammals	Golden-mantled Ground Squirrel	Spermophilus lateralis	Known to occur	Fairly Common
Mammals	Hoary Bat	Lasiurus cinereus	Likely to occur	Unknown
Mammals	House Mouse	Mus musculus	Known to occur	Abundant

Mammals	Little Brown Myotis	Myotis lucifugus	Likely to occur	Unknown
Mammals	Long-eared Myotis	Myotis evotis	Known to occur	Fairly Common
Mammals	Long-legged Myotis	Myotis volans	Known to occur	Common
Mammals	Long-tailed Vole	Microtus longicaudus	Known to occur	Fairly Common
Mammals	Long-tailed Weasel	Mustela frenata	Known to occur	Uncommon
Mammals	Lynx	Lynx canadensis	Known to occur	Very Rare
Mammals	Masked Shrew	Sorex cinereus	Known to occur	Fairly Common
Mammals	Mink	Mustela vison	Known to occur	Uncommon
Mammals	Montane Shrew	Sorex monticolus	Known to occur	Common
Mammals	Montane Vole	Microtus montanus	Known to occur	Common
Mammals	Moose	Alces alces	Known to occur	Uncommon
Mammals	Mountain Cottontail	Sylvilagus nuttallii	Known to occur	Fairly Common
Mammals	Mountain Goat	Oreamnos americanus	Known to occur	Fairly Common
Mammals	Mountain Lion	Felis concolor	Known to occur	Uncommon
Mammals	Mule Deer	Odocoileus hemionus	Known to occur	Abundant
Mammals	Northern Pocket Gopher	Thomomys talpoides	Known to occur	Common
Mammals	Pine Squirrel	Tamiasciurus hudsonicus	Known to occur	Fairly Common
Mammals	Raccoon	Procyon lotor	Likely to occur	Unknown
Mammals	Red Fox	Vulpes vulpes	Known to occur	Uncommon
Mammals	Silver-haired Bat	Lasionycteris noctivagans	Likely to occur	Unknown
Mammals	Snowshoe Hare	Lepus americanus	Known to occur	Fairly Common
Mammals	Southern Red-backed Vole	Clethrionomys gapperi	Known to occur	Fairly Common
Mammals	Striped Skunk	Mephitis mephitis	Known to occur	Fairly Common
Mammals	Water Shrew	Sorex palustris	Likely to occur	Unknown
Mammals	Western Jumping Mouse	Zapus princeps	Known to occur	Fairly Common
Mammals	Western Small-footed Myotis	Myotis ciliolabrum	Known to occur	Fairly Common
Mammals	White-tailed Jackrabbit	Lepus townsendii	Known to occur	Fairly Common
Mammals	Wolverine	Gulo gulo	Known to occur	Extirpated
Mammals	Yellow-bellied Marmot	Marmota flaviventris	Known to occur	Common
Reptiles	Fence Lizard	Sceloporus undulatus	Likely to occur	Unknown
Reptiles	Gopher Snake	Pituophis catenifer	Likely to occur	Unknown
Reptiles	Milk Snake	Lampropeltis triangulum	Likely to occur	Unknown
Reptiles	Painted Turtle	Chrysemys picta	Likely to occur	Unknown
Reptiles	Short-horned Lizard	Phrynosoma hernandesi	Likely to occur	Unknown
Reptiles	Smooth Green Snake	Liochlorophis vernalis	Likely to occur	Unknown
Reptiles	Western Terrestrial Garter Snake	Thamnophis elegans	Known to occur	Locally Common

Appendix 7

Calculating hardness-specific benchmarks and HQs in surface water samples

Appendix 7.1.a: Calculating hardness-specific benchmarks and HQs for aluminum in surface water samples collected during the pre-runoff period
Baseline Ecological Risk Assessment
Upper Animas River Mining District

	PRE-RUNOFF PERIOD																								
Sampling Date	2/10							3/10							4/10							3/11						
Metal-fraction	Al-total		hardness	benchm.	benchm.	criterion	equation	Al-total		hardness	benchm.	benchm.	criterion	equation	Al-total		hardness	benchm.	benchm.	criterion	equation	Al-total		hardness	benchm.	benchm.	criterion	equation
Units	µg/L	pH	(mg/L)	criterion	equation	HQ	HQ	µg/L	pH	(mg/L)	criterion	equation	HQ	HQ	µg/L	pH	(mg/L)	criterion	equation	HQ	HQ	µg/L	pH	(mg/L)	criterion	equation	HQ	HQ
M34	5950	4.97	309	87	--	68	--	5360	5.02	308	87	--	62	--	2160	6.22	150	87	851	25	2.5	4830	5.12	247	87	--	56	--
CC48	8610	3.50	571	87	--	99	--	8100	3.42	541	87	--	93	--	5020	3.93	301	87	--	58	--	7540	3.54	493	87	--	87	--
A56 ("upstream")	NS							NS							NS							NS						
A68	269	6.74	202	87	1279	3.1	0.2	177	6.82	179	87	1084	2.0	0.2	368	6.85	148	87	835	4.2	0.4	275	7.18	172	--	1026	--	0.3
A72	4440	5.07	352	87	--	51	--	4090	5.04	337	87	--	47	--	1980	6.09	177	87	1067	23	1.9	3310	5.30	273	87	--	38	--
A73	NS							NS							NS							NS						
A75D	NS							NS							NS							NS						
Bakers Bridge	NS							NS							NS							NS						

NS = not sampled
criterion HQ = hazard quotient calculated using the chronic benchmark criterion; equation HQ = hazard quotient calculated using the chronic benchmark ec
shading shows HQ > 1.0 or highest HQ
[a] surface water pH was not measured in April 2014. To support the calculations, it was assumed that surface water pH fell below 7.0 based on pH values from previous years
the chronic surface water benchmarks for aluminum were calculated using the following equation: $e^{(1.3695*\ln \text{hardness})-0.1158}$
The procedures for calculating the chronic HQs are as follows:
- use the chronic hardness-dependent equation if (a) pH $\geq$ 7.0 and (b) hardness $\leq$ 220 mg/L
- use the more stringent of the chronic hardness-dependent equation or the 87 ug/L chronic total recoverable Al criterion if (a) pH $\leq$ 7.0 and (b) hardness $\leq$ 220 mg/L
- use the 87 ug/L chronic total recoverable Al criterion if hardness > 220 mg/L

Appendix 7.1.b: Calculating hardness-specific benchmarks and HQs for aluminum in surface water samples collected during the runoff period
Baseline Ecological Risk Assessment
Upper Animas River Mining District

| | RUNOFF PERIOD | | |

Appendix 7.1.c: Calculating hardness-specific benchmarks and HQs for aluminum in surface water samples collected during the post-runoff period
Baseline Ecological Risk Assessment
Upper Animas River Mining District

| | POST-RUNOFF PERIOD | | |

Appendix 7.2: Calculating hardness-specific benchmarks and HQs for dissolved cadmium in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

	PRE-RUNOFF PERIOD																			
Sampling Date	**2/10**				**3/10**				**4/10**				**3/11**				**4/14**			
Metal-fraction	**Cd-diss**	**hardness**	**benchm.**		**Cd-diss**	**hardness**	**benchm.**		**Cd-diss**	**hardness**	**benchm.**		**Cd-diss**	**hardness**	**benchm.**		**Cd-diss**	**hardness**	**benchm.**	
Units	**ug/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**
M34	1.10	309	0.99	1.1	1.00	308	0.99	1.0	2.00	150	0.58	3.5	1.10	247	0.84	1.3				
CC48	5.50	571	1.57	3.5	5.30	541	1.51	3.5	4.90	301	0.97	5.0	5.30	493	1.41	3.8				
A56 ("upstream")																	0.58	131	0.52	1.1
A60																				
A61																				
A64																				
A65																				
A66																				
A68	1.80	202	0.72	2.5	1.60	179	0.66	2.4	4.10	148	0.57	7.2	2.70	172	0.64	4.2	3.00	151	0.58	5.2
A72	2.60	352	1.09	2.4	2.70	337	1.06	2.6	2.90	177	0.65	4.4	2.60	273	0.90	2.9				
A73																	1.79	182	0.67	2.7
A73B																				
A75D																	1.02	133	0.53	1.9
A75B																				
Bakers Bridge																	0.53	127	0.51	1.0

	RUNOFF PERIOD																							
Sampling Date	**5/09**				**6/09**				**6/10**				**6/11**				**5/12**				**5/13**				**5/14**			
Metal-fraction	**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**	
Units	**ug/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**
M34	0.30	52	0.26	1.2	0.20	72	0.33	0.6	0.10	49	0.25	0.4	0.20	53	0.26	0.8	0.28	77	0.35	0.8	0.25	79	0.35	0.7	0.56	92	0.40	1.4
CC48	2.10	81	0.36	5.8	3.40	189	0.68	5.0	2.20	88	0.38	5.7	2.00	76	0.34	5.8	2.91	177	0.65	4.5	3.20	129	0.51	6.3	3.83	126	0.50	7.6
A56 ("upstream")																					0.70	65	0.31	2.3	0.97	79	0.35	2.7
A60																					0.70	74	0.34	2.1	1.01	78	0.35	2.9
A61																					1.00	78	0.35	2.9	1.51	80	0.36	4.2
A64																					0.90	63	0.30	3.0	1.35	76	0.34	3.9
A65																					0.90	65	0.31	2.9	1.31	80	0.36	3.7
A66																					0.90	64	0.30	3.0	1.40	79	0.35	4.0
A68	0.90	49	0.25	3.6	0.80	65	0.31	2.6	0.90	50	0.25	3.6	0.90	53	0.26	3.4	0.87	71	0.33	2.7	1.00	66	0.31	3.2	1.33	87	0.38	3.5
A72	0.60	45	0.23	2.6	0.80	78	0.35	2.3	0.70	54	0.27	2.6	0.80	55	0.27	3.0	0.89	86	0.38	2.4	1.00	82	0.36	2.7	1.40	103	0.43	3.2
A73																					0.70	71	0.33	2.1	1.09	88	0.38	2.8
A73B																					0.30	37	0.20	1.5	0.56	54	0.27	2.1
A75D																					0.50	60	0.29	1.7	0.71	76	0.34	2.1
A75B																					0.50	61	0.29	1.7	0.69	70	0.32	2.1
Bakers Bridge																					0.30	58	0.28	1.1	0.42	73	0.33	1.3

	POST-RUNOFF PERIOD																																			
Sampling Date	**7/09**				**8/09**				**9/09**				**11/09**				**7/10**				**9/10**				**11/10**				**7/11**				**8/11**				**9/11**			
Metal-fraction	**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**	
Units	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**
M34	0.30	91	0.39	0.8	0.70	186	0.67	1.0	0.70	156	0.59	1.2	1.00	238	0.81	1.2	0.40	114	0.47	0.9	0.70	199	0.71	1.0	0.80	219	0.76	1.1	0.20	65	0.31	0.7	0.50	144	0.56	0.9	0.70	188	0.68	1.0
CC48	4.60	293	0.95	4.9	6.60	467	1.34	4.9	6.60	470	1.35	4.9	6.40	495	1.40	4.6	4.40	345	1.07	4.1	5.70	509	1.43	4.0	6.70	517	1.45	4.6	3.10	191	0.69	4.5	5.60	398	1.19	4.7	5.90	474	1.36	4.3
CC49																																									
A56 ("upstream")																																								
A60																																								
A61																																								
A64																																								
A65																																								
A66																																								
A68	0.80	85	0.37	2.1	1.00	135	0.53	1.9	1.20	141	0.55	2.2	1.70	167	0.62	2.7	0.80	97	0.41	1.9	1.30	144	0.56	2.3	1.40	154	0.58	2.4	0.80	66	0.31	2.6	0.90	111	0.46	2.0	1.10	140	0.54	2.0
A69A																																								
A70B																																								
A71B																																								
A72	0.90	109	0.45	2.0	1.80	211	0.74	2.4	1.80	199	0.71	2.5	2.80	296	0.95	2.9	1.10	136	0.53	2.1	1.80	245	0.83	2.2	2.10	232	0.80	2.6	0.70	75	0.34	2.1	1.30	161	0.60	2.2	1.70	210	0.74	2.3
A73																																								
A73B																																								
A75D																																								
A75B																																								
Bakers Bridge																																								

	POST-RUNOFF PERIOD															
Sampling Date	**10/11**				**10/12**				**9/14**			
Metal-fraction	**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**		**Cd-diss**	**hardness**	**benchm**	
Units	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**
M34	0.60	155	0.59	1.0	0.90	220	0.76	1.2	0.39	118	0.48	0.8
CC48	7.00	435	1.27	5.5	5.10	515	1.45	3.5	5.08	67	0.31	16.3
CC49					5.60	545	1.51	3.7				
A56 ("upstream")					0.60	168	0.62	1.0	0.86	114	0.47	1.9
A60									0.99	111	0.46	2.2
A61									0.93	111	0.46	2.0
A64									1.01	113	0.46	2.2
A65									1.05	117	0.48	2.2
A66									1.13	120	0.48	2.3
A68	1.10	140	0.54	2.0	1.20	174	0.64	1.9	1.08	114	0.47	2.3
A69A					2.70	297	0.96	2.8				
A70B					2.70	295	0.95	2.8				
A71B					1.90	263	0.87	2.2				
A72	1.60	183	0.67	2.4	1.80	261	0.87	2.1	1.19	144	0.56	2.1
A73					1.70	251	0.84	2.0	1.01	142	0.55	1.8
A73B					1.40	217	0.76	1.9	0.57	83	0.37	1.6
A75D					1.10	191	0.69	1.6	0.54	92	0.40	1.4
A75B					1.10	193	0.69	1.6	0.52	85	0.37	1.4
Bakers Bridge					0.70	183	0.67	1.1	0.35	99	0.42	0.8

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for cadmium were calculated using the following equation: ((1.101672-ln hardness)*0.041838)*$e^{(0.7988*\ln \text{hardness})-4.4451}$

Appendix 7.3: Calculating hardness-specific benchmarks and HQs for dissolved chromium in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ
Units	ug/L				µg/L				µg/L				µg/L				µg/L			
M34	1.0	309	187	0.01	1.0	308	186	0.01	1.0	150	103	0.01	2.5	247	155	0.02				
CC48	1.0	571	309	0.00	1.0	541	295	0.00	1.0	301	183	0.01	2.5	493	274	0.01				
A56 ("upstream")																	0.5	131	92	0.01
A60																				
A61																				
A64																				
A65																				
A66																				
A68	1.0	202	132	0.01	1.0	179	119	0.01	1.0	148	102	0.01	2.5	172	116	0.02	0.5	151	104	<0.01
A72	1.0	352	208	0.00	1.0	337	200	0.00	1.0	177	118	0.01	2.5	273	169	0.01				
A73																	0.5	182	121	<0.01
A73B																				
A75D																	0.5	133	94	0.01
A75B																				
Bakers Bridge																	0.5	127	90	0.01

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ
Units	ug/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L			
M34	1.0	52	43	0.02	1.0	72	57	0.02	2.5	49	41	0.06	2.5	53	44	0.06	0.5	77	60	0.01	2.5	79	61	0.04	0.5	92	69	0.01
CC48	1.0	81	62	0.02	1.0	189	125	0.01	2.5	88	67	0.04	2.5	76	59	0.04	0.5	177	118	0.00	5.0	129	91	0.05	0.5	126	90	0.01
A56 ("upstream")																					0.5	65	52	0.01	0.5	79	61	0.01
A60																					0.5	74	58	0.01	0.5	78	60	0.01
A61																					0.5	78	60	0.01	0.5	80	62	0.01
A64																					0.5	63	51	0.01	0.5	76	59	0.01
A65																					0.5	65	52	0.01	0.5	80	62	0.01
A66																					0.5	64	51	0.01	0.5	79	61	0.01
A68	1.0	49	41	0.02	1.0	65	52	0.02	2.5	50	42	0.06	2.5	53	44	0.06	0.5	71	56	0.01	0.5	66	53	0.01	0.5	87	66	0.01
A72	1.0	45	39	0.03	1.0	78	60	0.02	2.5	54	45	0.06	2.5	55	45	0.06	0.5	86	66	0.01	2.5	82	63	0.04	0.5	103	76	0.01
A73																					2.5	71	56	0.04	0.5	88	67	0.01
A73B																					0.5	37	33	0.02	0.5	54	45	0.01
A75D																					0.5	60	49	0.01	0.5	76	59	0.01
A75B																					0.5	61	49	0.01	0.5	70	55	0.01
Bakers Bridge																					0.5	58	47	0.01	0.5	73	57	0.01

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10				9/10				11/10				7/11				8/11				9/11				10/11				10/12				9/14			
Metal-fraction	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ	Cr-diss	hardness	benchm.	HQ
Units	µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L			
M34	1.0	91	69	0.01	1.0	186	123	0.01	1.0	156	107	0.01	1.0	238	151	0.01	2.5	114	83	0.03	0.3	199	130	<0.01	0.3	219	141	<0.01	2.5	65	52	0.05	2.5	144	100	0.03	2.5	188	124	0.02	2.5	155	106	0.02	2.5	220	141	0.02	0.5	118	85	0.01
CC48	1.0	293	179	0.01	1.0	467	262	0.00	1.0	470	263	<0.01	1.0	495	275	0.00	2.5	345	204	0.01	0.3	509	281	<0.01	0.3	517	285	<0.01	2.5	191	126	0.02	2.5	398	230	0.01	2.5	474	265	0.01	2.5	435	247	0.01	2.5	515	284	0.01	2.5	67	53	0.05
CC49																																													2.5	545	297	0.01				
A56 ("upstream")																																												0.5	168	113	<0.01	0.5	114	83	0.01
A60																																																0.5	111	81	0.01
A61																																																0.5	111	81	0.01
A64																																																0.5	113	82	0.01
A65																																																0.5	117	84	0.01
A66																																																0.5	120	86	0.01
A68	1.0	85	65	0.02	1.0	135	95	0.01	1.0	141	98	0.01	1.0	167	113	0.01	2.5	97	72	0.03	0.3	144	100	<0.01	0.3	154	106	<0.01	2.5	66	53	0.05	2.5	111	81	0.03	2.5	140	98	0.03	2.5	138	96	0.03	0.5	174	117	<0.01	0.5	114	83	0.01
A69A																																																0.5	297	181	<0.01				
A70B																																																0.5	295	180	<0.01				
A71B																																																0.5	263	164	<0.01				
A72	1.0	109	80	0.01	1.0	211	137	0.01	1.0	199	130	0.01	1.0	296	180	0.01	2.5	136	95	0.03	0.3	245	154	<0.01	0.3	232	148	<0.01	2.5	75	59	0.04	2.5	161	109	0.02	2.5	210	136	0.02	2.5	183	122	0.02	2.3	261	163	0.01	0.5	144	100	0.01
A73																																																0.5	251	157	<0.01	0.5	142	99	0.01
A73B																																																0.5	217	140	<0.01	0.5	83	64	0.01
A75D																																																0.5	191	126	<0.01	0.5	92	69	0.01
A75B																																																0.5	193	127	<0.01	0.5	85	65	0.01
Bakers Bridge																																																0.5	183	122	<0.01	0.5	99	74	0.01

the hardness-specific chronic surface water benchmarks for chromium were calculated using the following equation: $e^{(0.819*\ln \text{hardness})+0.534}$

Appendix 7.4: Calculating hardness-specific benchmarks and HQs for dissolved copper in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

	PRE-RUNOFF PERIOD																			
Sampling Date	**2/10**				**3/10**				**4/10**				**3/11**				**4/14**			
Metal-fraction	**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**	
Units	**ug/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**
M34	10.3	309	23	0.4	11.2	308	23	0.5	12.3	150	13	1.0	16.2	247	19	0.8				
CC48	119	571	40	3.0	109	541	38	2.9	110	301	23	4.8	89.1	493	35	2.5				
A56 ("upstream")																	2.07	131	11	0.2
A60																				
A61																				
A64																				
A65																				
A66																				
A68	1.5	202	16	0.1	1.5	179	15	0.1	8.3	148	13	0.7	5.0	172	14	0.4	6.0	151	13	0.5
A72	35.9	352	26	1.4	35.2	337	25	1.4	19.2	177	15	1.3	25.2	273	21	1.2				
A73																	2.48	182	15	0.2
A73B																				
A75D																	2.14	133	11	0.2
A75B																				
Bakers Bridge																	2.49	127	11	0.2

	RUNOFF PERIOD																							
Sampling Date	**5/09**				**6/09**				**6/10**				**6/11**				**5/12**				**5/13**				**5/14**			
Metal-fraction	**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**	
Units	**ug/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**
M34	3.9	52	5.1	0.8	1.5	72	6.8	0.2	5.0	49	4.9	1.0	5.0	53	5.2	1.0	1.7	77	7.2	0.2	1.3	79	7.3	0.2	3.1	92	8.3	0.4
CC48	56.3	81	7.5	7.5	90.6	189	15	5.9	72.0	88	8.0	9.0	55.6	76	7.1	7.8	61.2	177	15	4.2	79.3	129	11	7.1	65.4	126	11	6.0
A56 ("upstream")																					8.4	65.0	6.2	1.4	13.4	79	7.3	1.8
A60																					7.8	74.0	6.9	1.1	12.6	78	7.2	1.7
A61																					9.6	78.0	7.2	1.3	16.5	80	7.4	2.2
A64																					8.5	63.0	6.0	1.4	14.3	76	7.1	2.0
A65																					8.9	65.0	6.2	1.4	14.1	80	7.4	1.9
A66																					9.1	64.0	6.1	1.5	13.9	79	7.3	1.9
A68	4.5	49	4.9	0.9	3.7	65	6.2	0.6	5.0	50	5.0	1.0	5.0	53	5.2	1.0	4.3	71	6.7	0.6	10.3	66	6.3	1.6	11.3	87	8.0	1.4
A72	3.6	45	4.5	0.8	4.5	78	7.2	0.6	5.0	54	5.3	0.9	5.0	55	5.4	0.9	4.1	86	7.9	0.5	7.6	82	7.6	1.0	6.4	103	9.2	0.7
A73																					5.0	71.0	6.7	0.7	4.9	88	8.0	0.6
A73B																					2.0	37.0	3.8	0.5	3.8	54	5.3	0.7
A75D																					3.7	60.0	5.8	0.6	4.2	76	7.1	0.6
A75B																					3.7	61.0	5.9	0.6	4.1	70	6.6	0.6
Bakers Bridge																					3.5	58.0	5.6	0.6	3.7	73	6.8	0.5

	POST-RUNOFF PERIOD																																			
Sampling Date	**7/09**				**8/09**				**9/09**				**11/09**				**7/10**				**9/10**				**11/10**				**7/11**				**8/11**				**9/11**				**10/11**				**10/12**				**9/14**			
Metal-fraction	**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**		**Cu-diss**	**nardness**	**benchm.**	
Units	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**
M34	1.5	91	8.3	0.2	3.4	186	15	0.2	3.7	156	13	0.3	9.5	238	19	0.5	5.0	114	10	0.5	2.0	199	16	0.1	2.0	219	17	0.1	10.0	65	6.2	1.6	10.0	144	12	0.8	10.0	188	15	0.7	10.0	155	13	0.8	3.8	220	18	0.2	1.5	118	10	0.1
CC48	110	293	22	4.9	221	467	33	6.6	189	470	34	5.6	152	495	35	4.3	118	345	26	4.6	166	509	36	4.6	140	517	36	3.8	76.6	191	16	4.9	145	398	29	5.0	148	474	34	4.4	139	435	31	4.4	74.4	515	36	2.0	65.3	67	6.4	10.3
CC49																																													78.3	545	38	2.1				
A56 ("upstream")																																												0.7	168	14	0.1	2.4	114	10	0.2
A60																																												2.8	111	9.8	0.3
A61																																												3.4	111	9.8	0.4
A64																																												3.5	113	9.9	0.3
A65																																												3.0	117	10	0.3
A66																																												3.5	120	10	0.3
A68	1.5	85	7.8	0.2	1.5	135	12	0.1	1.5	141	12	0.1	1.5	167	14	0.1	5.0	97	8.7	0.6	2.0	144	12	0.2	2.0	154	13	0.2	10.0	66	6.3	1.6	10.0	111	9.8	1.0	10.0	140	12	0.8	10.0	138	12	0.8	2.7	174	14	0.2	3.3	114	10	0.3
A69A																																													16.3	297	23	0.7				
A70B																																													24.8	295	23	1.1				
A71B																																													8.7	263	20	0.4				
A72	4.8	109	9.6	0.5	17.4	211	17	1.0	14.7	199	16	0.9	36.9	296	23	1.6	5.0	136	12	0.4	13.0	245	19	0.7	14.5	232	18	0.8	10.0	75	7.0	1.4	10.0	161	13	0.7	10.0	210	17	0.6	10.0	183	15	0.7	9.5	261	20	0.5	3.0	144	12	0.2
A73																																													4.3	251	20	0.2	1.9	142	12	0.2
A73B																																													3.1	217	17	0.2	1.4	83	7.6	0.2
A75D																																													0.6	191	16	0.0	1.9	92	8.3	0.2
A75B																																													0.7	193	16	0.0	2.0	85	7.8	0.3
Bakers Bridge																																													0.3	183	15	0.0	1.9	99	8.9	0.2

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for copper were calculated using the following equation: $e^{(0.854*\ln \text{hardness})-1.7428}$

Appendix 7.5: Calculating hardness-specific benchmarks and HQs for dissolved manganese in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	630	309	2402	0.3	634	308	2399	0.3	324	150	1888	0.2	530	247	2229	0.2				
CC48	5290	571	2947	1.8	5200	541	2895	1.8	3040	301	2381	1.3	4940	493	2806	1.8				
A56 ("upstream")																	172	131	1805	0.1
A60																				
A61																				
A64																				
A65																				
A66																				
A68	3560	202	2085	1.7	2710	179	2003	1.4	3730	148	1880	2.0	3160	172	1976	1.6	3340	151	1892	1.8
A72	2710	352	2509	1.1	2920	337	2472	1.2	1770	177	1995	0.9	2340	273	2305	1.0				
A73																	1830	182	2014	0.9
A73B																				
A75D																	1090	133	1814	0.6
A75B																				
Bakers Bridge																	584	127	1786	0.3

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	160	52	1327	0.1	120	72	1479	0.1	84.9	49	1301	0.1	150	53	1335	0.1	115	77	1512	0.1	128	79	1525	0.1	184	92	1604	0.1
CC48	766	81	1538	0.5	1770	189	2039	0.9	811	88	1581	0.5	731	76	1505	0.5	1620	177	1995	0.8	1440	129	1796	0.8	1740	126	1782	1.0
A56 ("upstream")																					140	65	1429	0.1	196	79	1525	0.1
A60																					153	74	1492	0.1	189	78	1519	0.1
A61																					328	78	1519	0.2	786	80	1531	0.5
A64																					240	63	1414	0.2	639	76	1505	0.4
A65																					304	65	1429	0.2	655	80	1531	0.4
A66																					343	64	1422	0.2	805	79	1525	0.5
A68	340	49	1301	0.3	636	65	1429	0.4	335	50	1309	0.3	415	53	1335	0.3	699	71	1472	0.5	656	66	1436	0.5	1220	87	1575	0.8
A72	219	45	1264	0.2	450	78	1519	0.3	241	54	1343	0.2	305	55	1352	0.2	471	86	1569	0.3	478	82	1544	0.3	823	103	1666	0.5
A73																					341	71	1472	0.2	624	88	1581	0.4
A73B																					109	37	1185	0.1	294	54	1343	0.2
A75D																					232	60	1391	0.2	408	76	1505	0.3
A75B																					233	61	1399	0.2	394	70	1465	0.3
Bakers Bridge																					149	58	1376	0.1	246	73	1485	0.2

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10				9/10				11/10				7/11				8/11				9/11				10/11				10/12				9/14			
Metal-fraction	Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.		Mn-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	169	91	1599	0.1	410	186	2028	0.2	336	156	1913	0.2	592	238	2202	0.3	212	114	1723	0.1	435	199	2075	0.2	456	219	2142	0.2	104	65	1429	0.1	293	144	1863	0.2	406	188	2036	0.2	303	155	1909	0.2	435	220	2145	0.2	221	118	1743	0.1
CC48	2830	293	2360	1.2	4810	467	2756	1.7	4920	470	2762	1.8	5270	495	2810	1.9	3280	345	2492	1.3	5030	509	2837	1.8	5220	517	2851	1.8	1740	191	2046	0.9	3890	398	2613	1.5	4900	474	2770	1.8	4620	435	2692	1.7	5050	515	2848	1.8	710	67	1444	0.5
CC49																																															5300	545	2902	1.8				
A56 ("upstream")																																														184	168	1961	0.1	469	114	1723	0.3
A60																																																	416	111	1708	0.2
A61																																																	464	111	1708	0.3
A64																																																	569	113	1718	0.3
A65																																																	614	117	1738	0.4
A66																																																	860	120	1753	0.5
A68	668	85	1563	0.4	1320	135	1823	0.7	1540	141	1850	0.8	2380	167	1957	1.2	649	97	1633	0.4	1310	144	1863	0.7	1790	154	1905	0.9	537	66	1436	0.4	821	111	1708	0.5	1140	140	1845	0.6	1310	138	1836	0.7	1340	174	1984	0.7	826	114	1723	0.5
A69A																																														2590	297	2371	1.1				
A70B																																														2540	295	2365	1.1				
A71B																																														1660	263	2276	0.7				
A72	603	109	1698	0.4	1420	211	2115	0.7	1370	199	2075	0.7	2490	296	2368	1.1	736	136	1828	0.4	1590	245	2223	0.7	1690	232	2183	0.8	405	75	1499	0.3	923	161	1933	0.5	1290	210	2112	0.6	1180	183	2017	0.6	1580	261	2271	0.7	863	144	1863	0.5
A73																																														1440	251	2241	0.6	811	142	1854	0.4
A73B																																														1210	217	2135	0.6	419	83	1550	0.3
A75D																																														847	191	2046	0.4	371	92	1604	0.2
A75B																																														856	193	2054	0.4	363	85	1563	0.2
Bakers Bridge																																														546	183	2017	0.3	254	99	1644	0.2

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for dissolved manganese were calculated using the following equation: $e^{(0.3331*\ln \text{hardness})+5.8743}$

Appendix 7.6: Calculating hardness-specific benchmarks and HQs for dissolved nickel in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	5.3	309	135	0.04	3.3	308	135	0.02	1.0	150	73	0.01	4.0	247	112	0.04				
CC48	19.4	571	227	0.09	16.3	541	217	0.08	10.3	301	132	0.08	16.4	493	201	0.08				
A56 ("upstream")																	0.3	131	65	<0.01
A60																				
A61																				
A64																				
A65																				
A66																				
A68	1.0	202	94	0.01	1.0	179	85	0.01	1.0	148	72	0.01	2.0	172	82	0.02	0.3	151	74	<0.01
A72	8.2	352	151	0.05	6.4	337	145	0.04	3.4	177	84	0.04	5.8	273	122	0.05				
A73																	0.9	182	86	0.01
A73B																				
A75D																	0.8	133	66	0.01
A75B																				
Bakers Bridge																	0.3	127	64	0.00

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	1.0	52	30	0.03	1.0	72	39	0.03	2.0	49	28	0.07	2.0	53	30	0.07	0.6	77	42	0.02	1.3	79	43	0.03	0.3	92	48	0.01
CC48	2.2	81	44	0.05	5.3	189	89	0.06	2.0	88	47	0.04	2.0	76	41	0.05	4.9	177	84	0.06	2.5	129	65	0.04	3.1	126	63	0.05
A56 ("upstream")																					0.3	65	36	0.01	0.3	79	43	0.01
A60																					0.3	74	40	0.01	0.3	78	42	0.01
A61																					0.3	78	42	0.01	0.3	80	43	0.01
A64																					0.3	63	35	0.01	0.3	76	41	0.01
A65																					0.3	65	36	0.01	0.3	80	43	0.01
A66																					0.3	64	36	0.01	0.3	79	43	0.01
A68	1.0	49	28	0.04	1.0	65	36	0.03	2.0	50	29	0.07	2.0	53	30	0.07	0.3	71	39	0.01	0.3	66	37	0.01	0.3	87	46	0.01
A72	1.0	45	26	0.04	1.0	78	42	0.02	2.0	54	31	0.06	2.0	55	31	0.06	0.9	86	46	0.02	1.3	82	44	0.03	0.6	103	53	0.01
A73																					1.3	71	39	0.03	0.3	88	47	0.01
A73B																					1.4	37	22	0.06	0.8	54	31	0.03
A75D																					0.6	60	34	0.02	0.3	76	41	0.01
A75B																					0.5	61	34	0.01	0.3	70	38	0.01
Bakers Bridge																					0.3	58	33	0.01	0.3	73	40	0.01

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10				9/10				11/10				7/11				8/11				9/11				10/11				10/12				9/14			
Metal-fraction	Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	1.0	91	48	0.02	2.1	186	88	0.02	2.3	156	76	0.03	4.1	238	108	0.04	2.0	114	58	0.03	0.4	199	93	0	0.4	219	101	0	2.0	65	36	0.06	2.0	144	71	0.03	2.0	188	89	0.02	2.00	155	75	0.03	1.3	220	101	0.01	0.5	118	60	0.01
CC48	9.1	293	129	0.07	15.0	467	192	0.08	15.7	470	193	0.08	17.4	495	201	0.09	8.6	345	148	0.06	16.5	509	206	0.08	16.2	517	209	0.08	6.0	191	90	0.07	13.0	398	167	0.08	14.5	474	194	0.07	13.70	435	180	0.08	12.4	515	208	0.06	5.9	67	37	0.16
CC49																																															13.5	545	218	0.06				
A56 ("upstream")																																														0.3	168	81	0.00	0.3	114	58	<0.01
A60																																																	0.3	111	57	<0.01
A61																																																	0.3	111	57	<0.01
A64																																																	0.3	113	58	<0.01
A65																																																	0.3	117	59	<0.01
A66																																																	0.3	120	61	<0.01
A68	1.0	85	45	0.02	1.0	135	67	0.01	1.0	141	70	0.01	1.0	167	80	0.01	2.0	97	51	0.04	0.4	144	71	0	0.4	154	75	0	2.0	66	37	0.05	2.0	111	57	0.04	2.0	140	69	0.03	2.00	138	68	0.03	0.3	174	83	0.00		114	58	<0.01
A69A																																														4.8	297	131	0.04				
A70B																																														5.2	295	130	0.04				
A71B																																														4.9	263	118	0.04				
A72	1.0	109	56	0.02	3.0	211	98	0.03	3.7	199	93	0.04	6.4	296	130	0.05	2.0	136	67	0.03	0.4	245	111	0	4.2	232	106	0.04	2.0	75	41	0.05	2.0	161	78	0.03	2.0	210	97	0.02	2.00	183	87	0.02	5.9	261	117	0.05	1.1	144	71	0.02
A73																																														4.8	251	113	0.04	0.9	142	70	0.01
A73B																																														3.3	217	100	0.03	1.9	83	44	0.04
A75D																																														2.3	191	90	0.03	1.0	92	48	0.02
A75B																																														2.4	193	91	0.03	1.0	85	45	0.02
Bakers Bridge																																														0.6	183	87	0.01	0.7	99	52	0.01

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for dissolved nickel were calculated using the following equation: $e^{(0.846*\ln \text{hardness})+0.0554}$

Appendix 7.7: Calculating hardness-specific benchmarks and HQs for dissolved lead in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	1.5	309	8.4	0.2	2.0	308	8.4	0.2	1.7	150	3.9	0.4	4.2	247	6.6	0.6				
CC48	13.2	571	15.7	0.8	14.2	541	14.9	1.0	14.3	301	8.2	1.8	15.1	493	13.5	1.1				
A56 ("upstream")																	0.381	131	3.4	0.1
A60																				
A61																				
A64																				
A65																				
A66																				
A68	0.5	202	5.4	0.1	0.5	179	4.7	0.1	0.5	148	3.8	0.1	0.5	172	4.5	0.1	0.05	151	3.9	0.01
A72	2.7	352	9.6	0.3	1.3	337	9.2	0.1	0.5	177	4.7	0.1	1.5	273	7.4	0.2				
A73																	0.05	182	4.8	0.01
A73B																				
A75D																	0.05	133	3.4	0.01
A75B																				
Bakers Bridge																	0.05	127	3.3	0.02

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.5	52	1.2	0.4	0.5	72	1.8	0.3	0.5	49	1.1	0.4	0.5	53	1.3	0.4	0.1	77	1.9	0.1	0.3	79	1.9	0.1	0.1	92	2.3	0.05
CC48	4.2	81	2.0	2.1	9.6	189	5.0	1.9	8	88	2.2	3.7	9	76	1.9	4.8	8.0	177	4.7	1.7	13.1	129	3.3	3.9	6.9	126	3.2	2.1
A56 ("upstream")																					0.6	65	1.6	0.4	1.0	79	1.9	0.5
A60																					0.7	74	1.8	0.4	0.9	78	1.9	0.5
A61																					0.7	78	1.9	0.4	1.0	80	2.0	0.5
A64																					1.2	63	1.5	0.8	1.0	76	1.9	0.5
A65																					1.3	65	1.6	0.8	0.9	80	2.0	0.4
A66																					1.5	64	1.5	1.0	1.1	79	1.9	0.6
A68	0.5	49	1.1	0.4	0.5	65	1.6	0.3	0.5	50	1.2	0.4	0.5	53	1.3	0.4	0.6	71	1.7	0.4	1.3	66	1.6	0.8	1.1	87	2.2	0.5
A72	0.5	45	1.0	0.5	0.5	78	1.9	0.3	0.5	54	1.3	0.4	0.5	55	1.3	0.4	0.05	86	2.1	0.02	1.2	82	2.0	0.6	0.1	103	2.6	0.02
A73																					0.7	71	1.7	0.4	0.2	88	2.2	0.1
A73B																					0.3	37	0.8	0.4	0.1	54	1.3	0.1
A75D																					0.8	60	1.4	0.6	0.3	76	1.9	0.2
A75B																					0.8	61	1.5	0.5	0.3	70	1.7	0.2
Bakers Bridge																					0.5	58	1.4	0.4	0.3	73	1.8	0.2

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10				9/10				11/10				7/11				8/11				9/11				10/11				10/12				9/14			
Metal-fraction	Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.5	91	2.3	0.2	0.5	186	4.9	0.1	0.5	156	4.1	0.1	0.5	238	6.4	0.1	0.5	114	2.9	0.2	0.1	199	5.3	0.0	0.1	219	5.8	0.02	0.5	65	1.6	0.3	0.5	144	3.7	0.1	0.5	188	5.0	0.1	0.5	155	4.0	0.1	0.3	220	5.9	0.04	0.1	118	3.0	0.02
CC48	13	293	7.9	1.6	16.8	467	12.8	1.3	14.5	470	12.9	1.1	16.2	495	13.6	1.2	17.4	345	9.4	1.9	16.8	509	14.0	1.2	17.1	517	14.2	1.2	8.5	191	5.1	1.7	19.2	398	10.9	1.8	21.4	474	13.0	1.6	18.7	435	11.9	1.6	11.2	515	14.2	0.8	14.2	67	1.6	8.7
CC49																																														11.3	545	15.0	0.8				
A56 ("upstream")																																													0.2	168	4.4	0.05	0.2	114	2.9	0.07
A60																																																	0.3	111	2.8	0.11
A61																																																	0.3	111	2.8	0.12
A64																																																	0.3	113	2.9	0.10
A65																																																	0.3	117	3.0	0.09
A66																																																	0.4	120	3.1	0.14
A68	0.5	85	2.1	0.2	0.5	135	3.5	0.1	0.5	141	3.7	0.1	0.5	167	4.4	0.1	0.5	97	2.4	0.2	0.1	144	3.7	0.0	0.1	154	4.0	0.02	0.5	66	1.6	0.3	0.5	111	2.8	0.2	0.5	140	3.6	0.1	0.5	138	3.6	0.1	0.1	174	4.6	0.02	0.4	114	2.9	0.13
A69A																																														0.2	297	8.0	0.02				
A70B																																														3.0	295	8.0	0.4				
A71B																																														0.05	263	7.1	0.01				
A72	0.5	109	2.8	0.2	0.5	211	5.6	0.1	0.5	199	5.3	0.1	0.5	296	8.0	0.1	0.5	136	3.5	0.1	0.1	245	6.6	0.0	0.1	232	6.2	0.02	0.5	75	1.8	0.3	0.5	161	4.2	0.1	0.5	210	5.6	0.1	0.5	183	4.8	0.1	0.2	261	7.0	0.03	0.1	144	3.7	0.01
A73																																														0.05	251	6.7	0.01	0.05	142	3.7	0.01
A73B																																														0.05	217	5.8	0.01	0.05	83	2.1	0.02
A75D																																														0.05	191	5.1	0.01	0.05	92	2.3	0.02
A75B																																														0.05	193	5.1	0.01	0.14	85	2.1	0.07
Bakers Bridge																																														0.05	183	4.8	0.01	0.05	99	2.5	0.02

Appendix 7.8: Calculating hardness-specific benchmarks and HQs for dissolved silver in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.60	309	0.52	1.1	0.50	308	0.52	1.0	0.25	150	0.15	1.7	0.25	247	0.36	0.7				
CC48	0.25	571	1.50	0.2	0.25	541	1.37	0.2	0.25	301	0.50	0.5	0.25	493	1.17	0.2				
A56 ("upstream")																	0.25	131	0.12	2.1
A60																				
A61																				
A64																				
A65																				
A66																				
A68	0.25	202	0.25	1.0	0.25	179	0.20	1.2	0.25	148	0.15	1.7	0.25	172	0.19	1.3	0.25	151	0.15	1.6
A72	0.25	352	0.65	0.4	0.25	337	0.61	0.4	0.25	177	0.20	1.2	0.25	273	0.42	0.6				
A73																	0.25	182	0.21	1.2
A73B																				
A75D																	0.25	133	0.12	2.0
A75B																				
Bakers Bridge																	0.25	127	0.11	2.2

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.25	52	0.02	10.3	0.25	72	0.04	5.9	0.25	49	0.02	11.4	0.25	53	0.03	9.9	0.25	77	0.05	5.2	1.25	79	0.05	25.0	0.25	92	0.07	3.8
CC48	0.25	81	0.05	4.8	0.25	189	0.22	1.1	0.25	88	0.06	4.1	0.25	76	0.05	5.3	0.25	177	0.20	1.2	2.50	129	0.12	21.5	0.25	126	0.11	2.2
A56 ("upstream")																					0.25	65	0.04	7.0	0.25	79	0.05	5.0
A60																					0.25	74	0.04	5.6	0.25	78	0.05	5.1
A61																					0.25	78	0.05	5.1	0.25	80	0.05	4.9
A64																					0.25	63	0.03	7.4	0.25	76	0.05	5.3
A65																					0.25	65	0.04	7.0	0.25	80	0.05	4.9
A66																					0.25	64	0.03	7.2	0.25	79	0.05	5.0
A68	0.25	49	0.02	11.4	0.25	65	0.04	7.0	0.25	50	0.02	11.0	0.25	53	0.03	9.9	0.25	71	0.04	6.0	0.25	66	0.04	6.8	0.25	87	0.06	4.2
A72	0.25	45	0.02	13.1	0.25	78	0.05	5.1	0.25	54	0.03	9.6	0.25	55	0.03	9.3	0.25	86	0.06	4.3	1.25	82	0.05	23.4	0.25	103	0.08	3.2
A73																					1.25	71	0.04	30.0	0.25	88	0.06	4.1
A73B																					0.25	37	0.01	18.4	0.25	54	0.03	9.6
A75D																					0.25	60	0.03	8.0	0.25	76	0.05	5.3
A75B																					0.25	61	0.03	7.8	0.25	70	0.04	6.1
Bakers Bridge																					0.25	58	0.03	8.5	0.25	73	0.04	5.7

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10				9/10				11/10				7/11				8/11				9/11				10/11				12/12				9/14			
Metal-fraction	Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.25	91	0.06	3.9	0.25	186	0.22	1.1	0.25	156	0.16	1.5	0.25	238	0.33	0.7	0.25	114	0.09	2.7	0.05	199	0.25	0.2	0.05	219	0.29	0.2	0.25	65	0.04	7.0	0.25	144	0.14	1.8	0.25	188	0.22	1.1	0.25	155	0.16	1.6	1.25	220	0.29	4.3	0.25	118	0.10	2.5
CC48	0.25	293	0.48	0.5	0.25	467	1.06	0.2	0.25	470	1.08	0.2	0.25	495	1.18	0.2	0.25	345	0.63	0.4	0.05	509	1.23	0.04	0.05	517	1.27	0.0	0.25	191	0.23	1.1	0.25	398	0.81	0.3	0.25	474	1.09	0.2	0.25	435	0.94	0.3	1.25	515	1.26	1.0	1.25	67	0.04	33.2
CC49																																														1.25	545	1.39	0.9				
A56 ("upstream")																																													0.25	168	0.18	1.4	0.25	114	0.09	2.7
A60																																																0.25	111	0.09	2.8
A61																																																0.25	111	0.09	2.8
A64																																																0.25	113	0.09	2.7
A65																																																0.25	117	0.10	2.5
A66																																																0.25	120	0.10	2.4
A68	0.25	85	0.06	4.4	0.25	135	0.13	2.0	0.25	141	0.14	1.8	0.25	167	0.18	1.4	0.25	97	0.07	3.5	0.05	144	0.14	0.4	0.05	154	0.16	0.3	0.25	66	0.04	6.8	0.25	111	0.09	2.8	0.25	140	0.13	1.9	0.25	138	0.13	1.9	0.25	174	0.19	1.3	0.25	114	0.09	2.7
A69A																																														0.25	297	0.49	0.5				
A70B																																														0.25	295	0.48	0.5				
A71B																																														0.25	263	0.40	0.6				
A72	0.25	109	0.09	2.9	0.25	211	0.27	0.9	0.25	199	0.25	1.0	0.25	296	0.49	0.5	0.25	136	0.13	2.0	0.05	245	0.35	0.1	0.05	232	0.32	0.2	0.25	75	0.05	5.5	0.25	161	0.17	1.5	0.25	210	0.27	0.9	0.25	183	0.21	1.2	0.25	261	0.39	0.6	0.25	144	0.14	1.8
A73																																														0.25	251	0.37	0.7	0.25	142	0.14	1.8
A73B																																														0.25	217	0.28	0.9	0.25	83	0.05	4.6
A75D																																														0.25	191	0.23	1.1	0.25	92	0.07	3.8
A75B																																														0.25	193	0.23	1.1	0.25	85	0.06	4.4
Bakers Bridge																																														0.25	183	0.21	1.2	0.25	99	0.07	3.4

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for dissolved silver were calculated using the following equation: $e^{(1.72*\ln \text{hardness})-10.51}$

Appendix 7.9: Calculating hardness-specific benchmarks and HQs for dissolved zinc in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

	PRE-RUNOFF PERIOD																			
Sampling Date	**2/10**				**3/10**				**4/10**				**3/11**				**4/14**			
Metal-fraction	**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**	
Units	**ug/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**
M34	328	309	338	1.0	292	308	337	0.9	499	150	175	2.8	312	247	276	1.1				
CC48	2670	571	591	4.5	2600	541	563	4.6	1600	301	330	4.8	2340	493	517	4.5				
A56 ("upstream")																	241	131	155	1.6
A60																				
A61																				
A64																				
A65																				
A66																				
A68	702	202	230	3.1	610	179	206	3.0	985	148	173	5.7	874	172	198	4.4	1030	151	176	5.8
A72	1110	352	381	2.9	1230	337	366	3.4	864	177	204	4.2	972	273	302	3.2				
A73																	701	182	209	3.4
A73B																				
A75D																	367	133	157	2.3
A75B																				
Bakers Bridge																	174	127	151	1.2

	RUNOFF PERIOD																							
Sampling Date	**5/09**				**6/09**				**6/10**				**6/11**				**5/12**				**5/13**				**5/14**			
Metal-fraction	**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**	
Units	**ug/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**
M34	48.1	52	67	0.7	72.5	72	90	0.8	68.6	49	63	1.1	25.0	53	68	0.4	68.2	77	96	0.7	100	79	98	1.0	146	92	112	1.3
CC48	611	81	100	6.1	1080	189	216	5.0	660	88	108	6.1	614	76	94	6.5	1070	177	204	5.3	1160	129	153	7.6	1310	126	150	8.8
A56 ("upstream")																					224	65.0	82	2.7	361	79.0	98	3.7
A60																					242	74.0	92	2.6	360	78.0	97	3.7
A61																					305	78.0	97	3.2	509	80.0	99	5.1
A64																					280	63.0	80	3.5	452	76.0	94	4.8
A65																					296	65.0	82	3.6	455	80.0	99	4.6
A66																					292	64.0	81	3.6	461	79.0	98	4.7
A68	295	49	63	4.7	270	65	82	3.3	286	50	65	4.4	274	53	68	4.0	281	71	89	3.2	347	66	83	4.2	446	87	107	4.2
A72	133	45	59	2.3	249	78	97	2.6	206	54	69	3.0	217	55	70	3.1	284	86	106	2.7	369	82	101	3.6	453	103	124	3.6
A73																					242	71.0	89	2.7	364	88.0	108	3.4
A73B																					79.0	37.0	49	1.6	178	54.0	69	2.6
A75D																					140	60.0	76	1.8	217	76.0	94	2.3
A75B																					140	61.0	77	1.8	210	70.0	88	2.4
Bakers Bridge																					66.5	58.0	74	0.9	111	73.0	91	1.2

	POST-RUNOFF PERIOD																																			
Sampling Date	**7/09**				**8/09**				**10/09**				**11/09**				**7/10**				**9/10**				**11/10**				**7/11**				**8/11**				**9/11**				**10/11**				**10/12**				**9/14**			
Metal-fraction	**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**		**Zn-diss**	**hardness**	**benchm.**	
Units	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**	**µg/L**			**HQ**
M34	88.7	91	111	0.8	180	186	213	0.8	175	156	182	1.0	317	238	267	1.2	106	114	137	0.8	196	199	227	0.9	242	219	247	1.0	54.4	65	82	0.7	131	144	169	0.8	170	188	215	0.8	142	155	181	0.8	173	220	248	0.7	99	118	141	0.7
CC48	1620	293	322	5.0	2650	467	492	5.4	2570	470	495	5.2	2650	495	519	5.1	1800	345	374	4.8	2730	509	532	5.1	2890	517	540	5.4	1090	191	218	5.0	2140	398	426	5.0	2430	474	499	4.9	2400	435	461	5.2	2590	515	538	4.8	394	67	84	4.7
CC49																																												2710	545	566	4.8				
A56 ("upstream")																																											189	168	194	1.0	250	114	137	1.8
A60																																														266	111	133	2.0
A61																																														253	111	133	1.9
A64																																														260	113	135	1.9
A65																																														293	117	140	2.1
A66																																														341	120	143	2.4
A68	268	85	105	2.6	332	135	159	2.1	407	141	166	2.5	567	167	193	2.9	261	97	118	2.2	410	144	169	2.4	436	154	179	2.4	237	66	83	2.9	282	111	133	2.1	311	140	165	1.9	393	138	162	2.4	300	174	201	1.5	270	114	137	2.0
A69A																																												1160	297	326	3.6				
A70B																																												1160	295	324	3.6				
A71B																																												743	263	292	2.5				
A72	313	109	131	2.4	636	211	239	2.7	617	199	227	2.7	1120	296	325	3.4	392	136	160	2.4	762	245	274	2.8	754	232	261	2.9	228	75	93	2.4	467	161	187	2.5	590	210	238	2.5	549	183	210	2.6	733	261	290	2.5	362	144	169	2.1
A73																																												682	251	280	2.4	327	142	167	2.0
A73B																																												561	217	245	2.3	180	83	102	1.8
A75D																																												427	191	218	2.0	152	92	112	1.4
A75B																																												442	193	220	2.0	149	85	105	1.4
Bakers Bridge																																												241	183	210	1.1	87.7	99	120	0.7

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for dissolved zinc were calculated using the following equation: $e^{(0.8525*\ln \text{hardness})+0.9109)*0.986}$

Appendix 7*

Calculating surface water concentrations of Cd, Cu and Zn standardized to 50 mg/L hardness

Appendix 7.1*: Standardizing dissolved cadmium concentrations in surface water to a hardness of 50 mg/L
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)
Units	ug/L				µg/L				µg/L				µg/L				µg/L			
M34	1.10	309	0.25	0.28	1.00	308	0.25	0.25	2.00	150	0.44	0.88	1.10	247	0.3	0.33				
CC48	5.50	571	0.21	1.16	5.30	541	0.21	1.11	4.90	301	0.26	1.27	5.30	493	0.21	1.11				
A56 ("upstream")																	0.58	131	0.49	0.28
A60																				
A61																				
A64																				
A65																				
A66																				
A68	1.80	202	0.35	0.63	1.60	179	0.38	0.61	4.10	148	0.44	1.81	2.70	172	0.4	1.07	3.00	151	0.44	1.31
A72	2.60	352	0.23	0.60	2.70	337	0.24	0.64	2.90	177	0.39	1.12	2.60	273	0.28	0.73				
A73																	1.79	182	0.38	0.68
A73B																				
A75D																	1.02	133	0.48	0.49
A75B																				
Bakers Bridge																	0.53	127	0.5	0.26

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)
Units	ug/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L			
M34	0.30	52	0.97	0.29	0.20	72	0.76	0.15	0.10	49	1.02	0.10	0.20	53	0.96	0.19	0.28	77	0.72	0.21	0.25	79	0.71	0.18	0.56	92	0.63	0.36
CC48	2.10	81	0.7	1.46	3.40	189	0.37	1.25	2.20	88	0.65	1.44	2.00	76	0.73	1.46	2.91	177	0.39	1.13	3.20	129	0.49	1.57	3.83	126	0.5	1.91
A56 ("upstream")																					0.70	65	0.82	0.58	0.97	79	0.71	0.69
A60																					0.70	74	0.75	0.52	1.01	78	0.72	0.72
A61																					1.00	78	0.72	0.72	1.51	80	0.7	1.06
A64																					0.90	63	0.84	0.76	1.35	76	0.73	0.99
A65																					0.90	65	0.82	0.74	1.31	80	0.7	0.92
A66																					0.90	64	0.83	0.75	1.40	79	0.71	0.99
A68	0.90	49	1.02	0.92	0.80	65	0.82	0.66	0.90	50	1	0.90	0.90	53	0.96	0.86	0.87	71	0.77	0.67	1.00	66	0.81	0.81	1.33	87	0.66	0.88
A72	0.60	45	1.08	0.65	0.80	78	0.72	0.57	0.70	54	0.95	0.66	0.80	55	0.93	0.75	0.89	86	0.67	0.59	1.00	82	0.69	0.69	1.40	103	0.58	0.81
A73																					0.70	71	0.77	0.54	1.09	88	0.65	0.71
A73B																					0.30	37	1.26	0.38	0.56	54	0.95	0.53
A75D																					0.50	60	0.87	0.44	0.71	76	0.73	0.52
A75B																					0.50	61	0.86	0.43	0.69	70	0.78	0.54
Bakers Bridge																					0.30	58	0.9	0.27	0.42	73	0.75	0.32

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10				9/10				11/10				7/11				8/11				9/11				10/11				10/12				9/14			
Metal-fraction	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)	Cd-diss	measured hardness	CHM	new conc. (ug/l)
Units	µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L			
M34	0.30	91	0.64	0.19	0.70	186	0.37	0.26	0.70	156	0.43	0.30	1.00	238	0.31	0.31	0.40	114	0.54	0.22	0.70	199	0.35	0.25	0.80	219	0.33	0.26	0.20	65	0.82	0.16	0.50	144	0.45	0.23	0.70	188	0.37	0.26	0.60	155	0.43	0.26	0.90	220	0.33	0.30	0.39	118	0.52	0.20
CC48	4.60	293	0.26	1.22	6.60	467	0.21	1.39	6.60	470	0.21	1.39	6.40	495	0.21	1.34	4.40	345	0.23	1.03	5.70	509	0.21	1.20	6.70	517	0.21	1.41	3.10	191	0.37	1.13	5.60	398	0.21	1.18	5.90	474	0.18	1.09	7.00	435	0.2	1.38	5.10	515	0.21	1.07	5.08	67	0.8	4.08
CC49																																													5.60	545	0.21	1.18				
A56 ("upstream")																																													0.60	168	0.4	0.24	0.86	114	0.54	0.46
A60																																																	0.99	111	0.55	0.54
A61																																																	0.93	111	0.55	0.51
A64																																																	1.01	113	0.54	0.55
A65																																																	1.05	117	0.53	0.55
A66																																																	1.13	120	0.52	0.59
A68	0.80	85	0.67	0.54	1.00	135	0.47	0.47	1.20	141	0.46	0.55	1.70	167	0.4	0.69	0.80	97	0.61	0.49	1.30	144	0.45	0.59	1.40	154	0.43	0.60	0.80	66	0.81	0.65	0.90	111	0.55	0.49	1.10	140	0.46	0.51	1.10	138	0.47	0.51	1.20	174	0.39	0.47	1.08	114	0.54	0.58
A69A																																																	2.70	297	0.26	0.71				
A70B																																																	2.70	295	0.26	0.71				
A71B																																																	1.90	263	0.29	0.55				
A72	0.90	109	0.56	0.50	1.80	211	0.34	0.61	1.80	199	0.35	0.64	2.80	296	0.26	0.74	1.10	136	0.47	0.52	1.80	245	0.3	0.54	2.10	232	0.32	0.66	0.70	75	0.74	0.52	1.30	161	0.42	0.54	1.70	210	0.34	0.58	1.60	183	0.38	0.60	1.80	261	0.29	0.52	1.19	144	0.45	0.54
A73																																																	1.70	251	0.3	0.51	1.01	142	0.46	0.46
A73B																																																	1.40	217	0.33	0.46	0.57	83	0.68	0.39
A75D																																																	1.10	191	0.37	0.40	0.54	92	0.63	0.34
A75B																																																	1.10	193	0.36	0.40	0.52	85	0.67	0.35
Bakers Bridge																																																	0.70	183	0.38	0.26	0.35	99	0.6	0.21

CHM = chronic hardness multiplier (see Appendix 5.a in the 2015 Animas River BERA)

Appendix 7.2*: Standardizing dissolved copper concentrations in surface water to a hardness of 50 mg/L
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)
Units	ug/L				µg/L				µg/L				µg/L				µg/L			
M34	10.3	309	0.21	2.2	11.2	308	0.21	2.4	12.3	150	0.39	4.8	16.2	247	0.26	4.1				
CC48	119	571	0.17	20	109	541	0.17	19	110	301	0.22	24	89.1	493	0.17	15				
A56 ("upstream")																	2.07	131	0.44	0.9
A60																				
A61																				
A64																				
A65																				
A66																				
A68	1.5	202	0.3	0.5	1.5	179	0.34	0.5	8.3	148	0.4	3.3	5.0	172	0.35	1.7	6.0	151	0.39	2.3
A72	35.9	352	0.19	6.8	35.2	337	0.2	6.9	19.2	177	0.34	6.5	25.2	273	0.24	5.9				
A73																	2.48	182	0.33	0.8
A73B																				
A75D																	2.14	133	0.43	0.9
A75B																				
Bakers Bridge																	2.49	127	0.45	1.1

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)
Units	µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L			
M34	3.9	52	0.97	3.8	1.5	72	0.73	1.1	5.0	49	1.02	5.1	5.0	53	0.95	4.8	1.7	77	0.69	1.2	1.3	79	0.68	0.8	3.1	92	0.6	1.9
CC48	56.3	81	0.66	37	90.6	189	0.32	29	72.0	88	0.62	45	55.6	76	0.7	39	61.2	177	0.34	21	79.3	129	0.45	35	65.4	126	0.46	30
A56 ("upstream")																					8.4	65.0	0.8	6.7	13.4	79	0.68	9.1
A60																					7.8	74.0	0.72	5.6	12.6	78	0.69	8.6
A61																					9.6	78.0	0.69	6.6	16.5	80	0.67	11
A64																					8.5	63.0	0.82	7.0	14.3	76	0.7	10
A65																					8.9	65.0	0.8	7.1	14.1	80	0.67	9.5
A66																					9.1	64.0	0.81	7.4	13.9	79	0.68	9.4
A68	4.5	49	1.02	4.6	3.7	65	0.80	3.0	5.0	50	1.0	5.0	5.0	53	0.95	4.8	4.3	71	0.74	3.2	10.3	66	0.79	8.1	11.3	87	0.62	7.1
A72	3.6	45	1.1	3.9	4.5	78	0.69	3.1	5.0	54	0.94	4.7	5.0	55	0.92	4.6	4.1	86	0.63	2.6	7.6	82	0.66	5.0	6.4	103	0.54	3.4
A73																					5.0	71.0	0.74	3.7	4.9	88	0.62	3.0
A73B																					2.0	37.0	1.3	2.6	3.8	54	0.94	3.6
A75D																					3.7	60.0	0.86	3.2	4.2	76	0.7	3.0
A75B																					3.7	61.0	0.85	3.1	4.1	70	0.75	3.0
Bakers Bridge																					3.5	58.0	0.88	3.1	3.7	73	0.73	2.7

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10				9/10				11/10				7/11				8/11				9/11				10/11				10/12				9/14			
Metal-fraction	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)	Cu-diss	measured hardness	CHM	new conc. (ug/l)
Units	µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L			
M34	1.5	91	0.6	0.9	3.4	186	0.33	1.1	3.7	156	0.38	1.4	9.5	238	0.26	3	5.0	114	0.5	2.5	2.0	199	0.31	0.6	2.0	219	0.28	0.6	10.0	65	0.8	8.0	10.0	144	0.41	4.1	10.0	188	0.32	3.2	10.0	155	0.38	3.8	3.8	220	0.28	1.1	1.5	118	0.48	0.7
CC48	110	293	0.22	24	221	467	0.17	38	189	470	0.17	32	152	495	0.17	26	118	345	0.19	23	166	509	0.17	28	140	517	0.17	24	76.6	191	0.32	24	145	398	0.17	25	148	474	0.17	25	139	435	0.17	24	74.4	515	0.17	13	65.3	67	0.78	51
CC49																																													78.3	545	0.17	13				
A56 ("upstream")																																												0.7	168	0.36	0.2	2.4	114	0.5	1.2
A60																																																2.8	111	0.51	1.4
A61																																																3.4	111	0.51	1.7
A64																																																3.5	113	0.5	1.7
A65																																																3.0	117	0.48	1.4
A66																																																3.5	120	0.47	1.6
A68	1.5	85	0.64	1.0	1.5	135	0.43	0.6	1.5	141	0.41	0.6	1.5	167	0.36	1	5.0	97	0.57	2.8	2.0	144	0.41	0.8	2.0	154	0.38	0.8	10.0	66	0.79	7.9	10.0	111	0.51	5.1	10.0	140	0.42	4.2	10.0	138	0.42	4.2	2.7	174	0.35	0.9	3.3	114	0.5	1.6
A69A																																																16.3	297	0.22	3.6				
A70B																																																24.8	295	0.22	5.5				
A71B																																																8.7	263	0.24	2.1				
A72	4.8	109	0.52	2.5	17.4	211	0.29	5.1	14.7	199	0.31	4.5	36.9	296	0.22	8	5.0	136	0.43	2.1	13.0	245	0.26	3.4	14.5	232	0.27	3.9	10.0	75	0.71	7.1	10.0	161	0.37	3.7	10.0	210	0.29	2.9	10.0	183	0.33	3.3	9.5	261	0.24	2.3	3.0	144	0.41	1.2
A73																																																4.3	251	0.25	1.1	1.9	142	0.41	0.8
A73B																																																3.1	217	0.29	0.9	1.4	83	0.65	0.9
A75D																																																0.6	191	0.32	0.2	1.9	92	0.6	1.1
A75B																																																0.7	193	0.32	0.2	2.0	85	0.64	1.3
Bakers Bridge																																																0.3	183	0.33	0.1	1.9	99	0.56	1.1

Appendix 7.3*: Standardizing dissolved zinc concentrations in surface water to a hardness of 50 mg/L
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	new conc. (ug/l)	new conc.
Units	ug/L				µg/L				µg/L				µg/L				µg/L			
M34	328	309	0.19	63	292	308	0.19	56	499	150	0.37	184	312	247	0.23	73				
CC48	2670	571	0.15	401	2600	541	0.15	390	1600	301	0.2	313	2340	493	0.15	351				
A56 ("upstream")																	241	131	0.42	101
A60																				
A61																				
A64																				
A65																				
A66																				
A68	702	202	0.28	198	610	179	0.31	192	985	148	0.37	368	874	172	0.33	285	1030	151	0.37	378
A72	1110	352	0.17	189	1230	337	0.18	217	864	177	0.32	274	972	273	0.21	208				
A73																	701	182	0.31	217
A73B																				
A75D																	367	133	0.41	151
A75B																				
Bakers Bridge																	174	127	0.43	75

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)
Units	ug/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L			
M34	48.1	52	0.97	46	72.5	72	0.72	52	68.6	49	1.0	70	25.0	53	0.95	24	68.2	77	0.68	46	100	79	0.66	66	146	92	0.58	84
CC48	611	81	0.65	395	1080	189	0.3	323	660	88	0.6	395	614	76	0.68	420	1070	177	0.32	340	1160	129	0.42	491	1310	126	0.43	566
A56 ("upstream")																					224	65.0	0.79	177	361	79.0	0.66	239
A60																					242	74.0	0.7	170	360	78.0	0.67	241
A61																					305	78.0	0.67	204	509	80.0	0.65	333
A64																					280	63.0	0.81	227	452	76.0	0.68	309
A65																					296	65.0	0.79	234	455	80.0	0.65	297
A66																					292	64.0	0.8	234	461	79.0	0.66	305
A68	295	49	1.02	301	270	65	0.79	213	286	50	1.0	286	274	53	0.95	260	281	71	0.73	205	347	66	0.78	270	446	87	0.61	270
A72	133	45	1.10	147	249	78	0.67	166	206	54	0.9	192	217	55	0.92	199	284	86	0.61	174	369	82	0.64	236	453	103	0.52	235
A73																					242	71.0	0.73	176	364	88.0	0.6	218
A73B																					79.0	37.0	1.32	104	178	54.0	0.93	166
A75D																					140	60.0	0.85	119	217	76.0	0.68	149
A75B																					140	61.0	0.84	117	210	70.0	0.74	155
Bakers Bridge																					66.5	58.0	0.88	58	111	73.0	0.71	79

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				10/09				11/09				7/10				9/10				11/10				7/11				8/11				9/11				10/11				10/12				9/14			
Metal-fraction	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)	Zn-diss	measured hardness	CHM	new conc. (ug/l)
Units	µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L				µg/L			
M34	88.7	91	0.58	52	180	186	0.30	55	175	156	0.36	62	317	238	0.24	77	106	114	0.47	50	196	199	0.29	56	242	219	0.26	63	54.4	65	0.79	43	131	144	0.38	50	170	188	0.30	51	142	155	0.36	51	173	220	0.26	45	99	118	0.46	45
CC48	1620	293	0.20	325	2650	467	0.15	398	2570	470	0.15	386	2650	495	0.15	398	1800	345	0.17	311	2730	509	0.15	410	2890	517	0.15	434	1090	191	0.30	323	2140	398	0.15	325	2430	474	0.15	365	2400	435	0.15	360	2590	515	0.15	389	394	67	0.77	302
CC49																																													2710	545	0.15	407				
A56 ("upstream")																																												189	168	0.33	63	250	114	0.47	118
A60																																																266	111	0.49	129
A61																																																253	111	0.49	123
A64																																																260	113	0.48	124
A65																																																293	117	0.46	135
A66																																																341	120	0.45	154
A68	268	85	0.62	166	332	135	0.41	135	407	141	0.39	159	567	167	0.33	190	261	97	0.55	143	410	144	0.38	157	436	154	0.36	157	237	66	0.78	184	282	111	0.49	137	311	140	0.39	122	393	138	0.40	156	300	174	0.32	97	270	114	0.47	128
A69A																																																1160	297	0.20	230				
A70B																																																1160	295	0.20	231				
A71B																																																743	263	0.22	165				
A72	313	109	0.49	154	636	211	0.27	172	617	199	0.29	176	1120	296	0.20	223	392	136	0.4	158	762	245	0.24	180	754	232	0.25	187	228	75	0.69	158	467	161	0.35	162	590	210	0.27	160	549	183	0.31	169	733	261	0.22	163	362	144	0.38	139
A73																																																682	251	0.23	158	327	142	0.39	127
A73B																																																561	217	0.26	148	180	83	0.63	114
A75D																																																427	191	0.30	126	152	92	0.58	87
A75B																																																442	193	0.29	130	149	85	0.62	92
Bakers Bridge																																																241	183	0.31	74	87.7	99	0.54	47

Appendix 8

Calculating sample-specific HQs for dissolved metals in pore water samples collected in the field

Appendix 8.1: Calculating sample-specific HQs for dissolved metals in pore water samples collected in April 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Hardness (mg/L)	Aluminum				Arsenic				Beryllium				Cadmium				Chromium				Copper				Iron			
					BM	HQ			BM	HQ			BM	HQ			BM	HQ			BM	HQ			BM	HQ			BM	HQ
Animas River above mainstem Cement Creek																														
A56 ("upstream")	µg/L	136	23.8 J	23.8	87	0.3	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.232	0.53	0.4		<1.00 U	0.5	95	0.01	1.3	12	0.1		<100 U	50	1000	0.05
A60	µg/L	158	20.9 J	20.9	87	0.2	0.547 J	0.547	150	0.00	<2.00 U	1.0	0.66	1.5	0.809	0.60	1.4		<1.00 U	0.5	108	0.00	1.41	13	0.1		<100 U	50	1000	0.05
A61	µg/L	853	6170 D	6170	87	70.9	<5.00 U	2.5	150	0.02	<20.0 U	10.0	0.66	15	100 D	2.12	47.1		<10.0 U	5.0	429	0.01	2250 D	56	40.2		<1000 U	500	1000	0.5
A64	µg/L	141	<20.0 U	10	87	0.1	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.279	0.55	0.5		<1.00 U	0.5	98	0.01	1.83	12	0.2		<100 U	50	1000	0.05
A65	µg/L	350	671	671	87	7.7	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	22.4	1.09	20.6		0.8 J	0.8	207	0.00	53.8	26	2.1		<100 U	50	1000	0.05
A66	µg/L	141	<20.0 U	10	87	0.1	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.546	0.55	1.0		1.83 J	1.83	98	0.02	1.4	12	0.1		<100 U	50	1000	0.05
A68	µg/L	149	42.2 J	42.2	87	0.5	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	1.67	0.57	2.9		<1.00 U	0.5	103	0.00	3.46	13	0.3		<100 U	50	1000	0.05
Animas River between mainstem Cement Creek and mainstem Mineral Crreek																														
A69A	µg/L																													
A70B	µg/L																													
Animas River below mainstem Mineral Creek																														
A71B																														
A72	µg/L	256	517	517	87	5.9	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	2.98	0.86	3.5		<1.00 U	0.5	160	0.00	8.07	20	0.4		<100 U	50	1000	0.05
A73	µg/L	185	29.2 J	29.2	87	0.3	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	2.03	0.67	3.0		<1.00 U	0.5	123	0.00	2.28	15	0.2		341	341	1000	0.341
A73B	µg/L																													
A75D	µg/L	135	27.7 J	27.7	87	0.3	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.387	0.53	0.7		<1.00 U	0.5	95	0.01	1.67	12	0.1		<100 U	50	1000	0.05
A75B	µg/L																													
Bakers Bridge	µg/L	125	47 J	47	87	0.5	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.334	0.50	0.7		1.15 J	1.15	89	0.01	2.21	11	0.2		<100 U	50	1000	0.05
mainstem Cement Creek																														
CC48	µg/L																													
CC49	µg/L																													
mainstem Mineral Creek																														
M34	µg/L																													

BM = benchmark; HQ = hazard quotient

the hardness-specific chronic surface water benchmarks for dissolved cadmium were calculated using the following equation: $((1.101672-\ln \text{hardness})*0.041838)*e^{(0.7988*\ln \text{hardness})-4.4451}$

the hardness-specific chronic surface water benchmarks for dissolved chromium were calculated using the following equation: $e^{(0.819*\ln \text{hardness})+0.534}$

the hardness-specific chronic surface water benchmarks for dissolved copper were calculated using the following equation: $e^{(0.854*\ln \text{hardness})-1.7428}$

the hardness-specific chronic surface water benchmarks for dissolved manganese were calculated using the following equation: $e^{(0.3331*\ln \text{hardness})+5.8743}$

the hardness-specific chronic surface water benchmarks for dissolved nickel were calculated using the following equation: $e^{(0.846*\ln \text{hardness})+0.0554}$

the hardness-specific chronic surface water benchmarks for dissolved lead were calculated using the following equation: $((1.46203-\ln \text{hardness})*0.145712)*e^{(1.273*\ln \text{hardness})-4.705}$

the hardness-specific chronic surface water benchmarks for dissolved silver were calculated using the following equation: $e^{(1.72*\ln \text{hardness})-10.51}$

the hardness-specific chronic surface water benchmarks for dissolved zinc were calculated using the following equation: $0.986*e^{((0.9094*\ln \text{hardness})+0.6235)}$

prepared by: SJP (2/22/15)
reviewed by:

Appendix 8.1: Calculating sample-specific HQs for dissolved metals in pore water samples collected in April 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Hardness (mg/L)	Lead				Manganese				Nickel				Selenium				Silver				Zinc			
					BM	HQ			BM	HQ			BM	HQ			BM	HQ			BM	HQ			BM	HQ
Animas River above mainstem Cement Creek																										
A56 ("upstream")	µg/L	136	0.964	0.964	3.5	0.27	4.87 J	4.87	1828	0.00	<0.500 U	0.25	67	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.13	2.0	124	160	0.8	
A60	µg/L	158	<0.100 U	0.05	4.1	0.01	<2.00 U	1.0	1921	0.00	<0.500 U	0.25	77	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.16	1.5	353	184	1.9	
A61	µg/L	853	13.4 D	13.4	23.3	0.57	78300 D	78300	3369	23.24	77.5 D	77.5	319	0.24	<10.0 U	5.0	4.6	1.1	<5.00 U	2.5	3.00	0.8	29900 D	851	35.1	
A64	µg/L	141	<0.100 U	0.05	3.7	0.01	4.27 J	4.27	1850	0.00	<0.500 U	0.25	70	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.14	1.8	264	166	1.6	
A65	µg/L	350	2.00	2.00	9.5	0.21	18450	18450	2503	7.37	11.3	11.3	150	0.08	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.65	0.4	6230	378	16.5	
A66	µg/L	141	0.123 J	0.123	3.7	0.03	226	226	1850	0.12	<0.500 U	0.25	70	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.14	1.8	307	166	1.9	
A68	µg/L	149	<0.100 U	0.05	3.9	0.01	1540	1540	1884	0.82	<0.500 U	0.25	73	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.15	1.7	675	174	3.9	
Animas River between mainstem Cement Creek and mainstem Mineral Crreek																										
A69A	µg/L																									
A70B	µg/L																									
Animas River below mainstem Mineral Creek																										
A71B																										
A72	µg/L	256	0.453	0.453	6.9	0.07	448	448	2256	0.20	1.95	1.95	115	0.02	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.38	0.7	1630	285	5.7	
A73	µg/L	185	<0.100 U	0.05	4.9	0.01	1870	1870	2025	0.92	1.19	1.19	88	0.01	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.22	1.2	709	212	3.3	
A73B	µg/L																									
A75D	µg/L	135	<0.100 U	0.05	3.5	0.01	185	185	1823	0.10	<0.500 U	0.25	67	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.13	2.0	173	159	1.1	
A75B	µg/L																									
Bakers Bridge	µg/L	125	<0.100 U	0.05	3.2	0.02	325	325	1777	0.18	<0.500 U	0.25	63	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.11	2.3	115	148	0.8	
mainstem Cement Creek																										
CC48	µg/L																									
CC49	µg/L																									
mainstem Mineral Creek																										
M34	µg/L																									

BM = benchmark; HQ = hazard quotient

the hardness-specific chronic surface water benchmarks for dissolved chromium were calculated using the following equation: $e^{(0.819*\ln \text{hardness})+0.534}$
the hardness-specific chronic surface water benchmarks for dissolved copper were calculated using the following equation: $e^{(0.854*\ln \text{hardness})-1.7428}$
the hardness-specific chronic surface water benchmarks for dissolved manganese were calculated using the following equation: $e^{(0.3331*\ln \text{hardness})+5.8743}$
the hardness-specific chronic surface water benchmarks for dissolved nickel were calculated using the following equation: $e^{(0.846*\ln \text{hardness})+0.0554}$
the hardness-specific chronic surface water benchmarks for dissolved lead were calculated using the following equation: $((1.46203-\ln \text{hardness})*0.145712)*e^{(1.273*\ln \text{hardness})-4.705}$
the hardness-specific chronic surface water benchmarks for dissolved silver were calculated using the following equation: $e^{(1.72*\ln \text{hardness})-10.51}$
the hardness-specific chronic surface water benchmarks for dissolved zinc were calculated using the following equation: $0.986*e^{((0.9094*\ln \text{hardness})+0.6235)}$

Appendix 8.2: Calculating sample-specific HQs for dissolved metals in pore water samples collected in September 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Hardness (mg/L)	Aluminum				Arsenic				Beryllium				Cadmium				Chromium				Copper				Iron			
					BM	HQ			BM	HQ			BM	HQ			BM	HQ			BM	HQ			BM	HQ			BM	HQ
Animas River above mainstem Cement Creek																														
A56 ("upstream")	µg/L	129	28.4 J	28.4	87	0.33	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	1.16	1.16	0.51	2.3	<1.00 U	0.5	91	0.01	4.15	4.15	11	0.4	<100 U	50	1000	0.1
A60	µg/L	340	119	119	87	1.37	<2.50 U	0.12	150	0.00	<2.00 U	1.0	0.66	1.5	3.86 D	3.86	1.07	3.6	<5.00 U	2.5	202	0.01	2.67 JD	2.67	25	0.1	<100 U	50	1000	0.1
A61	µg/L	497	2604.5 D	2604.5	87	29.9	<3.8 U	1.7	150	0.01	<11.0 U	5.5	0.66	8.3	106.5 D	106.5	1.42	75.2	<7.5 U	3.75	275	0.01	95.9 JD	95.9	35	2.7	<550 U	275	1000	0.3
A64	µg/L																													
A65	µg/L	389	401	401	87	4.61	<2.50 U	1.25	150	0.01	<2.00 U	1.0	0.66	1.5	22 D	22	1.18	18.7	<5.00 U	2.5	225	0.01	47.2 D	47.2	29	1.7	<100 U	50	1000	0.1
A66	µg/L	118	<20.0 U	10	87	0.11	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.296	0.296	0.48	0.6	<1.00 U	0.5	85	0.01	1.27	1.27	10	0.1	<100 U	50	1000	0.1
A68	µg/L	121	42.8 J	42.8	87	0.49	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	1.06	1.06	0.49	2.2	<1.00 U	0.5	87	0.01	4.13	4.13	11	0.4	<100 U	50	1000	0.1
Animas River between mainstem Cement Creek and mainstem Mineral Crreek																														
A69A	µg/L																													
A70B	µg/L																													
Animas River below mainstem Mineral Creek																														
71B	µg/L																													
A72	µg/L	160	46.9 J	46.9	87	0.54	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	1.4	1.4	0.60	2.3	<1.00 U	0.5	109	0.00	2.87	2.87	13	0.2	338	338	1000	0.3
A73	µg/L	151	23.3 J	23.3	87	0.27	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.374	0.374	0.58	0.6	<1.00 U	0.5	104	0.00	1.18	1.18	13	0.1	<100 U	50	1000	0.1
A73B	µg/L	49	<20.0 U	10	87	0.11	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	<0.100 U	0.05	0.25	0.2	<1.00 U	0.5	41	0.01	0.915 J	0.915	4.9	0.2	<100 U	50	1000	0.1
A75D	µg/L	96	40 J	40	87	0.46	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.786	0.786	0.41	1.9	<1.00 U	0.5	72	0.01	2.6	2.6	8.6	0.3	107 J	107	1000	0.1
A75B	µg/L																													
Bakers Bridge	µg/L	271	35.2 J	35.2	87	0.4	3.74	3.74	150	0.02	<2.00 U	1.0	0.66	1.5	<0.100 U	0.5	0.90	0.6	3.23	3.23	168	0.02	<0.500 U	0.25	21	0.0	1260	1260	1000	1.3
mainstem Cement Creek																														
CC48	µg/L																													
CC49	µg/L																													
mainstem Mineral Creek																														
M34	µg/L	139	45.7 J	45.7	87	0.53	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.127 J	0.127	0.54	0.2	<1.00 U	0.5	97	0.01	1.18	1.18	12	0.1	<100 U	50	1000	0.1

BM = benchmark; HQ = hazard quotient

the hardness-specific chronic surface water benchmarks for cadmium were calculated using the following equation: $((1.101672-\ln \text{hardness})*0.041838)*e^{(0.7988*\ln \text{hardness})-4.4451}$
the hardness-specific chronic surface water benchmarks for chromium were calculated using the following equation: $e^{(0.819*\ln \text{hardness})+0.534}$
the hardness-specific chronic surface water benchmarks for copper were calculated using the following equation: $e^{(0.854*\ln \text{hardness})-1.7428}$
the hardness-specific chronic surface water benchmarks for dissolved manganese were calculated using the following equation: $e^{(0.3331*\ln \text{hardness})+5.8743}$
the hardness-specific chronic surface water benchmarks for dissolved nickel were calculated using the following equation: $e^{(0.846*\ln \text{hardness})+0.0554}$
the hardness-specific chronic surface water benchmarks for dissolved lead were calculated using the following equation: $((1.46203-\ln \text{hardness})*0.145712)*e^{(1.273*\ln \text{hardness})-4.705}$
the hardness-specific chronic surface water benchmarks for dissolved silver were calculated using the following equation: $e^{(1.72*\ln \text{hardness})-10.51}$
the hardness-specific chronic surface water benchmarks for dissolved zinc were calculated using the following equation: $0.986*e^{((0.9094*\ln \text{hardness})+0.6235)}$

prepared by: SJP (2/22/15)
reviewed by:

Appendix 8.2: Calculating sample-specific HQs for dissolved metals in pore water samples collected in September 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Hardness (mg/L)	Lead				Manganese			Nickel				Selenium				Silver				Zinc			
					BM	HQ		BM	HQ			BM	HQ			BM	HQ			BM	HQ		BM	HQ
Animas River above mainstem Cement Creek																									
A56 ("upstream")	µg/L	129	0.523	0.523	3.3	0.16	689	1796	0.38	<0.500 U	0.25	65	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.1	2.1	463	153	3.0
A60	µg/L	340	<0.500 U	0.25	9.3	0.03	6.46	2480	0.00	<2.50 U	1.25	146	0.01	<5.00 U	2.5	4.6	0.5	<2.50 U	1.25	0.6	2.0	1630	369	4.4
A61	µg/L	497	65.6 D	65.6	13.6	4.8	63800 D	2813	22.7	37.8 D	37.8	202	0.19	<7.5 U	3.8	4.6	0.8	<3.8 U	1.9	1.2	1.6	18490 D	520	35.5
A64	µg/L										13.4													
A65	µg/L	389	0.579 JD	0.579	10.6	0.05	16200	2594	6.25	13.4 D	0.25	164	0.00	<5.00 U	2.5	4.6	0.5	<2.50 U	1.25	0.8	1.6	4760	417	11.4
A66	µg/L	118	<0.100 U	0.05	3.0	0.02	2.57 J	1743	0.00	<0.500 U	0.25	60	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.1	2.5	179	141	1.3
A68	µg/L	121	0.258	0.258	3.1	0.08	590	1758	0.34	<0.500 U		61	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.1	2.4	294	144	2.0
Animas River between mainstem Cement Creek and mainstem Mineral Crreek																									
A69A	µg/L																								
A70B	µg/L																								
Animas River below mainstem Mineral Creek																									
71B	µg/L																								
A72	µg/L	160	<0.100 U	0.05	4.2	0.01	995	1929	0.52	1.31	1.31	77	0.02	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.2	1.5	407	186	2.2
A73	µg/L	151	<0.100 U	0.05	3.9	0.01	2.45 J	1892	0.00	1.35	1.35	74	0.02	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.2	1.6	362	176	2.1
A73B	µg/L	49	<0.100 U	0.05	1.1	0.04	3.37 J	1301	0.00	0.581 J	0.581	28	0.02	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.02	11.4	32.9	63	0.5
A75D	µg/L	96	0.205	0.205	2.4	0.09	290	1627	0.18	1.52	1.52	50	0.03	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.1	3.6	190	117	1.6
A75B	µg/L																								
Bakers Bridge	µg/L	271	0.193 J	0.193	7.3	0.03	5870	2299	2.6	0.85 J	0.85	121	0.01	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.4	0.6	13.3 J	300	0.0
mainstem Cement Creek																									
CC48	µg/L																								
CC49	µg/L																								
mainstem Mineral Creek																									
M34	µg/L	139	<0.100 U	0.05	3.6	0.01	27.6	1841	0.01	<0.500 U	0.25	69	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.1	1.9	48.2	163	0.3

BM = benchmark; HQ = hazard quotient

the hardness-specific chronic surface water benchmarks for cadmium were calculated using the following equation: $((1.101672-\ln \text{hardness})*0.041838)*e^{(0.7988*\ln \text{hardness})-4.4451}$
the hardness-specific chronic surface water benchmarks for chromium were calculated using the following equation: $e^{(0.819*\ln \text{hardness})+0.534}$
the hardness-specific chronic surface water benchmarks for copper were calculated using the following equation: $e^{(0.854*\ln \text{hardness})-1.7428}$
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the hardness-specific chronic surface water benchmarks for dissolved lead were calculated using the following equation: $((1.46203-\ln \text{hardness})*0.145712)*e^{(1.273*\ln \text{hardness})-4.705}$
the hardness-specific chronic surface water benchmarks for dissolved silver were calculated using the following equation: $e^{(1.72*\ln \text{hardness})-10.51}$
the hardness-specific chronic surface water benchmarks for dissolved zinc were calculated using the following equation: $0.986*e^{((0.9094*\ln \text{hardness})+0.6235)}$

prepared by: SJP (2/16/15)

Appendix 9a

Surface water toxicity testing report for the Upper Animas River (October and November 2012)

Final

Upper Animas River
2012 Surface Water Toxicity Testing Report

Prepared for:
United States Environmental Protection Agency, Region 8
Ecosystem Protection and Remediation-Program Support
1595 Wynkoop St.
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December 2013

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Figure 3.5-1 Zinc LC_{50} Reference Chart

Acronym List

BERA	Baseline Ecological Risk Assessment
BLM	Bureau of Land Management
ºC	Degrees Celsius
CETIS	Comprehensive Environmental Toxicity Information System
DO	Dissolved Oxygen
DRMS	Division of Reclamation, Mining and Safety
EC_{50}	50% Effect Concentration
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
FS	Feasibility Study
gpm	Gallons Per Minute
LC_{50}	50% Lethal Concentration
LCL	Lower Confidence Limit
MHRW	Moderately Hard Reconstituted Water
mL	Milliliter
mg/L	Milligrams per liter
µg/L	Micrograms per liter
µs/cm	Microsiemens/centimeter
QA	Quality Assurance
RI	Remedial Investigation
SGC	Sunnyside Gold Corporation
UCL	Upper Confidence Limit

1.0 INTRODUCTION

Two 96-hour static renewal toxicity tests were performed at the United States Environmental Protection Agency (EPA) Region 8 Laboratory in October and November 2012 using juvenile rainbow trout (*Oncorhynchus mykiss*) to determine the acute toxicity of surface water samples collected from the Animas River and its two major tributaries Cement Creek and Mineral Creek, located in Silverton in the San Juan Country, Colorado. During the first test, conducted in October of 2012, three sets of Site samples were run consisting of an undiluted set, a set diluted with reference water from sample location A56 and another set diluted with reference water from sample location A68. As a Quality Assurance (QA) measure, a simultaneous reference toxicity test with a separate batch of juvenile rainbow trout was performed using Moderately Hard Reconstituted Water (MHRW) spiked with different concentrations of zinc sulfate heptahydrate ($ZnSO_4$).

A second Site toxicity test and concurrent reference toxicity test were conducted following the October, 2012 round of testing. This Site test consisted of three sets of diluted samples, all diluted with reference water from sample location A68. Section 2.5 below provides a detailed description of the sample preparation for all the diluted samples from the October and November 2012 Site tests.

Survival was the endpoint evaluated in all tests. This toxicity test report includes a brief background of the Upper Animas River area, materials and methods, test results, a discussion of results, and supporting references.

1.1 Background

Information in this section was obtained from the *Final 2012 Sampling and Analysis Plan/Quality Assurance Project Plan, Revision 1, Upper Animas Mining District Gladstone, San Juan County, Colorado*, dated September 2012 (Environmental Services Assistance Team [ESAT], 2012).

The discovery of gold and silver brought miners to the Silverton area and Animas Mining District in the early 1870's. The discovery of silver in the base-metal ores was the major factor in establishing Silverton as a permanent settlement. Between 1870 and 1890, the richer ore deposits were discovered and mined to the extent possible. Not until 1890 was any serious attempt made to mine and concentrate the larger low-grade ore bodies in the area. By 1900, there were 12 concentration mills in the valley sending products to the Kendrick and Gelder Smelter near the mouth of Cement Creek. Mining and milling operations slowed down circa 1905, and mines were consolidated into fewer and larger operations with the facilities for milling large volumes of ore. After 1907, mining and milling continued throughout the basin whenever prices were favorable.

Gladstone, located about eight miles upstream of Silverton on Cement Creek, is the site of an historic mining town developed in the 1880s commensurate with the onset of mining in the surrounding area. The town was the central location and railroad terminus for the milling and shipping of mine ores from the surrounding three-square-mile valley. The town declined in the 1920 s and no remnants of the town remain. By the 1970's only one year-round producing mine (Sunnyside Mine) remained in the county. This mine ceased production in 1991, and has since undergone extensive reclamation efforts. The Gold King Mine's permit with Division of Reclamation, Mining and Safety (DRMS) is currently in inactive status; however, landowners hope to rehabilitate the mine. Both the Sunnyside and Gold King properties were partially accessed through the American Tunnel that has its portal in Gladstone.

Previously the American Tunnel drained as much as 1,600 gallons per minute (gpm) of water from the mines. A lime feed and settling pond type treatment facility was constructed in Gladstone in 1979 by Standard Metals Corporation. Water discharging from the American Tunnel was treated as required by the water discharge permit. The facility operations and mine ownership was later transferred to the Sunnyside Gold Corporation (SGC). Under jurisdiction of a court consent decree to terminate their discharge permit, SGC installed several bulkheads within the Sunnyside Mine that greatly reduced the amount of discharge from the American Tunnel. Seventy to one hundred gpm continue to discharge presumably from near surface groundwater. All terms of the consent decree were met by SGC in 2002.

In January 2003 the treatment facility, operations, and permit were transferred to the Gold King Mines Corporation. The settling ponds were deeded to the San Juan Corporation by SGC prior to the lease between the Gold King Mines and San Juan Corporations. The treatment facility continued to treat the remaining American Tunnel discharge and the Gold King discharge until September 2004. The San Juan Corporation required SGC to reclaim the four settling ponds (completed in 2005) following termination of the San Juan Corporation and SGC lease. The Gold King Mines Corporation was subsequently evicted and the balance of the Gold King Mines Corporation land was acquired by the San Juan Corporation as the lien holder. The American Tunnel portal reclamation and removal of some out buildings were completed in 2006. The Bureau of Land Management (BLM) manages land associated with the American Tunnel portal and vicinity; however, the San Juan Corporation owns the majority of the land surrounding the portal.

Numerous historic and now abandoned mines exist within a two-mile radius of Gladstone. They include: the Upper Gold King 7 Level, American Tunnel, Grand Mogul, Mogul, and Red and Bonita, Evelyne, Henrietta, Joe and John, and Lark mines. Some of these mines have acid mine drainage that flows between 30 and 300 gpm directly or indirectly into Cement Creek and eventually into the Animas River, the confluence located about eight miles downstream of Gladstone. The Animas River Stakeholder Group, Bureau of Land Management, Division of Reclamation, Mining and Safety and private stakeholders have completed remediation projects at

the Evelyne, Henrietta, Joe and John, and Lark mines. The remaining sites located in the Cement Creek drainage that will be the focus of these sampling efforts include the American Tunnel, Grand Mogul, Mogul, Red and Bonita, and the Upper Gold King 7 Level.

1.2 Objective

The objective of these toxicity tests was to characterize the effects of mine waste-impacted surface water on juvenile rainbow trout under acute exposure conditions. The results will be used to support the development of a site-wide Remedial Investigation/Feasibility Study (RI/FS) that will include a Baseline Ecological Risk Assessment (BERA) for the Animas River Site.

2.0 MATERIALS AND METHODS

This section outlines the materials and methods used for testing purposes, including surface water collection procedures, water preparation and delivery, test organisms, food preparation, and test conditions. The general test methods and testing criteria followed EPA protocol (EPA, 2002) and are summarized in **Table 2.5-1**.

2.1 Surface Water Collection

Surface water was collected in October 2012 from six locations along the Animas River. Samples from two reference locations (A56 and A68) were collected above where Cement Creek flows into the Animas River. Four Site samples (A72, A73B, A75B, and Baker Bridge) were collected downstream of the confluence with Cement Creek. Surface water was collected from two tributaries (Cement Creek and Mineral Creek) for diluting the Site samples (**Figure 2.1-1**). The water from these two tributaries was not included in the toxicity test other than as a diluent. However, analytical results for water collected from Cement Creek and Mineral Creek are included in the analytical results (**Tables 2.5-2, 2.5-3,** and **2.5-4**). The weather before and during the sampling event was sunny with no rain.

Surface water was collected in November 2012 for a follow-up Site test. Samples were collected from four locations; one reference location on the Animas River (A68) upstream of the confluence with Cement Creek, one location on the Animas River downstream of the confluence with Mineral Creek (A72), one location on Cement Creek (CC48), and one location on Mineral Creek (M34).

Adequate volume of water was collected for each sample location with a minimum of 5 gallons collected at each location. This was accomplished by using one gallon and two and a half gallon cubitainers that were dedicated for each sample location. Equipment decontamination was not necessary because cubitainers were used once. All surface water samples were stored on ice in coolers immediately after collection and were then transported to the Region 8 laboratory in

Golden, CO. All samples were placed in a 4ºC refrigerator at the laboratory for preservation until test initiation, which took place within 36 hours of the last sample collection.

2.2 Water Preparation and Renewal

The MHRW used in the reference toxicity tests was prepared in accordance with Smith *et al.* (1997) by adding 47.4 grams of calcium sulfate, 122.8 grams of magnesium sulfate heptahydrate, 96 grams of sodium bicarbonate, and 4 grams of potassium chloride to the laboratory stainless steel batch tank containing 1,000 liters of deionized water. The batch tank of MHRW was continuously aerated during the toxicity test. The water quality of the MHRW was checked to verify that the following parameters had been met: hardness between 90 and 100 milligrams per liter (mg/L), alkalinity between 50 and 70 mg/L, conductivity between 330 and 360 microsiemens/centimeter (µs/cm), and pH between 7.8 and 8.2 standard units (EPA, 2002). The average results from the four replicates for the MHRW batch water for the October test were as follows: hardness = 96 mg/L; alkalinity = 59.4 mg/L; conductivity = 312 µs/cm; and pH = 7.38. The average results from the four replicates for the MHRW for the November test were as follows: hardness= 91 mg/L; alkalinity = 55.2 mg/L; conductivity = 297.6 µs/cm; and pH = 7.63. Note that both the average conductivity and average pH of the October and November 2012 MHRW fell below the expected range.

The MHRW and site water in the test chambers were renewed entirely each day by pouring 900 mL of site water into a clean 1000 milliters (mL) glass beaker and carefully removing live organisms and placing them into the newly mixed water. Site water used for renewal was first warmed to 12 degrees Celsius (ºC). The water temperature was held constant during the 96-hour exposure period by placing all the test chambers in a temperature-controlled water bath.

2.3 Test Organisms

Juvenile rainbow trout (*O. mykiss*) obtained from Trout Lodge, Inc. (located in Sumner, Washington) were used for site water and reference toxicity testing. An importation license was obtained from the Colorado Division of Wildlife before the *O. mykiss* were shipped by the supplier. The fish in the shipping bag were placed in the holding tank after they arrived at the Region 8 laboratory to equilibrate the temperature. Once temperature was equilibrated, the shipping bag was carefully opened to allow a small amount of laboratory reconstituted water to enter the bag. This procedure was repeated several times throughout the day until laboratory MHRW and shipping water were well mixed. The fish were then released from the shipping bag into the holding tank where they were held for 5 days until used for testing. The fish were also cultured and shipped in MHRW such that water quality acclimation was not an issue. At the time of testing, organisms were 15-30 days post yolk sac absorption and were uniform in size. The average weight of the organisms was 0.28 grams at the start of the October test and an average weight of 0.84 grams at the start of the November test.

2.4 Feeding Procedure

The fish were fed starter trout chow obtained from Nelson's Silver Cup, Inc. in accordance with EPA methodology (EPA, 2002). They were fed twice daily before the test started and once daily thereafter. The fish were not fed for 24 hours before the test started in order to reduce the accumulation of metabolic wastes.

2.5 Test Procedures

The following sections discuss the procedures used for the site water toxicity test and reference toxicity tests.

2.5.1 October 2012 Site Water Toxicity Testing

Site water used for testing purposes during the October 2012 Site test was obtained from the following four locations along the Animas River: A72, A73B, A75B, and Baker Bridge (the furthest down-river sample location). Reference surface water samples were collected from sample locations A56 and A68 on the Animas River, upstream of the confluence with Cement Creek. All six samples were run un-diluted in the Site test. Surface water was also collected from Mineral Creek (M34) and Cement Creek (CC48). The water from these two tributaries was combined in a 61% (M34), 39% (CC48) ratio and then diluted using water from the reference location A56 at concentrations of 6.25%, 12.5%, 25%, 50% and 100% (see table below). The ratio of M34 and CC48 were based on the flow rate of each tributary into the Animas River.

Concentration	Volume M34* (ml)	Volume CC48** (ml)	Volume A56 (ml) (Reference Water)
M34/CC48/A56-Control	0	0	900 (MHRW)
M34/CC48/56A-6.25%	34.3	21.9	844
M34/CC48/A56-12.5%	68.6	43.9	788
M34/CC48/A56-25%	137	87.8	675
M34/CC48/A56-50%	275	176	450
M34/CC48/A56-100%	549	351	0

*Based off a flow rate of 23 cubic feet per second (61%).
** Based off a flow rate of 14 cubic feet per second (39%).

A second set of diluted samples was run using water from Reference location A68 as the diluent to a mixture of M34 and CC48. The identical ratio of M34 and CC48 were used as indicated above, except a 100% solution of M34/CC48 was not included in the Site test (see table below)

Concentration	Volume M34* (ml)	Volume CC48* (ml)	Volume A68 (ml) (Reference Water)
M34/CC48/A68-Control	0	0	900 (MHRW)
M34/CC48/A68-6.25%	34.3	21.9	844
M34/CC48/A68-12.5%	68.6	43.9	788
M34/CC48/A68-25%	137	87.8	675
M34/CC48/A68-50%	275	176	450

*Based off a flow rate of 23 cubic feet per second (61%).
** Based off a flow rate of 14 cubic feet per second (39%).

2.5.2 November 2012 Site Water Toxicity Test

Surface water for use in the November 2012 Site test was obtained from the following four locations; A68 and A72 on the Animas River, M34 from Mineral Creek, and CC48 from Cement Creek. Reference location A68 was collected on the Animas River upstream of the confluence with Cement Creek. Samples M34 and A68 were run undiluted in the Site toxicity test. Surface water from reference location A68 was used to dilute samples A72 and CC48 at various dilutions. Water from A68 was also used to dilute a mixture of CC48 and M34. The tables below explain the three sets of dilutions.

Concentration Percentage of A72 water	Volume A72 (ml)	Volume A68 (ml) (Reference water)
Control	0	900 (MHRW)
A72/A68-5%	45	855
A72/A68-10%	90	810
A72/A68-25%	225	675
A72/A68-50%	450	450

A72/A68-75%	675	225
A72/A68-100%	900	0

Concentration Percentage of CC48 water	**Volume CC48 (ml)**	**Volume A68 (ml)** (Reference water)
Control	0	900 (MHRW)
CC48/A68- 1%	9	891
CC48/A68- 3%	27	873
CC48/A68- 6%	54	846
CC48/A68- 12%	108	792
CC48/A68- 25%	225	675
CC48/A68- 50%	450	450

Concentration Percentage of CC48/M34 water	**Volume CC48 (ml)**	**Volume M34 (ml)**	**Volume A68 (ml)** (Reference water)
Control	0	0	900 (MHRW)
CC48/M34/A68-4%	12	24	864
CC48/M34/A68-9%	26	55	819
CC48/M34/A68-20%	58	122	720
CC48/M34/A68-40%	115	245	540
CC48/M34/A68-65%	187	398	315
CC48/M34/A68-85%	245	520	135

A laboratory control sample of MHRW was simultaneously tested during both the October 2012 and November 2012 Site tests to verify the health of the fish used in the test. The same test procedure was followed for each test. The test chambers consisted of 1-L glass beakers, which were placed in a water bath to maintain a constant temperature of 12º C during the 96-hour exposure period. Four replicates were tested for each location and each sample dilution, as well as the laboratory control. Testing criteria specified in EPA (2002) were followed (**Table 2.5-1**).

Ten organisms were added to each test chamber at the start of the test using a small dip net and an 8-ounce cup, in which the count was quickly verified. Four replicate chambers were used for each of the Site and reference water samples. Each chamber contained 10 fish, for a total of 40 fish per sample location, dilution series or reference test dilution.

As previously stated, each test took place over a 96-hour period, with one daily water renewal. Water quality was measured daily for Dissolved Oxygen (DO), pH, conductivity, and temperature. Water samples were analyzed for alkalinity and hardness at the start and end of each test. Fish mortality was observed daily in each test chamber and recorded. All dead organisms were removed and discarded.

Appendix A provides the water chemistry and mortality data sheets for the October 2012 Site surface water toxicity test and **Appendix B** provides the water chemistry and mortality data sheets for the November 2012 Site surface water toxicity test. Water samples were collected on Day 0 and Day 4 for the following analyses: total and dissolved metals (EPA Method 200.7/200.8), anions (EPA Method 300.0), ammonia (EPA Method 350.1), and alkalinity (EPA Method 310.1). Results from the October 2012 test for dissolved metals are included in **Table 2.5-2**. **Table 2.5-3** shows initial and final results for total recoverable metals and **Table 2.5-4** includes wet chemistry data. **Table 2.5-5a** (Site test) and **Table 2.5-5b** (reference test) show initial and final results for ammonia, as well as calculated ammonia criteria. Results from the November 2012 test for dissolved metals are included in **Table 2.5-6**. **Table 2.5-7** shows initial and final results for total recoverable metals and **Table 2.5-8** includes wet chemistry data. **Table 2.5-9a** (Site test) and **Table 2.5-9b** (reference test) shows initial and final results for ammonia, as well as calculated ammonia criteria for acute toxicity.

2.5.3 Control Water Toxicity Testing

For QA purposes, a control toxicity test using *O. mykiss* was run concurrently with the October 2012 and November 2012 Site water toxicity tests. Test solutions were made by spiking MHRW with $ZnSO_4$ solution via serial dilution. Zinc concentrations were reduced by 50% starting with the highest target concentration (1000 µg/L) until the lowest dilution concentration of 6.25% (62.5 µg/L target concentration) was reached.

The following are the dilutions and average zinc concentrations (calculated from initial and final dissolved metals results) used for the October 2012 reference test: 100% concentration (1029.5 µg/L), 50% concentration (518.5 µg/L), 25% concentration (263.5 µg/L), 12.5% concentration (131.5 µg/L), and 6.25% concentration (68.85µg/L). The following are the dilutions and average zinc concentrations (calculated from initial and final dissolved metals results) used for the November 2012 reference test: 100% concentration (874 µg/L), 50% concentration (435 µg/L), 25% concentration (220 µg/L), 12.5% concentration (107 µg/L), and 6.25% concentration (55.3µg/L).

Zinc concentrations were verified in the analytical laboratory using EPA Method 200.7/200.8. The control surface water toxicity tests were performed using the same approach as outlined at the end of **Section 2.5.2** (November 2012 Site Water Toxicity Test). Mortality and daily water chemistry data for the control tests run in October 2012 and November 2012 are included in **Appendices A and B, respectively.** The measured zinc concentrations for the October 2012 and November 2012 tests are provided in **Tables 2.5-2 and 2.5-6,** respectively.

3.0 RESULTS

This section presents the results for the Site-specific surface water and reference toxicity testing, and also addresses any issues or potentially confounding conditions encountered during the tests.

Appendix A shows that the water quality parameters were consistently within the established criteria throughout both Site water toxicity tests, with one exception. DO was consistently above 6.0 mg/L, and average test chamber temperatures were maintained within +/- 2ºC of the target test temperature (12ºC), which met performance criteria. Sample A68/CC48- Control-Rep 1 was above the target test temperature on day one, ranging from 14.48 to 15.42°C. The average initial and final ammonia levels measured in the four replicates of each of the surface water samples used in the toxicity test were compared to their pH-dependent acute ammonia criterion. **Tables 2.5-5a and 2.5-9a** show the ammonia levels for the October 2012 and November 2012 tests, respectively. All ammonia levels for both tests fell consistently below the relevant criteria. This comparison indicates that any observed toxicity was not caused by excess ammonia in the test chambers.

3.1 Site-Specific Surface Water Toxicity Test - October 2012

Daily mortality numbers were evaluated at the end of the test to determine the Site water toxicity to the test organisms (**Appendix A** and **Figure 3.1-1**). The results of the undiluted Site samples showed 100% survival at both reference locations A56 and A68. Survival was also 100% at locations A73B, A75B, and Baker Bridge. Survival at location A72 was 0%. The laboratory control showed 100% survival, which met the performance criterion of 90% survival.

A combination of water from M34 and CC48 was diluted with water from reference location A56 and run at five different dilutions (6.25%, 12.5%, 25%, 50% and 100%). The results of the acute test showed 100% survival in the 6.25%, 12.5%, and 25% dilutions. The 50% dilution had 97.5% survival while the 100% dilution (with no reference water) had 0% survival. The control, which consisted of 100% reference water from A56, had 100% survival.

A combination of M34 and CC48 surface water was diluted with water from reference location A68 and run at four different dilutions (6.25%, 12.5%, 25%, and 50%). The results of the dilutions showed 100% survival in the 6.25%, 12.5%, and 25% dilutions. The 50% dilution had 37.5% survival. A 100% dilution (with no reference water) was not run. The control sample (0% dilution), consisting of 100% reference water from A68, had 100% survival.

3.2 Control Water Toxicity Test - October 2012

Water quality parameters were similar in all testing chambers, and water chemistries were held within acceptable ranges for temperature, DO, pH, and conductivity (**Appendix B**). Zinc levels are presented as average zinc concentrations taken from the initial and final dissolved metals

analysis. The control and the 6.25% concentration (68.85 µg/L zinc) had 100% survival. The 12.5% concentration (131.5 µg/L zinc) had 75% survival. The 25% (263.5 µg/L zinc) showed 5% survival. The 50% (518.5 µg/L zinc) concentration and the 100% concentration (1029.5 µg/L zinc) had 0% survival (see **Figure 3.2-1**).

The Spearman-Karber Estimates method [Comprehensive Environmental Toxicity Information System (CETIS), 2011] was used to calculate the 50% Lethal Concentration (LC_{50}) value for zinc, as well as Upper Confidence Limits (UCLs) and Lower Confidence Limits (LCLs) confidence limits. The LC_{50} value for the control toxicity test was 162.9 µg/L, with a UCL and LCL of 180.6 µg/L and 146.9 µg/L, respectively. This LC_{50} value is comparable to previous reference toxicity tests performed from 2005 through 2011. **Figure 3.5-1** provides the zinc LC_{50} control chart which shows historical LC_{50} data obtained at the Region 8 laboratory. Note that CETIS uses the term "EC50" (50% maximal Effect Concentration) instead of LC_{50}. Both terms represent the same calculated value.

3.3 Site-Specific Surface Water Toxicity Test - November 2012

Daily mortality numbers were evaluated at the end of the test to determine the Site water toxicity to the test organisms (**Appendix A** and **Figure 3.3**). The results of the undiluted Site samples showed 92.5% survival at reference location A68 and 0% survival at M34. The laboratory control showed 100% survival, which met the performance criterion of 90% survival.

Site sample A72 was diluted with water from reference location A68 and run at six different dilutions (5%, 10%, 25%, 50%, 75%, and 100%). The results of the dilutions showed A68/A72-5% with 92.5% survival while A68/A72-10% and A68/A72-25% showed 94.7% and 92.2% survival, respectively. Sample A68/A72-50% and A68/A72-75% each had 100% survival. Sample A68/A72-100% showed 2.5% survival. The A68/A72 control, which consisted of 100% A68, water had 100% survival.

Site sample CC48 was diluted with water from reference location A68 and run at six different dilutions (1%, 3%, 6%, 12%, 25%, and 50%). The results of the dilutions showed A68/CC48 1% with 85% survival while A68/CC48-3% and A68/CC48-6% had 97.5% survival. A68/CC48-12% and A68/CC48-25% showed 90% survival in each dilution. A68/CC48-50% had 0% survival. The A68/CC48 control which consisted of 100% A68 water had 100% survival.

A combination of CC48 and M34 surface water was diluted with water from reference location A68 at six different dilutions (4%, 9%, 20%, 40%, 65%, and 85%). The results of the dilutions showed A68/CC48/M34-4% with 97.5% survival, A68/CC48/M34-9% showed 95% survival, and A68/CC48/M34-20% showed 100% survival. Sample A68/CC48/M34-40% had 92.5% survival while A68/CC48/M34-65% and A68/CC48/M34-85% had 0% survival. The A68/CC48/M34 control, which consisted of 100% A68 water, had 100% survival.

Nine juvenile rainbow trout escaped from eight separate testing chambers during the November 2012 toxicity test and were found swimming in the water bath. These fish were excluded from the results and the statistical analyses. The number of fish exposed was reduced by the number of fish that escaped to prevent biasing the results (i.e. if one of the ten fish in a test chamber escaped and one of the remaining nine fish died, survival was calculated as 8/9, or 88.9%).

3.4 Control Water Toxicity Test - November 2012

Water quality parameters were similar in all testing chambers, and water chemistries were held within acceptable ranges for temperature, DO, pH, and conductivity (**Appendix B**). Zinc levels are presented as average zinc concentrations taken from the initial and final dissolved metals analysis. Survival was 100% in the control and the 6.25% concentration (55.3 µg/L zinc), and 75% in the 12.5% concentration (107 µg/L zinc). The 25% (220 µg/L zinc), 50% (435 µg/L zinc), and 100% (874 µg/L zinc) concentrations all had 0% survival, (**Figure 3.4-1)**.

The Trimmed Spearman-Karber Estimates method (CETIS, 2011) was used to calculate the LC_{50} value for zinc, as well as UCLs and LCLs. The LC_{50} for the reference toxicity test was 129.1 µg/L, with a UCL and LCL equal to 141.9 µg/L and 117.5 µg/L, respectively. The LC_{50} is comparable to previous control toxicity tests performed from 2005 through 2011. **Figure 3.5-1** provides the zinc LC_{50} control chart which shows historical LC_{50} data obtained at the Region 8 laboratory.

4.0 DISCUSSION

4.1 October 2012 Toxicity Test

Un-diluted Site Samples

Results of the site-specific surface water toxicity test conducted in October 2012 using un-diluted surface water indicated that location A72 was acutely toxic, with 0% survival, to *O. mykiss* over a 96-hour exposure period. 100% survival was observed at A56 (reference location), A68 (reference location), A73B, A75B, and Baker Bridge.

A Steel Many-One Rank Test was performed in order to determine the significance of the observed toxic effects (**Attachment A**). The Steel Many-One Rank test is a non-parametric test which was used in the analyses because the data distribution was non-normal. The data were determined to be non-normal by the Shapiro-Wilk W test because they did not follow a predictable pattern with 50% of the values greater than the mean and 50% values less than the mean. The results of the statistical analysis show the presence of significant mortality at location A72 ($p = 0.0480$) when compared to the laboratory control sample. No significant difference was observed in mortality between the remaining locations when compared to the laboratory control sample.

A Steel Many-One Rank Test was also used to compare the Site locations to reference locations A56 and A68. The results of this comparison were identical because both reference samples had 100% survival. There was significant mortality at sample location A72 (p = 0.0350) when compared to each reference location. No significant difference in mortality was observed between the remaining locations when compared to either A56 or A68.

M34/CC48 diluted with A56

Results of the Site-specific surface water toxicity test conducted in October 2012 using a combination of M34 and CC48 surface water diluted with water from reference location A56 at five different concentrations indicated that M34/CC48/A56 at 100% was acutely toxic to *O. mykiss* over a 96-hour exposure period. 100% survival was observed in M34/CC48/A56 concentrations of 6.25%, 12.5%, and 25%. M34/CC48/A56-50% had 97.5% survival. Site control sample M34/CC48/A56 (which consisted of 100% A56 surface water) had 100% survival.

A Steel Many-One Rank Test was performed in order to determine the significance of the observed toxic effects (**Attachment A**). The results of the statistical analysis show the presence of significant mortality at M34/CC48/A56-100% (p = 0.0417) when compared to M34/CC48/A56-Control. No significant difference was observed in mortality between the remaining dilutions when compared to the Site control sample.

M34/CC48 diluted with A68

Results of the Site-specific surface water toxicity test conducted in October 2012 using a combination of M34 and CC48 surface water diluted with water from reference location A68 at four different concentrations indicated that M34/CC48/A68 at 50% was acutely toxic to *O. mykiss* over a 96-hour exposure period, with only 37.5% survival. 100% survival was observed in M34/CC48/A68 at concentrations 6.25%, 12.5%, and 25%. The Site control sample, M34/CC48/A68, (100% A68 surface water) had 100% survival.

A Steel Many-One Rank Test was performed in order to determine the significance of the observed toxic effects (**Attachment A**). The results of the statistical analysis show the presence of significant mortality at M34/CC48/A56-100% (p = 0.0350) when compared to M34/CC48/A68-Control. No significant difference was observed in mortality between the remaining dilutions when compared to the Site control sample.

Summary

In conclusion, the results of the October 2012 toxicity test showed that the surface water samples collected from A72 and tested un-diluted, as well as M34/CC48/A56-100% and M34/CC48/A68-50%, were acutely toxic to juvenile rainbow trout after 96 hours of exposure. The mortality at

all the other locations and dilutions were not statistically different from either the laboratory control sample or the two Animas River reference samples.

4.2 November Toxicity Test

Undiluted Samples

Results of the Site-specific surface water toxicity test conducted in November 2012 using un-diluted surface water indicated that location M34 was acutely toxic (0 % survival) to *O. mykiss* over a 96-hour exposure period when tested as an undiluted sample. 92.5% survival was observed at reference location A68. Only a M34 and A68 were run un-diluted during the November 2012 test.

An Equal Variance Two- Sample *t*-test was performed in order to determine the significance of the observed toxic effects (**Attachment A**). The data met the conditions for conducting a t-test because the sample variances were statistically equal, determined by Mod Levene Equality of Variance test and the data had normal distribution determined by Shapiro-Wilk W Normality test. The results of the statistical analysis show the presence of significant mortality at location M34 ($p = <0.0001$) when compared to A68.

Site sample A72 diluted with A68

Results of the site-specific surface water toxicity test conducted in November 2012 using A72 surface water diluted with water from reference location A68 at six different concentrations indicated that A68/A72 at 100% was acutely toxic to *O. mykiss* over a 96-hour exposure period with 2.5% survival. 100% survival was observed in the 75% and 50% dilutions. Survival in the 5%, 10% and 25% dilutions resulted in 92.5%, 94.7%, and 92.2% survival, respectively. The Site control sample, A68/A72, (100% A68 surface water) had 100% survival.

A Steel Many-One Rank Test was performed in order to determine the significance of the observed toxic effects (**Attachment A**). The results of the statistical analysis show the presence of significant mortality at A68/A72-100% ($p = 0.0480$) when compared to A68/A72-Control. No significant difference was observed in mortality between the remaining dilutions when compared to the Site control sample.

Site sample CC48 diluted with A68

Results of the Site-specific surface water toxicity test conducted in November 2012 using CC48 surface water diluted with water from reference location A68 at six different concentrations indicated that A68/CC48 at 50% was acutely toxic (0% survival) to *O. mykiss* over a 96-hour exposure period. 90% survival was observed in the 25% and 12% dilutions. The 6%, 3% and 1% dilutions resulted in 97.5%, 97.5%, and 85% survival respectively. The Site control sample, A68/CC48, (100% A68 surface water) had 100% survival.

A Steel Many-One Rank Test was performed in order to determine the significance of the observed toxic effects (**Attachment A**). The results of the statistical analysis show the presence of significant mortality at A68/CC48-50% (p = 0.0480) when compared to A68/CC48-Control. No significant difference was observed in mortality between the remaining dilutions when compared to the Site control sample.

CC48/M34 diluted with A68

Results of the Site-specific surface water toxicity test conducted in November 2012 using a mixture of CC48 and M34 surface water diluted with water from reference location A68 at six different concentrations indicated that A68/CC48/M34 at 65% and 85% were acutely toxic (0% survival) to *O. mykiss* over a 96-hour exposure period. 92.5% survival was observed in A68/CC48/M34-40% while 20%, 9% and 4% dilutions resulted in 100%, 95%, and 97.5% survival, respectively. The Site control sample, A68/CC48/M34, (100% A68 surface water) had 100% survival.

A Steel Many-One Rank Test was performed in order to determine the significance of the observed toxic effects (**Attachment A**). The results of the statistical analysis show the presence of significant mortality at A68/CC48-65% and A68/CC48/M34 (p = 0.0480, for both dilutions) when compared to A68/CC48/M34-Control. No significant difference was observed in mortality between the remaining dilutions when compared to the Site control sample.

Summary

In conclusion, the results of the November 2012 toxicity test showed that the surface water samples collected from M34 (un-diluted) as well as A68/A72-100%, A68/CC48-50%, A68/CC48/M34-65% and A68/CC48/M34-85% were acutely toxic to juvenile rainbow trout after 96 hours of exposure. The survival for all other locations and dilutions was not statistically different from either the laboratory control sample or the two reference samples.

5.0 REFERENCES

Colorado Department of Public Health and Environment, Water Quality Control Commission. 1979-2012. Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31). Amended June 11, 2012.

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Tables

Table 2.5-1 Summary of Test Conditions

October 2012 and November 2012 Upper Animas River Surface Water Toxicity Test Using Juvenile *O. mykiss*

Test Parameter	Criteria
Test Type	Static Renewal
Test Duration	96-Hour
Temperature	12°C ± 2°C
Light Quality	Ambient Laboratory Illumination
Light Intensity	50-100 ft-c
Photo Period	16 Hours Light, 8 Hours Dark
Test Chamber Size	1 liter
Test Solution Volume	900mL
Renewal of Test Solutions	Daily
Age of Test Organisms	15-30 Days Post Yolk-Sac Absorption
No. Replicate Chambers per Concentration	Four
No. Organisms per Chamber	Ten
No. Organisms per Concentration	40
Feeding Regime	Feeding Not Required
Test Chamber Cleaning	Cleaning Not Required
Test Solution Aeration	Not Exceeding 100 Bubbles per Minute
Dissolved Oxygen	≥6.0 mg/L
Dilution Water	Moderatley Hard Reconstituted Water
End Point	Mortality
Sample Holding Time	36 hours after collection of last sample
Test Acceptability	≥90% survival in controls

Table 2.5-2 Initial and Final Dissolved Metals Results
October 2012 Upper Animas River Surface Water Toxicity Test Using Juvenile *O.mykiss*

Initial Dissolved Metals (µg/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Hardness (mg/L)	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of the Animas River, Mineral creek, and Cement Creek surface water samples																								
Control	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13800	<1.00U	<0.100U	0.736J	96	<100U	<0.100U	14900	<2.00U	0.543J	2210	<0.500U	<0.500U	26900	79.4	<0.500U	<2.00U	<10.0U
Baker Bridge	<20.0U	<0.500U	<0.500U	32.0	<2.00U	0.760	71500	<1.00U	2.42	<0.500U	206	<100U	<0.100U	6690	682	0.829J	1080	<0.500U	<0.500U	3240	649	<0.500U	<2.00U	333
A75B	<20.0U	<0.500U	<0.500U	29.3	<2.00U	1.03	73200	<1.00U	3.87	<0.500U	208	<100U	<0.100U	6080	912	1.95	1020	<0.500U	<0.500U	3290	688	<0.500U	<2.00U	437
A73B	321	<0.500U	<0.500U	24.8	<2.00U	1.61	87200	<1.00U	6.08	8.17	243	429	0.115J	6170	1410	3.11	975J	<0.500U	<0.500U	3450	882	<0.500U	<2.00U	695
A56	29.9J	<0.500U	<0.500U	25.0	<2.00U	0.399	62000	<1.00U	<0.100U	<0.500U	170	<100U	0.218	3580	121	<0.500U	684J	<0.500U	<0.500U	2670	600	<0.500U	<2.00U	165
A72	753	<0.500U	<0.500U	21.5	<2.00U	2.07	108000	<1.00U	7.96	12.6	299	2520	0.574	7050	1910	3.66	1100	<0.500U	<0.500U	4070	1090	<0.500U	<2.00U	864
A68	51.6	<0.500U	<0.500U	24.6	<2.00U	1.26	67000	<1.00U	<0.100U	1.89	183	<100U	0.414	3750	1600	<0.500U	689J	<0.500U	<0.500U	2830	666	<0.500U	<2.00U	374
M34	834	<0.500U	<0.500U	25.0	<2.00U	0.809	94600	<1.00U	9.02	5.19	268	4420	0.735B	7660	536	1.84	833J	0.517J	<0.500U	4390	870	<0.500U	<2.00U	211
CC48	7960D	<5.00U	<5.00U	<50.0U	<20.0U	5.46D	200000D	<10.0U	27.3D	71.0D	546D	6360D	13.7BD	11700D	5330D	16.4D	<2500U	<5.00U	<5.00U	5050JD	2400D	<5.00U	<20.0U	2730D
Combined sample M34/CC48 serially diluted by Animas River surface water sample A56																								
M34/CC48/A56 Control																								
M34/CC48/A56 6.25%	76.0	<0.500U	<0.500U	24.7	<2.00U	1.22	70500	<1.00U	0.805	1.68	193	<100U	<0.100U	4090	1640	<0.500U	735J	0.530J	<0.500U	3010	714	<0.500U	<2.00U	399
M34/CC48/A56 12.5%	33.2J	<0.500U	<0.500U	24.9	<2.00U	0.654	70800	<1.00U	1.63	1.62	194	372	<0.100U	4290	399	0.830J	770J	<0.500U	<0.500U	2950	706	<0.500U	<2.00U	276
M34/CC48/A56 25%	49.8J	<0.500U	<0.500U	24.9	<2.00U	0.854	79700	<1.00U	3.46	2.66	220	822	<0.100U	4990	675	1.75	821J	<0.500U	<0.500U	3220	810	<0.500U	<2.00U	404
M34/CC48/A56 50%	582	<0.500U	<0.500U	22.6	<2.00U	1.37	97700	<1.00U	7.47	9.70	270	1680	0.601B	6360	1240	2.83	986J	<0.500U	<0.500U	3680	1020	<0.500U	<2.00U	654
M34/CC48/A56 100%	3780	<0.500U	<0.500U	18.2	<2.00U	2.45	138000	<1.00U	14.8	25.0	382	4610	5.39B	9230	2410	5.57	1330	0.933J	<0.500U	4620	1430	<0.500U	<2.00U	1190
Combined sample M34/CC48 serially diluted by Animas River surface water sample A68																								
M34/CC48/A68 Control																								
M34/CC48/A68 6.25%	70.8	<0.500U	<0.500U	26.1	<2.00U	0.484	65600	<1.00U	0.392	1.29	180	151J	<0.100U	3940	261	<0.500U	735J	1.07	<0.500U	2860	656	<0.500U	<2.00U	219
M34/CC48/A68 12.5%	48.4J	<0.500U	<0.500U	24.5	<2.00U	1.25	71400	<1.00U	1.16	1.06	196	178J	<0.100U	4220	1610	0.518J	744J	<0.500U	<0.500U	3020	724	<0.500U	<2.00U	385
M34/CC48/A68 25%	52.4	<0.500U	<0.500U	23.0	<2.00U	1.46	84000	<1.00U	3.66	2.47	231	615	<0.100U	5150	1800	1.55	847J	0.542J	<0.500U	3330	867	<0.500U	<2.00U	555
M34/CC48/A68 50%	476	<0.500U	<0.500U	22.3	<2.00U	1.73	101000	<1.00U	6.95	8.50	278	1210	0.355JB	6470	1980	2.57	1010	0.772J	<0.500U	3770	1050	<0.500U	<2.00U	768
Reference toxicity test																								
Control-Ref	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13800	<1.00U	<0.100U	0.503J	96	<100U	<0.100U	14900	<2.00U	<0.500U	2220	<0.500U	<0.500U	26800	79.4	<0.500U	<2.00U	<10.0U
6.25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13900	<1.00U	<0.100U	0.694J	96	<100U	<0.100U	14900	<2.00U	<0.500U	2200	<0.500U	<0.500U	26700	79.1	<0.500U	<2.00U	70.0
12.50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	14000	<1.00U	<0.100U	0.686J	96	<100U	<0.100U	14900	<2.00U	<0.500U	2230	<0.500U	<0.500U	26400	78.7	<0.500U	<2.00U	142
25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	14100	<1.00U	<0.100U	0.617J	96	<100U	<0.100U	14900	<2.00U	<0.500U	2170	<0.500U	<0.500U	26300	78.6	<0.500U	<2.00U	279
50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	14000	<1.00U	<0.100U	0.630J	96	<100U	<0.100U	14900	<2.00U	<0.500U	2190	<0.500U	<0.500U	26300	78.6	<0.500U	<2.00U	543
100%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	14000	2.03	<0.100U	0.577J	96	<100U	<0.100U	14700	<2.00U	<0.500U	2170	<0.500U	<0.500U	26100	78.2	<0.500U	<2.00U	1080

Final Dissolved Metals (µg/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Hardness (mg/L)	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of the Animas River surface water samples																								
Control	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13400	1.90J	<0.100U	0.820J	95	<100U	<0.100U	14900	<2.00U	<0.500U	2440	<0.500U	<0.500U	27000	80.5	<0.500U	<2.00U	<10.0U
Baker Bridge	<20.0U	<0.500U	<0.500U	32.5	<2.00U	0.844	68000	<1.00U	2.39	<0.500U	197	<100U	<0.100U	6530	648	2.30	1380	<0.500U	<0.500U	3180	627	<0.500U	<2.00U	302
A75B	<20.0U	<0.500U	<0.500U	29.5	<2.00U	1.01	72100	<1.00U	3.63	0.718J	205	<100U	<0.100U	6100	902	2.14	1220	<0.500U	<0.500U	3300	693	<0.500U	<2.00U	411
A73B	62.2	<0.500U	<0.500U	24.7	<2.00U	1.66	85700	<1.00U	5.87	3.62	239	<100U	<0.100U	6140	1380	3.01	1250	<0.500U	<0.500U	3540	871	<0.500U	<2.00U	645
A56	21.5J	<0.500U	<0.500U	25.1	<2.00U	0.415	60700	<1.00U	<0.100U	0.676J	166	<100U	<0.100U	3590	106	<0.500U	882J	<0.500U	<0.500U	2680	598	<0.500U	<2.00U	149
A72	560	<0.500U	<0.500U	20.0	<2.00U	2.04	107000	<1.00U	7.42	10.0	296	1420	0.110J	7060	1840	3.03	2350	0.519J	<0.500U	4790	1060	<0.500U	<2.00U	812
A68	34.6J	<0.500U	<0.500U	24.6	<2.00U	1.20	65800	<1.00U	<0.100U	1.71	180	<100U	<0.100U	3720	1590	<0.500U	920J	<0.500U	<0.500U	2820	658	<0.500U	<2.00U	356
Combined sample M34/CC48 serially diluted by Animas River surface water sample A56																								
M34/CC48/A56 Control																								
M34/CC48/A56 6.25%	33.8J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	64500	<5.00U	0.650JD	<2.50U	177	<100U	<0.500U	3970	258	<2.50U	926J	<2.50U	<2.50U	2880	652	<2.50U	<10.0U	174
M34/CC48/A56 12.5%	20.3J	<2.50U	<2.50U	25.0JD	<2.00U	0.536JD	69700	12.9D	1.70D	<2.50U	192	<100U	<0.500U	4270	398	8.68D	951J	<2.50U	<2.50U	2960	699	<2.50U	<10.0U	211
M34/CC48/A56 25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	0.696JD	78700	<5.00U	3.62D	<2.50U	217	<100U	<0.500U	5010	682	<2.50U	1050	<2.50U	<2.50U	3220	813	<2.50U	<10.0U	306
M34/CC48/A56 50%	51.2	<5.00U	<5.00U	<50.0U	<2.00U	1.56JD	98400	<10.0U	8.09D	<5.00U	272	420	<1.00U	6430	1230	5.79JD	1390	<5.00U	<5.00U	4050	1020	<5.00U	<20.0U	622
M34/CC48/A56 100%	5740	<5.00U	<5.00U	<50.0U	<2.00U	2.27D	139000	22.9D	15.4D	35.3D	385	1220	4.72BD	9440	2380	19.8D	4180	6.96JD	<5.00U	5760	1430	<5.00U	<20.0U	1180
Combined sample M34/CC48 serially diluted by Animas River surface water sample A68																								
M34/CC48/A68 Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13300	<5.00U	<0.500U	<2.50U	94	<100U	<0.500U	14800	<2.00U	<2.50U	2430	<2.50U	<2.50U	26900	80.1	<2.50U	<10.0U	<10.0U
M34/CC48/A68 6.25%	34.6J	<2.50U	<2.50U	25.7JD	<2.00U	1.23D	70900	<5.00U	0.930JD	3.47JD	194	<100U	<0.500U	4120	1630	<2.50U	794J	<2.50U	<2.50U	3310	716	<2.50U	<10.0U	364
M34/CC48/A68 12.5%	24.3J	<2.50U	<2.50U	<25.0U	<2.00U	1.14D	74000	<5.00U	1.69D	3.75JD	203	<100U	<0.500U	4440	1660	<2.50U	720J	<2.50U	<2.50U	3460	764	<2.50U	<10.0U	372
M34/CC48/A68 25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	1.42D	83400	<5.00U	3.71D	3.40JD	230	<100U	<0.500U	5170	1770	<2.50U	866J	<2.50U	<2.50U	3710	863	<2.50U	<10.0U	466
M34/CC48/A68 50%	42.5J	<5.00U	<5.00U	<50.0U	<2.00U	1.91JD	101000	<10.0U	7.40D	<5.00U	278	375	<1.00U	6590	1960	5.89JD	1360	<5.00U	<5.00U	4210	1040	<5.00U	<20.0U	730
Reference toxicity test																								
Control-Ref	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13200	3.13	<0.100U	1.81	94	<100U	<0.100U	14800	<2.00U	1.21	2440	0.872J	<0.500U	27000	79.2	<0.500U	<2.00U	<10.0U
6.25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13800	1.40J	<0.100U	0.826J	97	<100U	<0.100U	15300	<2.00U	<0.500U	2450	<0.500U	<0.500U	27400	82.1	<0.500U	<2.00U	67.7
12.50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13000	1.10J	<0.100U	1.34	91	<100U	<0.100U	14300	<2.00U	<0.500U	2410	<0.500U	<0.500U	26400	75.8	<0.500U	<2.00U	121
25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13500	2.76	<0.100U	1.26	95	<100U	<0.100U	14800	<2.00U	1.09	3410	<0.500U	<0.500U	27400	78.8	<0.500U	<2.00U	248
50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13700	3.58	<0.100U	0.927J	95	<100U	<0.100U	14900	<2.00U	0.918J	3050	<0.500U	<0.500U	27200	78.3	<0.500U	<2.00U	494
100%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13600	<1.00U	<0.100U	<0.500U	94	<100U	<0.100U	14600	<2.00U	<0.500U	2730	<0.500U	<0.500U	26500	78.2	<0.500U	<2.00U	979

* No analytical data is available

Qualifiers:

D= Diluted sample

J= Estimated value

U= Non-detect

Prepared by: EC 3.7.13

Reviewed by: BGK 3.11.13

Table 2.5-3 Initial and Final Total Recoverable Metals Results
October 2012 Upper Animas River Surface Water Toxicity Test Using Juvenile *O.mykiss*

Initial Total Metals (µg/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of the Animas River, Mineral Creek, and Cement Creek surface water samples																							
Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	5.60JD	<0.500U	<2.50U	<100U	<0.500U	14000	<2.00U	<2.50U	2070	<2.50U	<2.50U	25300	78.0	<2.50U	<10.0U	<10.0U
Bbridge	285	<2.50U	<2.50U	31.6JD	<2.00U	0.853JD	69500	<5.00U	2.50D	<2.50U	284	<0.500U	6390	677	<2.50U	1010	<2.50U	<2.50U	3050	641	<2.50U	<10.0U	334
A75B	1560	<2.50U	<2.50U	30.1JD	<2.00U	1.03D	71400	<5.00U	3.73D	7.99D	1830	2.21D	5790	920	<2.50U	970J	<2.50U	<2.50U	3080	688	<2.50U	<10.0U	495
A73B	2450	<2.50U	<2.50U	<25.0U	<2.00U	1.69D	85500	<5.00U	5.81D	13.9D	3290	3.65D	5920	1410	<2.50U	933J	<2.50U	<2.50U	3240	875	<2.50U	<10.0U	659
A56	<20.0U	<2.50U	<2.50U	25.9JD	<2.00U	<0.500U	60300	5.37JD	<0.500U	<2.50U	<100U	0.549JD	3440	123	<2.50U	636J	<2.50U	<2.50U	2530	597	<2.50U	<10.0U	160
A72	3730	<2.50U	2.62JD	<25.0U	<2.00U	1.93D	105000	<5.00U	7.47D	17.2D	6220	6.32D	6700	1890	2.87JD	1020	<2.50U	<2.50U	3810	1080	<2.50U	<10.0U	830
A68	62.9	<2.50U	<2.50U	25.3JD	<2.00U	1.29D	64900	<5.00U	<0.500U	3.17JD	<100U	1.42D	3530	1580	<2.50U	667J	<2.50U	<2.50U	2620	657	<2.50U	<10.0U	354
M34	3900	<2.50U	<2.50U	<25.0U	<2.00U	0.663JD	91500	<5.00U	9.34D	6.83D	5730	2.49D	7230	532	<2.50U	744J	<2.50U	<2.50U	4070	853	<2.50U	<10.0U	197
CC48	7390D	<5.00U	<5.00U	<50.0U	<20.0U	3.58D	199000D	<10.0U	16.9D	43.3D	13800D	9.63D	11300D	5370D	10.5D	<2500U	<5.00U	<5.00U	4630JD	2380D	7.83JD	<20.0U	2720D
Combined sample M34/CC48 serially diluted by Animas River surface water sample A56																							
M34/CC48/A56 Control*																							
M34/CC48/A56 6.25%	386	<2.50U	<2.50U	<25.0U	<2.00U	1.45D	69700	<5.00U	0.725JD	3.91JD	588	1.47D	3960	1660	<2.50U	698J	<2.50U	<2.50U	2860	715	<2.50U	<10.0U	411
M34/CC48/A56 12.5%	651	<2.50U	<2.50U	<25.0U	<2.00U	0.705JD	68100	<5.00U	1.42D	4.47JD	1030	1.19D	4060	402	<2.50U	705J	<2.50U	<2.50U	2750	700	<2.50U	<10.0U	272
M34/CC48/A56 25%	1290	<2.50U	<2.50U	<25.0U	<2.00U	0.912JD	76600	<5.00U	3.26D	7.24D	2040	2.27D	4700	663	<2.50U	784J	<2.50U	<2.50U	2980	785	<2.50U	<10.0U	390
M34/CC48/A56 50%	2670	<2.50U	<2.50U	<25.0U	<2.00U	1.39D	96900	<5.00U	7.25D	13.6D	4270	3.29D	6190	1250	2.52JD	939J	<2.50U	<2.50U	3500	1020	<2.50U	<10.0U	653
M34/CC48/A56 100%	5530	<2.50U	<2.50U	<25.0U	<2.00U	2.32D	136000	<5.00U	16.0D	29.6D	8720	6.70D	8880	2400	6.53D	1220	<2.50U	<2.50U	4360	1420	<2.50U	<10.0U	1160
Combined sample M34/CC48 serially diluted by Animas River surface water sample A68																							
M34/CC48/A68 Control*																							
M34/CC48/A68 6.25%	323	<2.50U	<2.50U	25.2JD	<2.00U	<0.500U	63500	<5.00U	0.537JD	<2.50U	510	0.872JD	3740	262	<2.50U	648J	<2.50U	<2.50U	2650	647	<2.50U	<10.0U	216
M34/CC48/A68 12.5%	561	<2.50U	<2.50U	<25.0U	<2.00U	1.37D	70300	<5.00U	1.22D	5.12D	830	1.60D	4040	1630	<2.50U	688J	<2.50U	<2.50U	2830	721	<2.50U	<10.0U	403
M34/CC48/A68 25%	1490	<2.50U	<2.50U	<25.0U	<2.00U	1.62D	80900	<5.00U	3.92D	9.58D	2170	2.65D	4870	1780	<2.50U	781J	<2.50U	<2.50U	3100	852	<2.50U	<10.0U	547
M34/CC48/A68 50%	2610	<2.50U	<2.50U	<25.0U	<2.00U	1.64D	100000	<5.00U	7.66D	15.0D	4070	3.40D	6310	2010	2.95JD	932J	<2.50U	<2.50U	3610	1060	<2.50U	<10.0U	751
Reference toxicity test																							
Control-Ref	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13300	<5.00U	<0.500U	<2.50U	<100U	<0.500U	14200	<2.00U	<2.50U	2110	<2.50U	<2.50U	25500	78.7	<2.50U	<10.0U	<10.0U
6.25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13600	5.15JD	<0.500U	<2.50U	<100U	<0.500U	14300	<2.00U	<2.50U	2100	<2.50U	<2.50U	25600	79.5	<2.50U	<10.0U	66.2
12.50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13500	19.9D	<0.500U	2.59JD	<100U	0.877JD	14300	<2.00U	9.83D	2140	<2.50U	<2.50U	25400	78.6	3.79JD	<10.0U	132
25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13300	7.14JD	<0.500U	<2.50U	<100U	<0.500U	14000	<2.00U	2.75JD	2090	<2.50U	<2.50U	25100	78.3	<2.50U	<10.0U	259
50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13400	<5.00U	<0.500U	<2.50U	<100U	<0.500U	14200	<2.00U	<2.50U	2110	<2.50U	<2.50U	25400	79.0	<2.50U	<10.0U	516
100%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13400	<5.00U	<0.500U	<2.50U	<100U	<0.500U	14100	<2.00U	<2.50U	2170	<2.50U	<2.50U	25300	78.2	<2.50U	<10.0U	1000

Final Total Metals (µg/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of the Animas River surface water samples																							
Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	17.0D	<0.500U	<2.50U	<100U	<0.500U	14500	<2.00U	6.19D	2450	<2.50U	<2.50U	26200	81.0	<2.50U	<10.0U	<10.0U
Bbridge	147	<2.50U	<2.50U	32.2JD	<2.00U	0.856JD	67300	7.01JD	2.60D	<2.50U	114J	<0.500U	6460	662	<2.50U	1360	<2.50U	<2.50U	3130	658	<2.50U	<10.0U	306
A75B	557	<2.50U	<2.50U	31.4JD	<2.00U	1.16D	70500	5.61JD	3.85D	3.17JD	576	0.931JD	5970	911	<2.50U	1240	<2.50U	<2.50U	3250	711	<2.50U	<10.0U	424
A73B	568	<2.50U	<2.50U	25.5JD	<2.00U	1.53D	82800	5.80JD	6.15D	5.97D	644	0.935JD	5990	1390	<2.50U	1250	<2.50U	<2.50U	3490	883	<2.50U	<10.0U	621
A56	38.9J	<2.50U	<2.50U	26.0JD	<2.00U	0.579JD	58600	6.01JD	<0.500U	<2.50U	<100U	1.33D	3470	114	<2.50U	880J	4.89JD	<2.50U	2600	605	<2.50U	<10.0U	147
A72	831	<2.50U	<2.50U	<25.0U	<2.00U	1.96D	103000	5.11JD	8.24D	11.6D	1750	0.841JD	6820	1860	3.13JD	2350	4.98JD	<2.50U	4660	1090	<2.50U	<10.0U	786
A68	72.7	<2.50U	<2.50U	<25.0U	<2.00U	1.25D	62000	6.00JD	<0.500U	2.97JD	<100U	1.25D	3570	1550	<2.50U	928J	4.44JD	<2.50U	2720	653	<2.50U	<10.0U	333
Combined sample M34/CC48 serially diluted by Animas River surface water sample A56																							
M34/CC48/A56 Control*																							
M34/CC48/A56 6.25%	308	<2.50U	<2.50U	26.5JD	<2.00U	0.663JD	64300	5.16JD	0.574JD	<2.50U	463	0.831JD	3890	265	<2.50U	930J	<2.50U	<2.50U	2800	675	<2.50U	<10.0U	201
M34/CC48/A56 12.5%	412	<2.50U	<2.50U	26.4JD	<2.00U	0.583JD	67400	5.31JD	1.41D	<2.50U	625	0.960JD	4170	400	<2.50U	967J	3.29JBD	<2.50U	2880	717	<2.50U	<10.0U	238
M34/CC48/A56 25%	601	<2.50U	<2.50U	<25.0U	<2.00U	0.722JD	76700	<5.00U	3.46D	3.03JD	951	1.30D	4890	683	<2.50U	1070	5.23JBD	<2.50U	3130	825	<2.50U	<10.0U	328
M34/CC48/A56 50%	1540	<2.50U	<2.50U	<25.0U	<2.00U	1.49D	95100	<5.00U	7.03D	7.96D	2620	2.12D	6240	1230	<2.50U	1410	6.03JBD	<2.50U	3950	1020	<2.50U	<10.0U	616
M34/CC48/A56 100%	5700	<2.50U	<2.50U	<25.0U	<2.00U	2.67D	135000	<5.00U	15.2D	27.3D	1930	5.12D	9170	2400	5.94D	4180	<2.50U	<2.50U	5600	1470	<2.50U	<10.0U	1140
Combined sample M34/CC48 serially diluted by Animas River surface water sample A68																							
M34/CC48/A68 Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	7.61JD	<0.500U	<2.50U	<100U	<0.500U	14300	<2.00U	<2.50U	2440	<2.50U	<2.50U	26000	81.2	<2.50U	<10.0U	<10.0U
M34/CC48/A68 6.25%	335	<2.50U	<2.50U	26.1JD	<2.00U	1.26D	68900	5.33JD	0.842JD	4.00JD	474	1.55D	3960	1630	<2.50U	795J	<2.50U	<2.50U	3170	723	<2.50U	<10.0U	382
M34/CC48/A68 12.5%	577	<2.50U	<2.50U	<25.0U	<2.00U	1.32D	73000	5.25JD	1.79D	5.00D	809	1.91D	4300	1670	<2.50U	722J	<2.50U	<2.50U	3290	775	<2.50U	<10.0U	419
M34/CC48/A68 25%	1190	<2.50U	<2.50U	<25.0U	<2.00U	1.58D	81300	<5.00U	3.87D	7.94D	1710	2.57D	4970	1770	<2.50U	869J	<2.50U	<2.50U	3530	873	<2.50U	<10.0U	523
M34/CC48/A68 50%	753	<2.50U	<2.50U	<25.0U	<2.00U	1.83D	100000	<5.00U	7.70D	6.11D	1310	0.956JD	6360	1970	3.45JD	1330	<2.50U	<2.50U	4010	1060	<2.50U	<10.0U	709
Reference toxicity test																							
Control-Ref	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13200	<5.00U	<0.500U	<2.50U	<100U	<0.500U	14500	<2.00U	<2.50U	2440	7.76JBD	<2.50U	26300	84.3	<2.50U	<10.0U	<10.0U
6.25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13100	6.02JD	<0.500U	<2.50U	<100U	<0.500U	14700	<2.00U	<2.50U	2460	5.17D	<2.50U	26600	81.6	<2.50U	<10.0U	60.1
12.50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13300	5.84JD	<0.500U	<2.50U	<100U	0.580JD	14600	<2.00U	<2.50U	2470	3.38JD	<2.50U	26200	80.8	3.60JD	<10.0U	121
25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13300	8.14JD	<0.500U	<2.50U	<100U	<0.500U	14500	<2.00U	2.71JD	3390	<2.50U	<2.50U	26600	80.0	<2.50U	<10.0U	238
50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13300	5.05JD	<0.500U	<2.50U	<100U	<0.500U	14500	<2.00U	<2.50U	3060	4.65JD	<2.50U	26600	80.3	<2.50U	<10.0U	465
100%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13100	<5.00U	<0.500U	<2.50U	<100U	<0.500U	14100	<2.00U	<2.50U	2740	<2.50U	<2.50U	25500	78.4	<2.50U	<10.0U	910

* No Aanalytical data is available

Qualifiers:

D= Diluted sample

J= Estimated value

U= Non-detect

Prepared by: EC 3.7.13

Reviewed by: BGK 3.11.3

Table 2.5-4 Initial and Final Wet Chemistry Results
October 2012 Upper Animas River Surface Water Toxicity Test Using Juvenile *O.mykiss*

Initial Wet Chemistry Results (mg/L)

STATION_ID	Chloride	Fluoride	Nitrate/Nitrite as N	Sulfate as SO4	Dissolved Organic Carbon	Total Alkalinity (mg CaCO3/L)
Profile test of the Animas River, Mineral Creek, and Cement Creek surface water samples						
Control	2.3	<0.1U	<0.2U	84.3	<1.0U	59.4
Baker Bridge	16.8JD	4.3D	<2.0U	1730D	<1.0U	26.5
A75B	1.6J	0.4	<0.2U	184	<1.0U	17.1
A73B	1.5J	0.5	<0.2U	234	<1.0U	<5.00U
A56	1.3J	0.5	<0.2U	127	<1.0U	37.8
A72	<10.0U	<1.0U	<2.0U	263D	<1.0U	<5.00U
A68	1.2J	0.5	<0.2U	141	<1.0U	35.8
M34	<10.0U	<1.0U	<2.0U	232D	<1.0U	<5.00U
CC48	<1.0U	0.2	<0.2U	60.9	<1.0U	<5.00U
Combined sample M34/CC48 serially diluted by Animas River surface water sample A56						
M34/CC48/A56 Control*	--	--	--	--	--	--
M34/CC48/A56 6.25%	1.3J	0.5	<0.2U	145	<1.0U	32.3
M34/CC48/A56 100%	<10.0U	<1.0U	<2.0U	357D	<1.0U	<5.00U
M34/CC48/A56 12.5%	1.3J	0.5	<0.2U	162	<1.0U	27.5
M34/CC48/A56 25%	1.3J	0.5	<0.2U	196	<1.0U	17.5
M34/CC48/A56 50%	<10.0U	<1.0U	<2.0U	239D	<1.0U	<5.00U
M34/CC48/A56 100%	<10.0U	<1.0U	<2.0U	357D	<1.0U	<5.00U
Combined sample M34/CC48 serially diluted by Animas River surface water sample A68						
M34/CC48/A68 Control*	--	--	--	--	--	--
M34/CC48/A68 6.25%	1.2J	0.5	<0.2U	158	<1.0U	31.6
M34/CC48/A68 12.5%	1.3J	0.5	<0.2U	164	<1.0U	31.2
M34/CC48/A68 25%	1.2J	0.6	<0.2U	210	<1.0U	17.6
M34/CC48/A68 50%	<10.0U	<1.0U	<2.0U	254D	<1.0U	<5.00U
Reference toxicity test						
Control-Ref	2.3	<0.1U	<0.2U	84.1	<1.0U	56.6
6.25%	2.3	<0.1U	<0.2U	84.3	<1.0U	60.0
12.50%	2.3	<0.1U	<0.2U	84.3	<1.0U	56.7
25%	2.3	<0.1U	<0.2U	85.0	<1.0U	59.5
50%	2.3	<0.1U	<0.2U	85.2	<1.0U	58.4
100%	2.3	<0.1U	<0.2U	84.3	<1.0U	60.5

Final Wet Chemistry Results (mg/L)

STATION_ID	Chloride	Fluoride	Nitrate/Nitrite as N	Sulfate as SO4	Dissolved Organic Carbon	Total Alkalinity (mg CaCO3/L)
Profile test of the Animas River, Mineral Creek, and Cement Creek surface water samples						
Control	2.3	<0.1U	<0.2U	85.0	<1.0U	61.0
Baker Bridge	<10.0U	<1.0U	<2.0U	160D	<1.0U	31.8
A75B	1.6J	0.4	<0.2U	183	<1.0U	20.5
A73B	1.6J	0.4	<0.2U	232	<1.0U	<5.00U
A56	1.3J	0.4	<0.2U	125	<1.0U	40.9
A72	<10.0U	1.6JD	<2.0U	282D	3.1	<5.00U
A68	1.2J	0.5	<0.2U	139	<1.0U	42.7
Combined sample M34/CC48 serially diluted by Animas River surface water sample A56						
M34/CC48/A56 Control*	--	--	--	--	--	--
M34/CC48/A56 6.25%	1.3J	0.5	<0.2U	144	<1.0U	37.1
M34/CC48/A56 12.5%	1.2J	0.5	<0.2U	161	<1.0U	32.0
M34/CC48/A56 25%	1.3J	0.5	<0.2U	195	1.0	19.5
M34/CC48/A56 50%	<10.0U	<1.0U	<2.0U	242D	<1.0U	5.82
M34/CC48/A56 100%	<10.0U	<1.0U	<2.0U	371D	6.3	<5.00U
Combined sample M34/CC48 serially diluted by Animas River surface water sample A68						
M34/CC48/A68 Control	2.4	<0.1U	<0.2U	85.3	<1.0U	72.2
M34/CC48/A68 6.25%	1.7J	0.5	<0.2U	157	1.2	35.7
M34/CC48/A68 12.5%	1.7J	0.5	<0.2U	173	1.1	28.1
M34/CC48/A68 25%	1.8J	0.5	<0.2U	206	1.0	19.5
M34/CC48/A68 50%	<10.0U	<1.0U	<2.0U	248D	1.3	5.00
Reference toxicity test						
Control-Ref	2.3	<0.1U	<0.2U	84.6	<1.0U	70.5
Ref 6.25%	2.3	<0.1U	<0.2U	85.3	<1.0U	63.8
Ref 12.50%	2.3	<0.1U	<0.2U	85.4	<1.0U	66.3
Ref 25%	3.4	<0.1U	<0.2U	85.4	1.6	64.0
Ref 50%	3.1	<0.1U	<0.2U	84.8	1.3	62.4
Ref 100%	2.8	<0.1U	<0.2U	85.7	<1.0U	59.7

* No analytical data is available

Qualifiers:

D= Diluted sample

J= Estimated value

U= Non-detect

Prepared by: EC 3.7.13

Reviewed by: BGK 3.11.13

Table 2.5-5a: Initial and Final Average Ammonia Results for October 2012 Upper Animas River Surface Water Toxicity Test Using Juvenile *O. mykiss*

Replicate ID	Day 0 Measured Ammonia Conc. (mg N/L)	Day 0 Measured pH	Day 0 Average Measured Ammonia Conc. (mg N/L)	Day 0 Average Measured pH	Day 0 Ammonia Criterion (mg N/L)[a]	Day 4 Measured Ammonia Conc. (mg N/L)[b]	Day 4 Measured pH [b]	Day 4 Average Measured Ammonia Conc. (mg N/L)	Day 4 Average Measured pH	Day 4 Ammonia Criterion (mg N/L)[a]
PROFILE TEST										
Control-01	0.09422	7.3	0.0932	7.38	15.87	0.9190	7.5	0.9231	7.58	11.84
Control-02	0.09144	7.4				0.8345	7.6			
Control-03	0.08965	7.4				0.9018	7.6			
Control-04	0.09735	7.4				1.0370	7.6			
A56-01	0.10340	6.9	0.1012	7.00	24.10	1.0190	7.0	0.9032	7.10	21.94
A56-02	0.09974	7.0				0.8928	7.2			
A56-03	0.09829	7.0				0.8984	7.1			
A56-04	0.10330	7.1				0.8024	7.1			
A68-01	0.06243	7.2	0.0627	7.23	19.17	0.9075	7.3	0.9958	7.38	15.87
A68-02	0.06379	7.2				1.0410	7.4			
A68-03	0.06102	7.2				1.0590	7.4			
A68-04	0.06375	7.3				0.9758	7.4			
A72-01	0.10640	5.5	0.1072	5.50	38.25	1.1350	6.2	0.8267	6.03	36.59
A72-02	0.10750	5.5				0.7567	6.1			
A72-03	0.10750	5.5				0.4720	5.9			
A72-04	0.10740	5.5				0.9430	5.9			
A73B-01	0.11070	6.3	0.1149	6.15	35.86	1.1990	7.1	1.0718	6.85	27.12
A73B-02	0.11420	6.1				1.1250	6.9			
A73B-03	0.11800	6.1				1.0270	6.7			
A73B-04	0.11680	6.1				0.9361	6.7			
A75B-01	0.10380	7.1	0.1016	7.10	21.94	0.9501	7.4	0.9497	7.35	16.41
A75B-02	0.10130	7.1				0.9315	7.4			
A75B-03	0.10340	7.1				0.8740	7.3			
A75B-04	0.09803	7.1				1.0430	7.3			
Baker Bridge-01	0.11120	7.1	0.1088	7.10	21.94	0.9039	7.4	0.9099	7.40	15.34
Baker Bridge-02	0.10180	7.1				0.8546	7.4			
Baker Bridge-03	0.10270	7.1				0.8947	7.4			
Baker Bridge-04	0.11930	7.1				0.9865	7.4			
SERIAL DILUTION OF SAMPLE 34/48 WITH 56 AS THE DILUENT										
34/48/56 -Control-01	0.05895	7.6	0.0608	7.45	14.30	0.8217	7.6	0.8483	7.68	10.06
34/48/56 -Control-02	0.06058	7.4				0.8818	7.7			
34/48/56 -Control-03	0.06092	7.4				0.8147	7.7			
34/48/56 -Control-04	0.06276	7.4				0.8750	7.7			
34/48/56-6.25%-01	0.06189	7.3	0.0619	7.28	18.06	0.9375	7.6	0.8716	7.53	12.79
34/48/56-6.25%-02	0.06267	7.2				0.8028	7.5			
34/48/56-6.25%-03	0.06153	7.3				0.8767	7.5			
34/48/56-6.25%-04	0.06162	7.3				0.8695	7.5			
34/48/56-12.5%-01	0.05990	7.2	0.0570	7.20	19.73	0.8763	7.5	0.8755	7.43	14.81
34/48/56-12.5%-02	0.05917	7.2				0.9640	7.4			
34/48/56-12.5%-03	0.05431	7.2				0.8171	7.4			
34/48/56-12.5%-04	0.05476	7.2				0.8446	7.4			
34/48/56-25%-01	0.05823	7.1	0.0581	7.08	22.49	0.9556	7.4	0.9013	7.38	15.87
34/48/56-25%-02	0.05733	7.1				0.8771	7.4			
34/48/56-25%-03	0.05855	7.1				0.9341	7.3			
34/48/56-25%-04	0.05816	7.0				0.8384	7.4			
34/48/56-50%-01	0.05896	6.2	0.0581	6.18	35.69	0.9973	7.1	0.9348	6.98	24.63
34/48/56-50%-02	0.05784	6.2				1.0670	7.0			
34/48/56-50%-03	0.05704	6.2				0.7439	6.9			
34/48/56-50%-04	0.05855	6.1				0.9308	6.9			
34/48/56-100%-01	0.05955	3.9	0.0594	3.85	38.98	1.6430	4.2	0.7493	4.15	38.97
34/48/56-100%-02	0.05658	3.9				0.4627	4.1			
34/48/56-100%-03	0.06055	3.8				0.3219	4.1			
34/48/56-100%-04	0.06089	3.8				0.5694	4.2			
SERIAL DILUTION OF SAMPLE 34/48 WITH 68AS THE DILUENT										
34/48/68 Control-01	0.05814	7.2	0.0580	7.23	19.17	0.8449	7.3	0.8699	7.48	13.79
34/48/68 Control-02	0.05853	7.2				0.8881	7.4			
34/48/68 Control-03	0.05827	7.2				0.8595	7.6			
34/48/68 Control-04	0.05719	7.3				0.8872	7.6			
34/48/68-6.25%-01	0.17650	7.3	0.1822	7.33	16.96	0.5949	7.7	0.6156	7.60	11.37
34/48/68-6.25%-02	0.19660	7.3				0.6748	7.6			
34/48/68-6.25%-03	0.16030	7.3				0.5602	7.6			
34/48/68-6.25%-04	0.19520	7.4				0.6323	7.5			
34/48/68-12.5%-01	0.17150	7.3	0.1607	7.25	18.61	0.6344	7.6	0.6206	7.55	12.31
34/48/68-12.5%-02	0.15250	7.3				0.5795	7.6			
34/48/68-12.5%-03	0.15520	7.2				0.6419	7.5			
34/48/68-12.5%-04	0.16350	7.2				0.6265	7.5			
34/48/68-25%-01	0.16250	7.1	0.1656	6.98	24.63	0.6199	7.4	0.7245	7.45	14.30
34/48/68-25%-02	0.17310	6.9				0.8713	7.5			
34/48/68-25%-03	0.15450	7.0				0.6583	7.4			
34/48/68-25%-04	0.17230	6.9				0.7485	7.5			
34/48/68-50%-01	0.14220	6.1	0.1414	6.03	36.59	0.8853	7.1	0.9240	7.00	24.10
34/48/68-50%-02	0.14290	5.9				1.0520	7.1			
34/48/68-50%-03	0.14380	6.0				0.9768	6.9			
34/48/68-50%-04	0.13680	6.1				0.7819	6.9			

[a] The sample-specific acute ammonia criterion was calculated using the "salmon present" formula on p. 54 of the Colorado Department of Public Health and Environment, Water Quality Control Commission, Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31).

[b] Values shown are either the measurements made at the end of the test (day 4) or earlier if all test organisms died before the 4-day exposure period was completed.

Prepared by: EC 3/7/13

Reviewed by: BGK 3/13/13

Table 2.5-5b Initial and Final Average Ammonia Results for October 2012 Upper Animas River Concurrent Reference Toxicity Test Using Juvenile O. mykiss

Replicate ID	Day 0 Measured Ammonia Conc. (mg N/L)	Day 0 Measured pH	Day 0 Average Measured Ammonia Conc. (mg N/L)	Day 0 Average Measured pH	Day 0 Ammonia Criterion (mg N/L)[a]	Day 4 Measured Ammonia Conc. (mg N/L) [b]	Day 4 Measured pH [b]	Day 4 Average Measured Ammonia Conc. (mg N/L)	Day 4 Average Measured pH	Day 4 Ammonia Criterion (mg N/L)[a]
Ref Control-01	0.08144	7.40	0.0831	7.50	13.28	0.7470	7.60	0.7812	7.63	10.92
Ref Control-02	0.08438	7.50				0.8759	7.60			
Ref Control-03	0.08350	7.50				0.7547	7.70			
Ref Control-04	0.08304	7.60				0.7471	7.60			
6.25%-01	0.07884	7.50	0.0844	7.55	12.31	0.8604	7.60	0.8056	7.60	11.37
6.25%-02	0.08514	7.50				0.7369	7.60			
6.25%-03	0.08633	7.60				0.7664	7.60			
6.25%-04	0.08711	7.60				0.8588	7.60			
12.5%-01	0.06867	7.60	0.0693	7.60	11.37	0.5868	7.60	0.7010	7.65	10.49
12.5%-02	0.06773	7.60				0.6369	7.70			
12.5%-03	0.07157	7.60				0.8041	7.70			
12.5%-04	0.06908	7.60				0.7761	7.60			
25%-01	0.06999	7.60	0.0710	7.60	11.37	0.3805	7.60	0.4599	7.70	9.64
25%-02	0.07186	7.60				0.6962	7.70			
25%-03	0.07181	7.60				0.2761	7.70			
25%-04	0.07049	7.60				0.4869	7.80			
50%-01	0.06989	7.60	0.0699	7.60	11.37	0.2685	7.70	0.3577	7.75	8.85
50%-02	0.07212	7.60				0.2968	7.80			
50%-03	0.06837	7.60				0.5770	7.70			
50%-04	0.06923	7.60				0.2884	7.80			
100%-01	0.08044	7.60	0.0726	7.60	11.37	0.2373	7.70	0.2477	7.70	9.64
100%-02	0.06943	7.60				0.2355	7.70			
100%-03	0.06942	7.60				0.3495	7.80			
100%-04	0.07124	7.60				0.1686	7.60			

[a] The sample-specific acute ammonia criterion was calculated using the "salmon present" formula on p. 54 of the Colorado Department of Public Health and Environment, Water Quality Control Commission, Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31).

[b] Values shown are either the measurements made at the end of the test (day 4) or earlier if all test organisms died before the 4-day exposure period was completed.

Prepared by:EC 3/7/13

Reviewed by: BGK 3/11/13

Table 2.5-6 Initial and Final Dissolved Metals Results
November 2012 Upper Animas River Surface Water Toxicity Test Using Juvenile *O.mykiss*

Initial Analytical Data (µg/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Hardness (mg/L)	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of the Animas River, Mineral Creek, and Cement Creek surface water samples																								
Profile Control	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13000	<1.00U	<0.100	0.544J	91	<100U	<0.100	14100	<2.00U	<0.500	2040	<0.500U	<0.500	25500	73.4	<0.500	<2.00U	<10.0U
A72	965	<2.50U	<2.50U	<25.0U	<2.00U	2.10D	107000	<5.00U	8.95D	17.0D	296	2770	0.849JD	7000	1860	5.13D	1080	<2.50U	<2.50U	4060	1080	<2.50U	<10.0U	827
A68	55.5	<0.500U	<0.500	24.1	<2.00U	1.40	66400	<1.00U	<0.100	1.56J	181	<100U	0.212	3730	1870	<0.500	695J	<0.500U	<0.500	2780	660	<0.500	<2.00U	397
CC48	7700D	<5.00U	<5.00U	<50.0U	<10.0U	5.51D	196000	<10.0U	26.1D	71.0D	536D	6460D	13.1D	11400D	5380D	17.2D	2040JD	<5.00U	<5.00U	4760JD	2370D	<5.00U	<20.0U	2710D
M34	1200	<2.50U	<2.50U	<25.0U	<2.00U	0.789JD	97600	<5.00U	10.1D	6.91D	276	5060	1.03D	7790	585	3.25JD	835J	<2.50U	<2.50U	4470	942	<2.50U	<10.0U	216
Aminas River surface water sample A72 serially diluted by Animas River surface water sample A68																								
A68/A72 control	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13100	<1.00U	<0.100	<0.500	92	<100U	<0.100	14500	<2.00U	<0.500	2100	<0.500U	<0.500	26100	78.1	<0.500	<2.00U	<10.0U
A68/A72 5%	67.8	<0.500U	<0.500	23.5	<2.00U	1.40	68500	<1.00U	0.509	1.02J	187	<100U	<0.100	3890	1860	0.840J	682J	<0.500U	<0.500	2860	688	<0.500	<2.00U	389
A68/A72 10%	73.0	<0.500U	<0.500	23.3	<2.00U	1.41	70600	2.43	0.963	1.97J	193	172J	<0.100	4120	1870	2.65	742J	<0.500U	<0.500	2970	715	<0.500	<2.00U	423
A68/A72 25%	33.4J	<0.500U	<0.500	22.5	<2.00U	1.48	76300	<1.00U	2.07	1.86J	209	492	<0.100	4570	1860	1.66	791J	0.643J	<0.500	3150	771	<0.500	<2.00U	482
A68/A72 50%	38.2J	<0.500U	<0.500	22.6	<2.00U	1.74	86500	<1.00U	4.06	3.92	238	1250	<0.100	5440	1700	2.21	920J	0.796J	<0.500	3490	805	<0.500	<2.00U	566
A68/A72 75%	197	<0.500U	<0.500	21.7	<2.00U	1.92	90300	<1.00U	6.27	8.80	250	1880	0.126J	5880	1940	3.84	918J	<0.500U	<0.500	3640	1030	<0.500	<2.00U	727
A68/A72 100%	990	<0.500U	<0.500	20.9	<2.00U	2.12	107000	3.41	8.47	15.0	298	2730	0.860	7130	1910	6.47	1080	0.664J	<0.500	4120	1130	<0.500	<2.00U	835
Cement Creek surface water sample CC48 serially diluted by Animas River surface water sample A68																								
A68/CC48 Control	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13100	1.36J	<0.100	0.580J	92	<100U	<0.100	14400	<2.00U	0.709J	2090	<0.500U	<0.500	26200	74.9	<0.500	<2.00U	<10.0U
A68/CC48 1%	101	<0.500U	<0.500	23.9	<2.00U	1.42	67500	<1.00U	0.347	2.07	184	<100U	0.127J	3820	1890	0.748J	700J	<0.500U	<0.500	2840	686	<0.500	<2.00U	410
A68/CC48 3%	72.2	<0.500U	<0.500	23.9	<2.00U	1.47	70700	<1.00U	0.879	1.91J	193	<100U	0.107J	3980	1960	1.52	729J	<0.500U	<0.500	2910	720	<0.500	<2.00U	447
A68/CC48 6%	76.7	<0.500U	<0.500	24.1	<2.00U	1.52	74500	1.22J	1.59	2.67	204	129J	<0.100	4250	2060	1.80	760J	0.728J	<0.500	3000	770	<0.500	<2.00U	516
A68/CC48 12%	56.5	<0.500U	<0.500	22.2	<2.00U	1.84	82600	<1.00U	3.01	2.85	226	248J	<0.100	4710	2310	2.50	843J	0.690J	<0.500	3090	886	<0.500	<2.00U	655
A68/CC48 25%	403	<0.500U	<0.500	20.5	<2.00U	2.34	99600	<1.00U	6.15	8.48	272	483	0.227	5740	2690	4.41	1030	0.520J	<0.500	3380	1070	<0.500	<2.00U	954
A68/CC48 50%	3870	<2.50U	<2.50U	<25.0U	<2.00U	3.26D	134000	6.67JD	12.5D	32.1D	368	1090	4.28D	7830	3510	11.7D	1400	<2.50U	<2.50U	3950	1480	<2.50U	<10.0U	1510
Combined sample M34/CC48 serially diluted by Animas River surface water sample A68																								
A68/M34/CC48 Control	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13200	<1.00U	<0.100	0.755J	91	<100U	<0.100	14200	<2.00U	<0.500	2030	<0.500U	<0.500	25500	73.2	<0.500	<2.00U	<10.0U
A68/M34/CC48 4%	99.7	<0.500U	<0.500	23.6	<2.00U	1.39	67800	<1.00U	0.561	1.39	185	150J	<0.100	3890	1850	<0.500	721J	<0.500U	<0.500	2880	690	<0.500	<2.00U	397
A68/M34/CC48 9%	84.1	<0.500U	<0.500	23.8	<2.00U	1.48	72600	<1.00U	1.22	1.83	199	373	<0.100	4190	1880	1.00	719J	<0.500U	<0.500	2960	723	<0.500	<2.00U	433
A68/M34/CC48 20%	73.3	<0.500U	<0.500	22.6	<2.00U	1.56	77500	<1.00U	2.91	2.68	213	783	0.119J	4700	1880	2.35	772J	<0.500U	<0.500	3150	802	<0.500	<2.00U	485
A68/M34/CC48 40%	332	<2.50U	<2.50U	<25.0U	<2.00U	1.82D	88300	<5.00U	5.88D	11.1D	244	1600	0.524JD	5680	1910	3.68JD	890J	<2.50U	<2.50U	3480	930	<2.50U	<10.0U	612
A68/M34/CC48 65%	1580	<2.50U	<2.50U	<25.0U	<2.00U	1.92D	107000	<5.00U	9.67D	18.7D	296	2670	1.90D	7150	1960	5.41D	1060	<2.50U	<2.50U	4000	1100	<2.50U	<10.0U	758
A68/M34/CC48 85%	2900	<2.50U	<2.50U	<25.0U	<2.00U	2.26D	118000	5.45JD	12.6D	28.9D	328	3770	5.19D	8190	1980	9.29D	1140	<2.50U	<2.50U	4440	1220	<2.50U	<10.0U	870
Reference toxicity test																								
Control-Ref	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13100	<1.00U	<0.100	<0.500	91	<100U	<0.100	14100	<2.00U	<0.500	2010	<0.500U	<0.500	25400	72.8	<0.500	<2.00U	<10.0U
Ref 6.25%	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13000	<1.00U	<0.100	<0.500	90	<100U	<0.100	14100	<2.00U	<0.500	2020	<0.500U	<0.500	25300	73.9	<0.500	<2.00U	57.9
Ref 12.5%	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13100	<1.00U	<0.100	0.519J	91	<100U	<0.100	14200	<2.00U	<0.500	2040	<0.500U	<0.500	25600	71.7	<0.500	<2.00U	108
Ref 25%	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13100	<1.00U	<0.100	<0.500	91	<100U	<0.100	14200	<2.00U	<0.500	2040	<0.500U	<0.500	25500	73.2	<0.500	<2.00U	214
Ref 50%	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13000	<1.00U	<0.100	0.594J	91	<100U	<0.100	14200	<2.00U	<0.500	2040	<0.500U	<0.500	25500	73.2	<0.500	<2.00U	430
Ref 100%	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	12900	<1.00U	<0.100	0.835J	90	<100U	<0.100	14000	<2.00U	<0.500	2030	<0.500U	<0.500	25300	75.3	<0.500	<2.00U	866

Final Analytical Data (µg/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Hardness (mg/L)	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of the Animas River and Mineral Creek surface water samples																								
Profile Control	25.1J	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	12800	<1.00U	<0.100	1.12	93	<100U	<0.100	14800	<2.00U	<0.500	2500	<0.500U	<0.500	27100	78.5	<0.500	<2.00U	<10.0U
A68	43.9J	<0.500U	<0.500	23.3	<2.00U	1.21	64700	<1.00U	<0.100	2.16	177	<100U	0.106J	3710	1720	<0.500	909J	1.25JB	<0.500	2990	661	<0.500	<2.00U	413
M34	248	<2.50U	<2.50U	<25.0U	<2.00U	0.712JD	99500	<5.00U	8.80D	3.14JD	282	4270	<0.500	8250	592	2.56JD	4010	<2.50U	<2.50U	7380	937	<2.50U	<10.0U	230
Aminas River surface water sample A72 serially diluted by Animas River surface water sample A68																								
A68/A72 control	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	12700	<1.00U	<0.100	1.35	93	<100U	<0.100	14800	<2.00U	<0.500	2440	<0.500U	<0.500	27200	78.1	<0.500	<2.00U	<10.0U
A68/A72 5%	53.7	<0.500U	<0.500	23.4	<2.00U	1.43	68400	<1.00U	0.480	2.75	187	<100U	<0.100	4000	1910	<0.500	860J	<0.500U	<0.500	3070	701	<0.500	<2.00U	388
A68/A72 10%	46.4J	<0.500U	<0.500	23.5	<2.00U	1.29	70100	1.02J	0.860	2.66	192	<100U	<0.100	4110	1880	0.572J	869J	2.32B	<0.500	3100	720	<0.500	<2.00U	389
A68/A72 25%	41.7J	<0.500U	<0.500	22.5	<2.00U	1.39	76200	<1.00U	1.97	2.62	209	<100U	0.230	4620	1900	0.961J	952J	1.10JB	<0.500	3230	787	<0.500	<2.00U	411
A68/A72 50%	<20.0U	<0.500U	<0.500	20.8	<2.00U	1.54	86100	<1.00U	4.15	1.62	238	<100U	<0.100	5450	1900	2.18	1150	<0.500U	<0.500	3600	898	<0.500	<2.00U	521
A68/A72 75%	20.5J	<0.500U	<0.500	21.2	<2.00U	1.88	96600	<1.00U	6.26	2.12	267	206J	<0.100	6300	1890	3.35	1390	<0.500U	<0.500	4490	1000	<0.500	<2.00U	693
A68/A72 100%	1170	<0.500U	<0.500	19.8	<2.00U	2.08	108000	<1.00U	8.88	14.5	298	758	0.633	7160	1870	4.29	1870	<0.500U	<0.500	4740	1090	<0.500	<2.00U	852
Aminas River surface water sample CC48 serially diluted by Animas River surface water sample A68																								
A68/CC48 Control	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	12800	1.09J	<0.100	1.42	93	<100U	<0.100	14800	<2.00U	<0.500	2440	<0.500U	<0.500	27000	78.3	<0.500	<2.00U	<10.0U
A68/CC48 1%	72.6	<0.500U	<0.500	23.0	<2.00U	1.35	66800	<1.00U	0.279	1.93	183	<100U	<0.100	3920	1910	0.654J	1020	<0.500U	<0.500	3230	696	<0.500	<2.00U	395
A68/CC48 3%	65.4	<0.500U	<0.500	22.6	<2.00U	1.38	66700	1.30J	0.742	2.13	182	<100U	<0.100	3850	1800	0.690J	899J	0.572JB	<0.500	3000	698	<0.500	<2.00U	431
A68/CC48 6%	56.4	<0.500U	<0.500	22.3	<2.00U	1.46	73400	<1.00U	1.47	2.78	201	<100U	<0.100	4240	1950	1.12	1020	1.12JB	<0.500	3100	776	<0.500	<2.00U	461
A68/CC48 12%	39.7J	<0.500U	<0.500	21.3	<2.00U	1.75	82200	<1.00U	3.17	2.55	225	<100U	<0.100	4790	2170	2.83	1110	<0.500U	<0.500	3350	878	<0.500	<2.00U	573
A68/CC48 25%	34.1J	<0.500U	<0.500	19.6	<2.00U	2.27	98300	<1.00U	6.39	4.32	269	<100U	<0.100	5750	2600	5.15	1390	<0.500U	<0.500	3780	1070	<0.500	<2.00U	820
A68/CC48 50%	2530	<0.500U	<0.500	17.3	<2.00U	3.42	135000	<1.00U	12.1	24.9	371	179J	2.33	8030	3620	7.87	3300	1.68JB	<0.500	9320	1510	<0.500	<2.00U	1560
Combined sample M34/CC48 serially diluted by Animas River surface water sample A68																								
A68/M34/CC48 Control	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	12600	<1.00U	<0.100	1.16	92	<100U	<0.100	14700	<2.00U	<0.500	2390	<0.500U	<0.500	26600	77.7	<0.500	<2.00U	<10.0U
A68/M34/CC48 4%	60.6	<0.500U	<0.500	23.2	<2.00U	1.30	68100	<1.00U	0.615	2.17	187	<100U	<0.100	4020	1760	0.875J	860J	1.46	<0.500	3180	707	<0.500	<2.00U	408
A68/M34/CC48 9%	40.8J	<0.500U	<0.500	23.2	<2.00U	1.22	71500	<1.00U	1.28	2.11	196	<100U	0.769	4280	1780	0.767J	923J	0.523J	<0.500	3180	741	<0.500	<2.00U	402
A68/M34/CC48 20%	31.6J	<0.500U	<0.500	22.9	<2.00U	1.32	78700	<1.00U	2.70	1.70	217	<100U	0.249	4890	1810	1.35	1100	0.706J	<0.500	3540	816	<0.500	<2.00U	413
A68/M34/CC48 40%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	1.71D	90400	<5.00U	5.62D	7.71D	250	<100U	0.587JD	5930	1890	4.93JD	1250	<2.50U	<2.50U	4040	943	<2.50U	<10.0U	572
A68/M34/CC48 65%	1460	<2.50U	<2.50U	<25.0U	<2.00U	2.01D	109000	<5.00U	9.06D	16.5D	302	1340	1.36D	7440	1980	6.24D	1800	3.35JD	<2.50U	4620	1130	<2.50U	<10.0U	815
A68/M34/CC48 85%	2400	<2.50U	<2.50U	<25.0U	<2.00U	2.26D	122000	<5.00U	12.7D	20.4D	341	2690	2.81D	8600	2080	6.32D	2680	3.54JD	<2.50U	9760	1270	<2.50U	<10.0U	921
Reference toxicity test																								
Control-Ref	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	12700	<1.00U	<0.100	0.617J	93	<100U	<0.100	14800	<2.00U	<0.500	2550	<0.500U	<0.500	27100	78.1	<0.500	<2.00U	<10.0U
Ref 6.25%	<20.0U	<0.500U	1.82J	<5.00U	<2.00U	<0.100U	12600	<1.00U	<0.100	0.902J	92	101J	0.279	14800	<2.00U	<0.500	2550	<0.500U	<0.500	27200	78.1	<0.500	<2.00U	52.7
Ref 12.5%	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	12700	<1.00U	<0.100	1.02	93	<100U	<0.100	14800	<2.00U	<0.500	2350	1.03J	<0.500	27000	77.9	<0.500	<2.00U	106
Ref 25%	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13300	1.58J	<0.100	<0.500	94	<100U	<0.100	14800	<2.00U	<0.500	2540	<0.500U	<0.500	27100	78.3	<0.500	<2.00U	226
Ref 50%	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13300	2.01	<0.100	0.657J	94	<100U	<0.100	14900	<2.00U	<0.500	3710	<0.500U	<0.500	27600	78.0	<0.500	<2.00U	440
Ref 100%	<20.0U	<0.500U	<0.500	<5.00U	<2.00U	<0.100U	13300	1.96J	<0.100	<0.500	94	<100U	<0.100	14700	<2.00U	<0.500	3550	0.921J	<0.500	27400	77.6	<0.500	<2.00U	882

Qualifiers:

D= Diluted sample
J= Estimated value
U= Non-detect

Prepared by: EC 3/8/13
Reviewed by: EB 3/13/13

Table 2.5-7 Initial and Final Total Recoverable Metals Results
November 2012 Upper Animas River Surface Water Toxicity Test Using Juvenile *O.mykiss*

Initial Analytical Data (µg/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of the Animas River, Mineral Creek, and Cement Creek Surface water samples																							
Profile Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13200	6.34JD	<0.500U	<2.50U	<100U	<0.500U	14000	<2.00U	<2.50U	2000	<2.50U	<2.50U	25200	76.8	<2.50U	<10.0U	<10.0U
A68	102	<2.50U	<2.50U	<25.0U	<2.00U	1.86D	64500	<5.00U	<0.500U	3.56JD	104J	8.37D	3610	1900	<2.50U	765J	<2.50U	<2.50U	2750	671	<2.50U	<10.0U	410
A72	3420	<2.50U	<2.50U	<25.0U	<2.00U	1.89D	106000	6.07JD	7.91D	18.6D	5920	5.78D	6770	1910	2.78JD	1080	<2.50U	<2.50U	3910	1100	<2.50U	<10.0U	850
CC48	8080D	<2.50U	2.73JD	<25.0U	<10.0U	5.58D	210000	5.11JD	25.2D	65.5D	16000D	16.2D	11900D	5550D	12.6D	2050JD	<2.50U	<2.50U	4880JD	2420D	<2.50U	<10.0U	2860D
M34	4560	<2.50U	<2.50U	<25.0U	<2.00U	0.914JD	98700	<5.00U	9.97D	7.33D	7080	3.24D	7750	590	<2.50U	856J	<2.50U	<2.50U	4390	931	<2.50U	<10.0U	220
Animas River surface water sample A72 serially diluted by Animas River surface water sample A68																							
A68/A72 control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12800	5.76JD	<0.500U	<2.50U	<100U	2.88D	13900	<2.00U	<2.50U	2000	<2.50U	<2.50U	25200	76.2	<2.50U	<10.0U	<10.0U
A68/A72 5%	293	<2.50U	<2.50U	<25.0U	<2.00U	1.72D	66900	5.52JD	<0.500U	4.01JD	464	7.69D	3760	1900	<2.50U	706J	2.94JD	<2.50U	2780	702	<2.50U	<10.0U	432
A68/A72 10%	448	<2.50U	<2.50U	<25.0U	<2.00U	1.85D	68800	8.10JD	0.869JD	5.46D	727	4.16D	3900	1890	<2.50U	718J	<2.50U	<2.50U	2800	715	4.77JD	<10.0U	446
A68/A72 25%	873	<2.50U	<2.50U	<25.0U	<2.00U	2.07D	74900	5.05JD	2.20D	8.86D	1480	8.24D	4430	1920	<2.50U	799J	<2.50U	<2.50U	3070	794	<2.50U	<10.0U	526
A68/A72 50%	1330	<2.50U	<2.50U	<25.0U	<2.00U	2.21D	85600	5.37JD	4.09D	10.2D	2470	8.56D	5250	1900	<2.50U	871J	<2.50U	<2.50U	3370	891	<2.50U	<10.0U	620
A68/A72 75%	2380	<2.50U	<2.50U	<25.0U	<2.00U	1.96D	95100	5.21JD	6.32D	14.8D	4120	7.11D	6170	1920	<2.50U	988J	<2.50U	<2.50U	3830	1010	<2.50U	<10.0U	740
A68/A72 100%	3010	<2.50U	<2.50U	<25.0U	<2.00U	3.04D	105000	5.05JD	8.24D	18.8D	5330	10.6D	6850	1900	4.62JD	1120	<2.50U	<2.50U	3980	1120	<2.50U	<10.0U	842
Cement Creek surface wtaer sample CC48 serially diluted by Animas River surface water sample A68																							
A68/CC48 Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	5.53JD	<0.500U	<2.50U	<100U	<0.500U	14100	<2.00U	<2.50U	2030	<2.50U	<2.50U	25500	77.0	<2.50U	<10.0U	<10.0U
A68/CC48 1%	168	<2.50U	<2.50U	<25.0U	<2.00U	1.89D	67000	6.87JD	<0.500U	3.67JD	216J	4.71D	3730	1950	<2.50U	717J	<2.50U	<2.50U	2780	697	<2.50U	<10.0U	427
A68/CC48 3%	322	<2.50U	<2.50U	<25.0U	<2.00U	1.40D	69000	<5.00U	0.670JD	4.06JD	473	1.66D	3840	1990	<2.50U	717J	5.18D	<2.50U	2800	731	<2.50U	<10.0U	472
A68/CC48 6%	555	<2.50U	<2.50U	<25.0U	<2.00U	1.72D	72600	6.22JD	1.66D	7.02D	850	2.20D	4070	2110	<2.50U	758J	<2.50U	<2.50U	2900	781	<2.50U	<10.0U	546
A68/CC48 12%	1010	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	80600	<5.00U	<0.500U	<2.50U	1600	<0.500U	4520	2300	<2.50U	820J	<2.50U	<2.50U	2950	876	<2.50U	<10.0U	672
A68/CC48 25%	2020	<2.50U	<2.50U	<25.0U	<2.00U	1.48D	98700	<5.00U	4.04D	11.8D	3500	2.86D	5600	2770	<2.50U	1000	<2.50U	<2.50U	3260	1100	<2.50U	<10.0U	981
A68/CC48 50%	3990	<2.50U	<2.50U	<25.0U	<2.00U	3.61D	133000	<5.00U	13.0D	33.6D	7400	8.55D	7630	3630	5.62D	1360	4.85JD	<2.50U	3840	1510	<2.50U	<10.0U	1550
Combined sample M34/CC48 serially diluted by Animas River surface water sample A68																							
A68/M34/CC48 Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	7.52JD	<0.500U	<2.50U	<100U	<0.500U	13800	<2.00U	<2.50U	1980	<2.50U	<2.50U	24500	75.6	<2.50U	<10.0U	<10.0U
A68/M34/CC48 4%	314	<2.50U	<2.50U	<25.0U	<2.00U	1.42D	66800	6.39JD	0.573JD	4.13JD	465	1.75D	3770	1910	<2.50U	668J	<2.50U	<2.50U	2760	703	<2.50U	<10.0U	429
A68/M34/CC48 9%	588	<2.50U	<2.50U	<25.0U	<2.00U	1.46D	70200	5.44JD	1.32D	5.28D	904	2.37D	4010	1920	<2.50U	699J	<2.50U	<2.50U	2830	732	<2.50U	<10.0U	462
A68/M34/CC48 20%	1200	<2.50U	<2.50U	<25.0U	<2.00U	1.70D	76200	6.48JD	3.01D	8.36D	1930	2.61D	4600	1930	<2.50U	752J	<2.50U	<2.50U	3050	815	<2.50U	<10.0U	521
A68/M34/CC48 40%	2310	<2.50U	<2.50U	<25.0U	<2.00U	2.04D	90700	6.04JD	5.94D	13.0D	3720	4.36D	5630	2000	<2.50U	876J	<2.50U	<2.50U	3370	950	4.98JD	<10.0U	653
A68/M34/CC48 65%	3760	<2.50U	<2.50U	<25.0U	<2.00U	2.06D	107000	<5.00U	8.87D	16.6D	6620	5.78D	6960	2030	3.22JD	1010	<2.50U	<2.50U	3850	1130	<2.50U	<10.0U	805
A68/M34/CC48 85%	4950	<2.50U	<2.50U	<25.0U	<2.00U	2.45D	119000	<5.00U	12.3D	25.7D	8200	7.97D	7970	2050	4.39JD	1100	<2.50U	<2.50U	4230	1250	<2.50U	<10.0U	912
Reference toxicity test																							
Control-Ref	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	5.97JD	<0.500U	<2.50U	<100U	<0.500U	13900	<2.00U	<2.50U	1980	<2.50U	<2.50U	24700	76.0	<2.50U	<10.0U	<10.0U
Ref 6.25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13100	8.78JD	<0.500U	<2.50U	<100U	<0.500U	13900	<2.00U	<2.50U	2000	<2.50U	<2.50U	24800	75.8	<2.50U	<10.0U	55.8
Ref 12.5%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	6.03JD	<0.500U	<2.50U	<100U	<0.500U	13900	<2.00U	<2.50U	1980	<2.50U	<2.50U	25000	75.9	<2.50U	<10.0U	111
Ref 25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	8.12JD	<0.500U	<2.50U	<100U	<0.500U	13800	<2.00U	<2.50U	1970	<2.50U	<2.50U	24700	75.7	<2.50U	<10.0U	217
Ref 50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	7.31JD	<0.500U	<2.50U	<100U	<0.500U	13800	<2.00U	<2.50U	1980	<2.50U	<2.50U	24600	75.4	<2.50U	<10.0U	430
Ref 100%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	5.06JD	<0.500U	<2.50U	<100U	<0.500U	13900	<2.00U	<2.50U	1990	<2.50U	<2.50U	24900	75.8	<2.50U	<10.0U	872

Final Analytical Data (µg/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of Animas River and Mineral Creek surface water samples																							
Profile Control	25.2J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	10700	9.66JD	<0.500U	<2.50U	<100U	<0.500U	12700	<2.00U	<2.50U	2370	<2.50U	<2.50U	25000	70.1	<2.50U	<10.0U	<10.0U
A68	84.4	<2.50U	<2.50U	<25.0U	<2.00U	1.49D	60100	<5.00U	<0.500U	3.40JD	125J	1.85D	3470	1640	<2.50U	976J	<2.50U	<2.50U	2890	636	<2.50U	<10.0U	390
M34	396	<2.50U	<2.50U	<25.0U	<2.00U	0.968JD	94300	8.67JD	10.1D	<2.50U	4100	<0.500U	7940	584	3.01JD	4040	<2.50U	<2.50U	7300	952	<2.50U	<10.0U	212
Animas River surface water sample A72 serially diluted by Animas River surface water sample A68																							
A68/A72 control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	10700	9.90JD	<0.500U	<2.50U	<100U	<0.500U	12800	<2.00U	<2.50U	2360	<2.50U	<2.50U	24900	69.9	<2.50U	<10.0U	<10.0U
A68/A72 5%	168	<2.50U	<2.50U	<25.0U	<2.00U	1.41D	60000	7.65JD	<0.500U	4.11JD	226J	1.72D	3590	1750	<2.50U	857J	<2.50U	<2.50U	2900	657	<2.50U	<10.0U	362
A68/A72 10%	323	<2.50U	<2.50U	<25.0U	<2.00U	1.58D	65500	11.2D	0.857JD	5.24D	503	2.82D	3830	1810	3.30JD	894J	<2.50U	<2.50U	2930	702	4.01JD	<10.0U	402
A68/A72 25%	597	<2.50U	<2.50U	<25.0U	<2.00U	1.60D	70500	6.50JD	2.21D	6.30D	911	3.39D	4370	1840	<2.50U	990J	<2.50U	<2.50U	3160	776	<2.50U	<10.0U	455
A68/A72 50%	830	<2.50U	<2.50U	<25.0U	<2.00U	1.67D	78100	7.70JD	3.85D	7.39D	1310	3.01D	5060	1800	<2.50U	1150	<2.50U	<2.50U	3460	859	<2.50U	<10.0U	525
A68/A72 75%	1450	<2.50U	<2.50U	<25.0U	<2.00U	1.99D	92300	7.30JD	6.33D	9.86D	2380	3.63D	6150	1870	3.02JD	1440	<2.50U	<2.50U	4460	1020	<2.50U	<10.0U	682
A68/A72 100%	1320	<2.50U	<2.50U	<25.0U	<2.00U	2.19D	100000	7.19JD	8.66D	16.7D	1110	1.32D	6780	1840	5.15D	1890	<2.50U	<2.50U	4590	1100	<2.50U	<10.0U	779
Cement Creek surface wtaer sample CC48 serially diluted by Animas River surface water sample A68																							
A68/CC48 Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11000	8.94JD	<0.500U	<2.50U	<100U	<0.500U	12900	2.02J	<2.50U	2330	<2.50U	<2.50U	25100	71.4	<2.50U	<10.0U	<10.0U
A68/CC48 1%	144	<2.50U	<2.50U	<25.0U	<2.00U	1.32D	61600	8.26JD	<0.500U	3.13JD	143J	1.58D	3660	1830	<2.50U	996J	<2.50U	<2.50U	3130	680	<2.50U	<10.0U	377
A68/CC48 3%	255	<2.50U	<2.50U	<25.0U	<2.00U	1.51D	67000	6.18JD	0.815JD	4.59JD	318	2.19D	3890	1880	<2.50U	922J	<2.50U	<2.50U	3020	740	<2.50U	<10.0U	453
A68/CC48 6%	445	<2.50U	<2.50U	<25.0U	<2.00U	1.45D	70900	7.86JD	1.29D	5.50D	591	2.90D	4130	1930	<2.50U	1050	<2.50U	<2.50U	3090	780	<2.50U	<10.0U	509
A68/CC48 12%	719	<2.50U	<2.50U	<25.0U	<2.00U	1.77D	77000	8.62JD	2.86D	8.47D	825	4.03D	4540	2110	<2.50U	1080	<2.50U	<2.50U	3230	875	<2.50U	<10.0U	623
A68/CC48 25%	990	<2.50U	<2.50U	<25.0U	<2.00U	2.33D	92600	8.49JD	6.01D	10.9D	1300	3.42D	5490	2540	3.68JD	1380	<2.50U	<2.50U	3670	1070	<2.50U	<10.0U	847
A68/CC48 50%	2560	<2.50U	<2.50U	<25.0U	<2.00U	3.53D	130000	7.28JD	12.4D	26.8D	201J	2.62D	7770	3580	7.52D	3270	<2.50U	<2.50U	9100	1540	<2.50U	<10.0U	1450
Combined sample M34/CC48 serially diluted by Animas River surface water sample A68																							
A68/M34/CC48 Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12000	8.44JD	<0.500U	<2.50U	<100U	<0.500U	14200	<2.00U	<2.50U	2460	<2.50U	<2.50U	26700	78.4	<2.50U	<10.0U	<10.0U
A68/M34/CC48 4%	229	<2.50U	<2.50U	<25.0U	<2.00U	1.40D	60800	7.94JD	<0.500U	3.52JD	290	1.98D	3620	1630	<2.50U	849J	<2.50U	<2.50U	3010	666	4.26JD	<10.0U	390
A68/M34/CC48 9%	391	<2.50U	<2.50U	<25.0U	<2.00U	1.25D	63600	7.62JD	1.17D	3.81JD	476	1.87D	3870	1660	<2.50U	912J	<2.50U	<2.50U	3020	701	<2.50U	<10.0U	414
A68/M34/CC48 20%	805	<2.50U	<2.50U	<25.0U	<2.00U	1.39D	70500	6.91JD	2.92D	6.84D	967	2.65D	4470	1690	<2.50U	1080	<2.50U	<2.50U	3390	783	<2.50U	<10.0U	468
A68/M34/CC48 40%	1560	<2.50U	<2.50U	<25.0U	<2.00U	1.75D	84600	6.39JD	5.60D	11.7D	1970	7.59D	5590	1830	3.33JD	1240	<2.50U	<2.50U	3940	934	<2.50U	<10.0U	613
A68/M34/CC48 65%	2510	<2.50U	<2.50U	<25.0U	<2.00U	1.87D	100000	7.11JD	9.88D	16.7D	3370	3.46D	6900	1870	5.99D	1710	<2.50U	<2.50U	4400	1110	<2.50U	<10.0U	735
A68/M34/CC48 85%	2830	<2.50U	<2.50U	<25.0U	<2.00U	2.29D	117000	7.09JD	11.7D	18.7D	3300	3.98D	8380	2040	5.60D	2690	<2.50U	<2.50U	9690	1300	<2.50U	<10.0U	863
Reference toxicity test																							
Control-Ref	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11800	11.6D	<0.500U	<2.50U	<100U	<0.500U	14000	<2.00U	<2.50U	2540	<2.50U	<2.50U	26600	76.3	<2.50U	<10.0U	<10.0U
Ref 6.25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11700	8.27JD	<0.500U	<2.50U	<100U	<0.500U	13900	<2.00U	<2.50U	2500	<2.50U	<2.50U	26300	76.3	<2.50U	<10.0U	47.6
Ref 12.5%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11400	6.26JD	<0.500U	<2.50U	<100U	<0.500U	13500	<2.00U	<2.50U	2280	<2.50U	<2.50U	25600	74.1	<2.50U	<10.0U	94.0
Ref 25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12700	8.25JD	<0.500U	<2.50U	<100U	<0.500U	14400	<2.00U	<2.50U	2620	<2.50U	<2.50U	26800	79.6	<2.50U	<10.0U	206
Ref 50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13300	9.99JD	<0.500U	<2.50U	<100U	<0.500U	15000	<2.00U	<2.50U	3800	<2.50U	<2.50U	28100	80.5	<2.50U	<10.0U	403
Ref 100%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12700	9.91JD	<0.500U	<2.50U	<100U	<0.500U	14400	<2.00U	<2.50U	3560	<2.50U	<2.50U	27200	79.5	<2.50U	<10.0U	794

Qualifiers:
D= Diluted sample
J= Estimated value
U= Non-detect

Prepared by: EC 3/8/13
Reviewed by: EB 3/13/13

Table 2.5-8 Initial and Final Wet Chemistry Results
November 2012 Upper Animas River Surface Water Toxicity Test Using Juvenile *O.mykiss*

Initial Wet Chemistry (mg/L)

STATION_ID	Chloride	Fluoride	Nitrate/Nitrite as N	Sulfate as SO4	Dissolved Organic Carbon	Total Alkalinity (mg CaCO3/L)
Profile test of the Animas River, Mineral Creek, and Cement Creek surface water samples						
Profile Control	2.3	<0.1U	<0.2U	86.6	<1.0U	55.2
A68	1.2J	0.5	<0.2U	150	<1.0U	37.6
A72	<10.0U	1.7JD	<2.0U	286D	<1.0U	<5.00U
CC48	<10.0U	1.7JD	<2.0U	594D	<1.0U	<5.00U
M34	22.9D	<1.0U	<2.0U	856D	<1.0U	<5.00U
Animas River surface water sample A72 serially diluted by Animas River surface water sample A68						
A68/A72 control	2.3	<0.1U	<0.2U	85.6	<1.0U	63.1
A68/A72 5%	1.2J	0.4	<0.2U	147	<1.0U	38.5
A68/A72 10%	1.3J	0.5	<0.2U	166	<1.0U	29.9
A68/A72 25%	1.2J	0.4	<0.2U	160	<1.0U	25.9
A68/A72 50%	1.5J	0.6	<0.2U	227	<1.0U	16.6
A68/A72 75%	<10.0U	<1.0U	<2.0U	264D	<1.0U	<5.00U
A68/A72 100%	<10.0U	2.4D	<2.0U	281D	<1.0U	<5.00U
Cement Creek surface water sample CC48 serially diluted by Animas River surface water sample A68						
A68/CC48 Control	2.3	<0.1U	<0.2U	85.9	<1.0U	62.4
A68/CC48 1%	1.2J	0.5	<0.2U	154	<1.0U	33.1
A68/CC48 3%	1.2J	0.5	<0.2U	165	<1.0U	35.9
A68/CC48 6%	1.2J	0.6	<0.2U	179	<1.0U	29.1
A68/CC48 12%	1.2J	0.6	<0.2U	223	<1.0U	22.4
A68/CC48 25%	<10.0U	1.4JD	<2.0U	254D	<1.0U	10.2
A68/CC48 50%	<10.0U	2.1D	<2.0U	364D	<1.0U	<5.00U
Combined sample M34/CC48 serially diluted by Animas River surface water samples A68						
A68/M34/CC48 Control	2.3	<0.1U	<0.2U	85.5	<1.0U	54.8
A68/M34/CC48 4%	1.2J	0.5	<0.2U	160	<1.0U	34.9
A68/M34/CC48 9%	1.2J	0.5	<0.2U	172	<1.0U	28.2
A68/M34/CC48 20%	1.3J	0.5	<0.2U	201	<1.0U	25.2
A68/M34/CC48 40%	<10.0U	<1.0U	<2.0U	268D	<1.0U	10.8
A68/M34/CC48 65%	<10.0U	3.4D	<2.0U	293D	<1.0U	<5.00U
A68/M34/CC48 85%	<10.0U	<1.0U	<2.0U	334D	<1.0U	<5.00U
Reference toxicity test						
Control-Ref	<1.0U	0.2	<0.2U	27.0	<1.0U	61.9
Ref 6.25%	2.3	<0.1U	<0.2U	85.5	<1.0U	58.9
Ref 12.5%	2.3	<0.1U	<0.2U	85.6	<1.0U	61.4
Ref 25%	2.4	<0.1U	<0.2U	97.0	<1.0U	58.2
Ref 50%	2.3	<0.1U	<0.2U	85.7	<1.0U	57.7
Ref 100%	2.2	<0.1U	<0.2U	85.5	<1.0U	60.5

Final Wet Chemistry (mg/L)

STATION_ID	Chloride	Fluoride	Nitrate/Nitrite as N	Sulfate as SO4	Dissolved Organic Carbon	Total Alkalinity (mg CaCO3/L)
Profile test of the Animas River and Mineral Creek						
Profile Control	2.6	<0.1U	<0.2U	87.2	1.5	65.8
A68	1.4J	0.5	<0.2U	147	1.9	47.0J
M34	25.5D	<1.0U	<0.2U	871D	6.6	8.16
Animas River surface water sample A72 serially diluted by Animas River surface water sample A68						
A68/A72 control	2.7	<0.1U	<0.2U	87.8	1.7	72.9
A68/A72 5%	1.3J	0.5	<0.2U	159	1.5	39.2
A68/A72 10%	1.4J	0.5	<0.2U	166	1.5	33.8
A68/A72 25%	1.4J	0.5	<0.2U	189	1.8	33.4
A68/A72 50%	1.5J	0.5	<0.2U	229	1.7	17.5
A68/A72 75%	<10.0U	<1.0U	<2.0U	251D	1.4	7.50
A68/A72 100%	<10.0U	<1.0U	<2.0U	287D	2.3	<5.00U
Cement Creek surface water sample CC48 serially diluted by Animas River surface water sample A68						
A68/CC48 Control	2.6	<0.1U	<0.2U	87.6	1.6	68.7
A68/CC48 1%	1.4J	0.5	<0.2U	155	1.7	39.4
A68/CC48 3%	1.3J	0.5	<0.2U	164	1.1	36.2
A68/CC48 6%	1.3J	0.5	<0.2U	178	1.4	36.8
A68/CC48 12%	1.4J	0.6	<0.2U	209	1.7	32.0
A68/CC48 25%	<10.0U	<1.0U	<2.0U	248D	1.6	13.4
A68/CC48 50%	13.0JD	<1.0U	<2.0U	358D	2.5	<5.00U
Combined sample M34/CC48 serially diluted by Animas River surface water samples A68						
A68/M34/CC48 Control	2.5	<0.1U	<0.2U	87.7	1.6	63.4
A68/M34/CC48 4%	1.4J	0.5	<0.2U	158	1.7	40.8
A68/M34/CC48 9%	1.4J	0.5	<0.2U	171	1.4	38.9
A68/M34/CC48 20%	1.5J	0.5	<0.2U	199	1.8	26.0
A68/M34/CC48 40%	1.7J	0.5	<0.2U	247	1.6	12.5
A68/M34/CC48 65%	<10.0U	<1.0U	<2.0U	294D	2.4	<5.00U
A68/M34/CC48 85%	13.3JD	<1.0U	<2.0U	338D	3.1	<5.00U
Reference toxicity test						
Control-Ref	2.5	<0.1U	<0.2U	86.7	1.5	70.5
Ref 6.25%	2.5	<0.1U	<0.2U	87.3	1.6	63.4
Ref 12.5%	2.2	<0.1U	<0.2U	87.1	1.1	63.6
Ref 25%	2.6	<0.1U	<0.2U	86.3	1.1	60.4
Ref 50%	3.6	<0.1U	<0.2U	87.5	2.9	61.8
Ref 100%	3.5	<0.1U	<0.2U	87.5	3.3	56.2

Qualifiers:
D= Diluted sample
J= Estimated value
U= Non-detect

Prepared by: EC 3/8/13
Reviewed by: EB 3/13/13

Table 2.5-9a: Initial and Final Average Ammonia Results for November 2012 Upper Animas River Surface Water Toxicity Test Using Juvenile O.mykiss

Replicate ID	Day 0 Measured Ammonia Conc. (mg N/L)	Day 0 Measured pH	Day 0 Average Measured Ammonia Conc. (mg N/L)	Day 0 Average Measured pH	Day 0 Ammonia Criterion (mg N/L)[a]	Day 4 Measured Ammonia Conc. (mg N/L)[b]	Day 4 Measured pH[b]	Day 4 Average Measured Ammonia Conc. (mg N/L)	Day 4 Average Measured pH	Day 4 Ammonia Criterion (mg N/L)[a]
PROFILE TEST										
Profile Control -01	0.09915	7.6	0.0938	7.63	10.92	1.0820	7.5	1.1470	7.50	13.33
Profile Control -02	0.09042	7.6				1.1090	7.5			
Profile Control -03	0.09398	7.6				1.1560	7.5			
Profile Control -04	0.09148	7.7				1.2410	7.5			
M34-01	0.10580	5.5	0.0931	5.45	38.33	1.5840	6.9	1.2936	6.58	31.60
M34-02	0.08369	5.5				1.6090	6.6			
M34-03	0.09395	5.4				0.1302	6.4			
M34-04	0.08881	5.4				1.8510	6.5			
A68-01	0.07452	7.4	0.0734	7.40	15.34	0.9252	6.3	1.1336	6.53	32.26
A68-02	0.07001	7.4				1.2240	6.6			
A68-03	0.07439	7.4				1.1930	6.6			
A68-04	0.07466	7.4				1.1920	6.6			
SERIAL DILUTION OF SAMPLE A72 WITH A68 AS THE DILUENT										
A68/A72-Control-01	0.04135	7.4	0.0440	7.35	16.41	1.1260	7.1	1.2693	7.07	22.55
A68/A72-Control-02	0.04542	7.4				1.2280	7.1			
A68/A72-Control-03	0.04386	7.3				1.3020	7.1			
A68/A72-Control-04	0.04523	7.3				1.4210	7.1			
A68/A72-5%-01	0.04698	7.8	0.0476	7.80	8.11	1.2880	6.9	1.1100	6.93	25.55
A68/A72-5%-02	0.04922	7.8				1.0150	7.0			
A68/A72-5%-03	0.04737	7.8				1.1230	6.9			
A68/A72-5%-04	0.04678	7.8				1.0140	7.0			
A68/A72 10% -01	0.04988	7.7	0.0372	7.63	10.92	0.9636	6.9	0.9880	6.95	25.19
A68/A72 10% -02	ND	7.6				0.9351	7.0			
A68/A72 10% -03	0.04844	7.6				0.9634	7.0			
A68/A72 10% -04	0.05062	7.6				1.0900	6.9			
A68/A72 25% -01	0.05549	7.5	0.0544	7.43	14.81	0.9789	6.9	1.2147	6.92	25.70
A68/A72 25% -02	0.05454	7.4				1.2540	6.9			
A68/A72 25% -03	0.05449	7.4				1.3120	6.9			
A68/A72 25% -04	0.05306	7.4				1.3140	6.9			
A68/A72 50% -01	0.05491	7.2	0.0551	7.15	20.84	1.2970	6.9	1.2483	6.89	26.35
A68/A72 50% -02	0.05637	7.2				1.3870	6.9			
A68/A72 50% -03	0.05432	7.1				1.1950	6.9			
A68/A72 50% -04	0.05488	7.1				1.1140	6.9			
A68/A72 75% -01	0.06126	6.7	0.0606	6.50	32.61	1.3580	6.9	1.5163	6.81	27.91
A68/A72 75% -02	0.06013	6.5				1.5560	6.8			
A68/A72 75% -03	0.05979	6.4				1.6440	6.8			
A68/A72 75% -04	0.06129	6.4				1.5070	6.8			
A68/A72 100% -01	0.06464	5.6	0.0636	5.60	38.06	0.3088	6.2	0.5028	5.91	37.12
A68/A72 100% -02	0.06302	5.6				0.6791	6.0			
A68/A72 100% -03	0.06331	5.6				0.6192	5.8			
A68/A72 100% -04	0.06358	5.6				0.4039	5.6			
SERIAL DILUTION OF SAMPLE CC48 WITH A68 AS THE DILUENT										
A68/CC48 Control-01	0.08444	7.6	0.0904	7.65	10.49	1.1240	7.2	1.2055	7.31	17.40
A68/CC48 Control-02	0.08753	7.6				1.0750	7.4			
A68/CC48 Control-03	0.09032	7.7				1.2050	7.4			
A68/CC48 Control-04	0.09938	7.7				1.4180	7.2			
A68/CC48 1% -01	0.09961	7.6	0.1049	7.50	13.28	1.3070	7.1	1.2458	7.09	22.11
A68/CC48 1% -02	0.10530	7.5				1.5330	7.1			
A68/CC48 1% -03	0.11370	7.5				1.2920	7.1			
A68/CC48 1% -04	0.10080	7.4				0.8512	7.1			
A68/CC48 3% -01	0.11190	7.4	0.1115	7.40	15.34	1.2220	7.1	1.2065	7.10	21.94
A68/CC48 3% -02	0.10720	7.4				1.3410	7.1			
A68/CC48 3% -03	0.10940	7.4				1.0690	7.1			
A68/CC48 3% -04	0.11750	7.4				1.1940	7.1			
A68/CC48 6% -01	0.12730	7.4	0.1213	7.30	17.51	1.0900	7.1	1.3280	7.09	22.27
A68/CC48 6% -02	0.10770	7.3				1.4650	7.1			
A68/CC48 6% -03	0.11730	7.2				1.1930	7.1			
A68/CC48 6% -04	0.13300	7.3				1.5640	7.1			
A68/CC48 12% -01	0.12320	7.1	0.1320	7.08	22.49	1.0650	7.1	1.2238	7.06	22.93
A68/CC48 12% -02	0.12810	7.1				1.5190	7.1			
A68/CC48 12% -03	0.13000	7.1				1.2540	7.1			
A68/CC48 12% -04	0.14660	7.0				1.0570	7.0			
A68/CC48 25% -01	0.12710	6.4	0.1340	6.28	34.92	0.7729	7.0	1.3542	6.96	24.94
A68/CC48 25% -02	0.13970	6.3				1.5710	7.0			
A68/CC48 25% -03	0.13020	6.2				1.4080	7.0			
A68/CC48 25% -04	0.13910	6.2				1.6650	6.9			
A68/CC48 50% -01	0.11610	4.8	0.1217	4.80	38.85	1.7450	5.2	1.9440	5.20	38.62
A68/CC48 50% -02	0.12460	4.8				1.8930	5.2			
A68/CC48 50% -03	0.11380	4.8				1.9700	5.2			
A68/CC48 50% -04	0.13210	4.8				2.1680	5.2			

Table 2.5-9a: Initial and Final Average Ammonia Results for November 2012 Upper Animas River Surface Water Toxicity Test Using Juvenile O.mykiss

Replicate ID	Day 0 Measured Ammonia Conc. (mg N/L)	Day 0 Measured pH	Day 0 Average Measured Ammonia Conc. (mg N/L)	Day 0 Average Measured pH	Day 0 Ammonia Criterion (mg N/L)[a]	Day 4 Measured Ammonia Conc. (mg N/L)[b]	Day 4 Measured pH[b]	Day 4 Average Measured Ammonia Conc. (mg N/L)	Day 4 Average Measured pH	Day 4 Ammonia Criterion (mg N/L)[a]
SERIAL DILUTION OF SAMPLE M34/CC48 WITH A68 AS THE DILUTENT										
A68/M34/CC48 Control -01	0.04273	7.7	0.0421	7.63	10.92	1.0710	7.3	1.1590	7.35	16.36
A68/M34/CC48 Control -02	0.04165	7.6				1.3430	7.4			
A68/M34/CC48 Control -03	0.04259	7.6				1.1660	7.4			
A68/M34/CC48 Control -04	0.04136	7.6				1.0560	7.4			
A68/M34/CC48 4% -01	0.04308	7.4	0.0434	7.40	15.34	1.1190	7.1	1.2160	7.07	22.60
A68/M34/CC48 4% -02	0.04428	7.4				1.0230	7.1			
A68/M34/CC48 4% -03	0.04365	7.4				1.4570	7.1			
A68/M34/CC48 4% -04	0.04270	7.4				1.2650	7.1			
A68/M34/CC48 9% -01	0.04428	7.4	0.0445	7.33	16.96	1.1650	7.1	1.1380	7.08	22.33
A68/M34/CC48 9% -02	0.04636	7.3				1.2340	7.1			
A68/M34/CC48 9% -03	0.04378	7.3				0.9838	7.1			
A68/M34/CC48 9% -04	0.04353	7.3				1.1690	7.1			
A68/M34/CC48 20% -01	0.04468	7.3	0.0439	7.25	18.61	1.1900	7.1	1.1478	7.08	22.49
A68/M34/CC48 20% -02	0.04355	7.3				1.1460	7.1			
A68/M34/CC48 20% -03	0.04479	7.2				1.1490	7.1			
A68/M34/CC48 20% -04	0.04263	7.2				1.1060	7.1			
A68/M34/CC48 40% -01	0.04493	7.1	0.0448	7.08	22.49	1.4140	7.0	1.4218	6.99	24.26
A68/M34/CC48 40% -02	0.04445	7.1				1.4350	7.0			
A68/M34/CC48 40% -03	0.04535	7.1				1.2290	7.0			
A68/M34/CC48 40% -04	0.04454	7.0				1.6090	7.0			
A68/M34/CC48 65% -01	0.04417	5.7	0.0448	5.63	38.01	0.2124	6.5	0.3039	6.10	36.20
A68/M34/CC48 65% -02	0.04407	5.6				0.1931	6.4			
A68/M34/CC48 65% -03	0.04552	5.6				0.3011	5.8			
A68/M34/CC48 65% -04	0.04535	5.6				0.5090	5.6			
A68/M34/CC48 85% -01	0.04524	4.8	0.0461	4.75	38.86	1.7680	5.1	1.7890	5.10	38.70
A68/M34/CC48 85% -02	0.04522	4.8				1.7120	5.1			
A68/M34/CC48 85% -03	0.04697	4.7				2.0110	5.1			
A68/M34/CC48 85% -04	0.04696	4.7				1.6650	5.1			

[a]The sample-specific acute ammonia criterion was calculated using the "salmon present" formula on p. 54 of the Colorado Department of Public Health and Environment, Water Quality Control Commission, Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31).

[b]Values shown are either the measurements made at the end of the test (day 4) or earlier if all test organisms died before the 4-day exposure period was completed.

Prepared by: EC 3/7/13

Reviewed by: EB 3/13/13

Table 2.5-9b Initial and Final Average Ammonia Results for November 2012 Upper Animas River Concurrent Reference Toxicity Toxicity Test Using Juvenile *O.mykiss*

Replicate ID	Initial (Day 0) Measured Ammonia Conc. (mg N/L)[a]	Initial (Day 0) Measured pH	Initial (Day 0) Average Measured Ammonia Conc. (mg N/L)	Initial (Day 0) Average Measured pH	Initial (Day 0) Ammonia Criterion (mg N/L)[a]	Final Measured Ammonia Conc. (mg N/L)	Final Measured pH	Final Average Measured Ammonia Conc. (mg N/L)	Final Average Measured pH	Final Ammonia Criterion (mg N/L)[a]
Ref Control-01	0.04525	8.00	0.0431	8.00	5.62	1.0190	7.47	1.0740	7.46	14.04
Ref Control-02	0.04274	8.00				1.1450	7.47			
Ref Control-03	0.04226	8.00				1.0550	7.46			
Ref Control-04	0.04211	8.00				1.0770	7.45			
6.25%-01	0.04487	8.00	0.0429	8.05	5.11	1.1310	7.46	1.1548	7.46	14.14
6.25%-02	0.04148	8.10				1.2320	7.46			
6.25%-03	0.04279	8.00				1.2320	7.46			
6.25%-04	0.04244	8.10				1.0240	7.45			
12.5%-01	0.04344	8.00	0.0434	8.08	4.87	0.6100	7.46	0.9802	7.45	14.40
12.5%-02	0.04696	8.00				1.2480	7.46			
12.5%-03	0.04195	8.20				1.1050	7.43			
12.5%-04	0.04107	8.10				0.9578	7.43			
25%-01	0.04180	8.00	0.0422	8.00	5.62	1.5420	7.20	0.4968	7.28	18.00
25%-02	0.04242	8.00				0.1751	7.30			
25%-03	0.04186	8.00				0.1281	7.31			
25%-04	0.04271	8.00				0.1420	7.30			
50%-01	0.04197	8.00	0.0428	8.03	5.36	0.9176	7.24	0.9436	7.26	18.34
50%-02	0.04282	8.00				1.2000	7.25			
50%-03	0.04278	8.10				0.9934	7.27			
50%-04	0.04359	8.00				0.6633	7.29			
100%-01	0.04281	8.00	0.0425	8.00	5.62	0.4526	6.50	0.4550	6.73	29.35
100%-02	0.04205	8.00				0.4628	6.60			
100%-03	0.04292	8.00				0.3182	6.90			
100%-04	0.04216	8.00				0.5862	6.90			

[a] The sample-specific acute ammonia criterion was calculated using the "salmon present" formula on p. 54 of the Colorado Department of Public Health and Environment, Water Quality Control Commission, Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31).

[b]Values shown are either the measurements made at the end of the test (day 4) or earlier if all test organisms died before the 4-day exposure period was completed.

Prepared by: EC 3/7/13
Reviewed by: EB 3/13/13

Figures

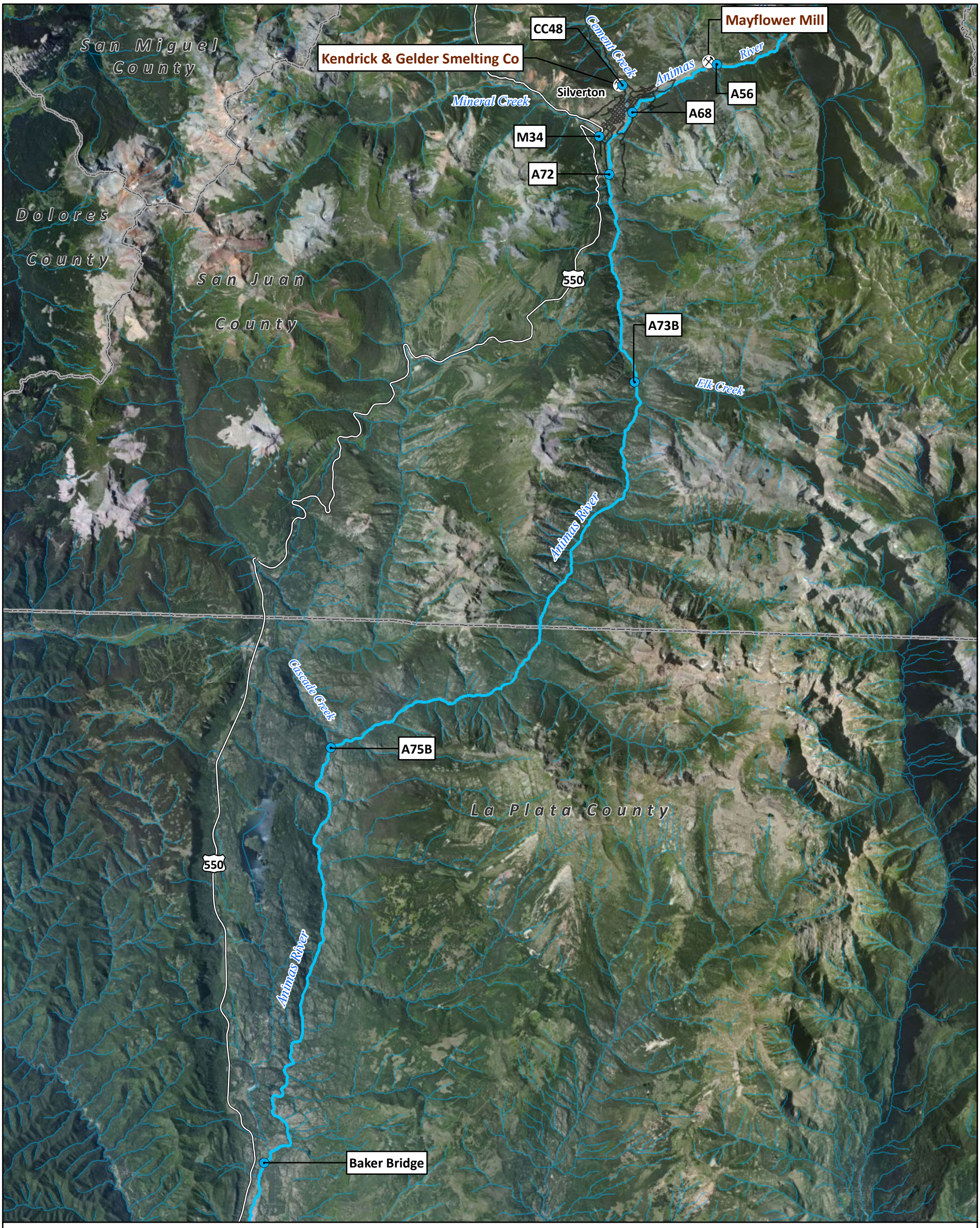


Figure 2.1-1
Upper Animas Mining District
2012 Surface Water Toxicity Test

- Sample Locations
- Mine Locations
- Rivers and Streams
- Roads
- County Boundaries

Date: July 15, 2013

Data Sources:
Sample Locations: U.S. EPA Region 8 and UOS (2013)
Mine Locations: U.S. EPA and ESAT (2012)
Roads: Navteq (2011)
Rivers and Streams: CDOW 1:24k (2004)
County Boundaries: U.S. Census Bureau (2011)
Image: Bing (2013)

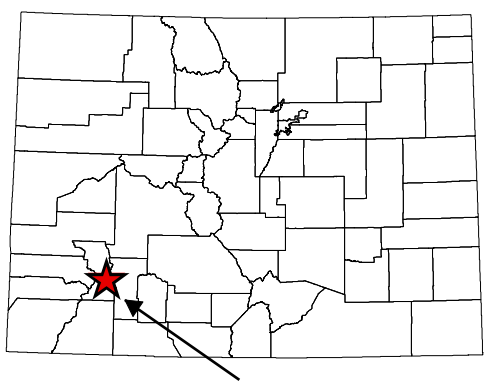
Coordinate System/Projection:
UTM Zone 13 North, NAD 83, Meters

N W E S

0 1 2 Miles

0 1 2 Kilometers

Colorado



Area of Interest

Figure 3.1-1
October 2012 Upper Animas River
Acute Surface Water Toxicity Test Using *O. mykiss*
Average Percent Survival + Percent SD per Location

* = Samples are statistically different when compared to their corresponding control

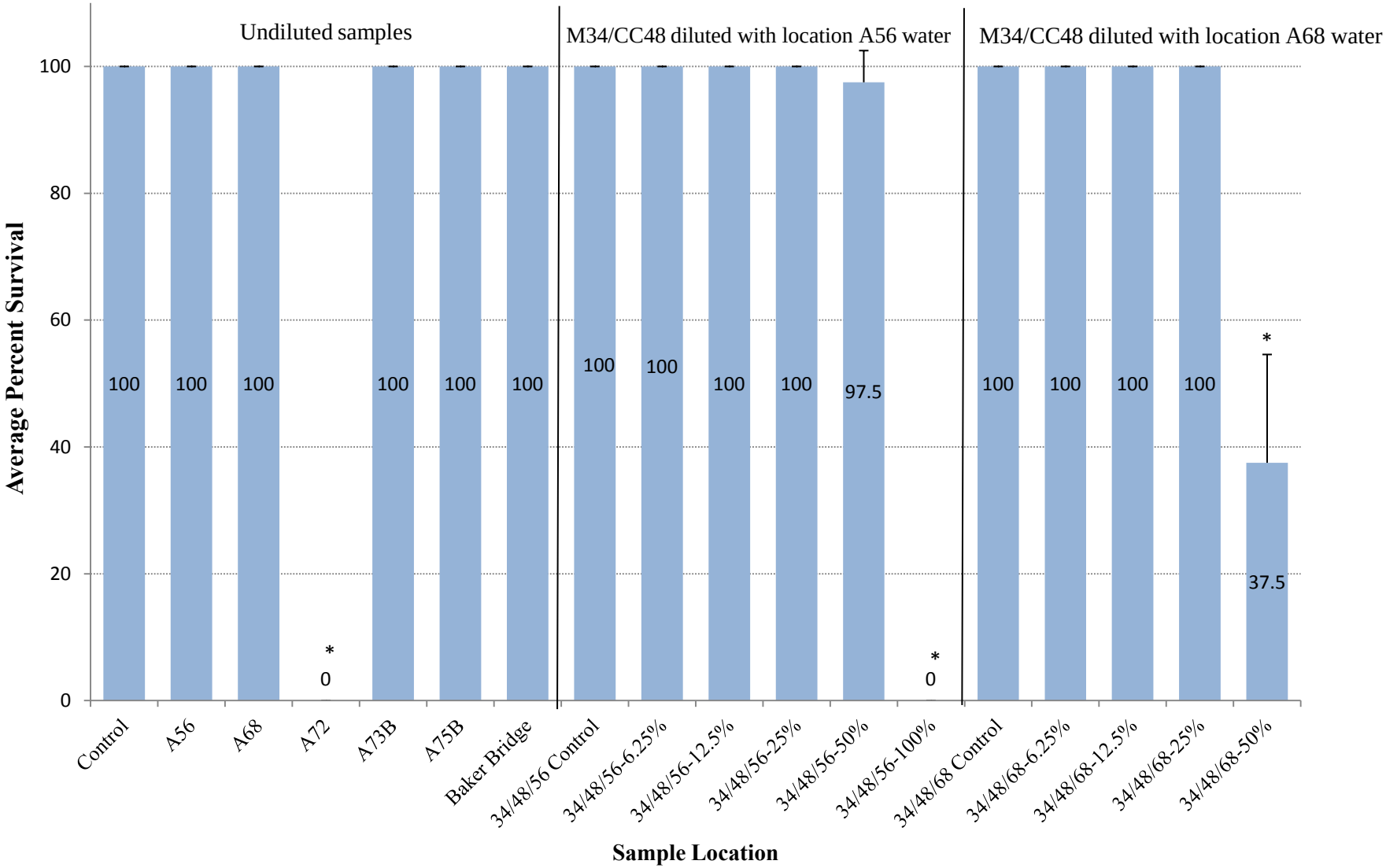


Figure 3.2-1
October 2012 Acute Reference Toxicity Test Using *O. mykiss* and Zinc Sulfate ($ZnSO_4$)
Average Percent Survival + Percent SD per Zinc Concentration

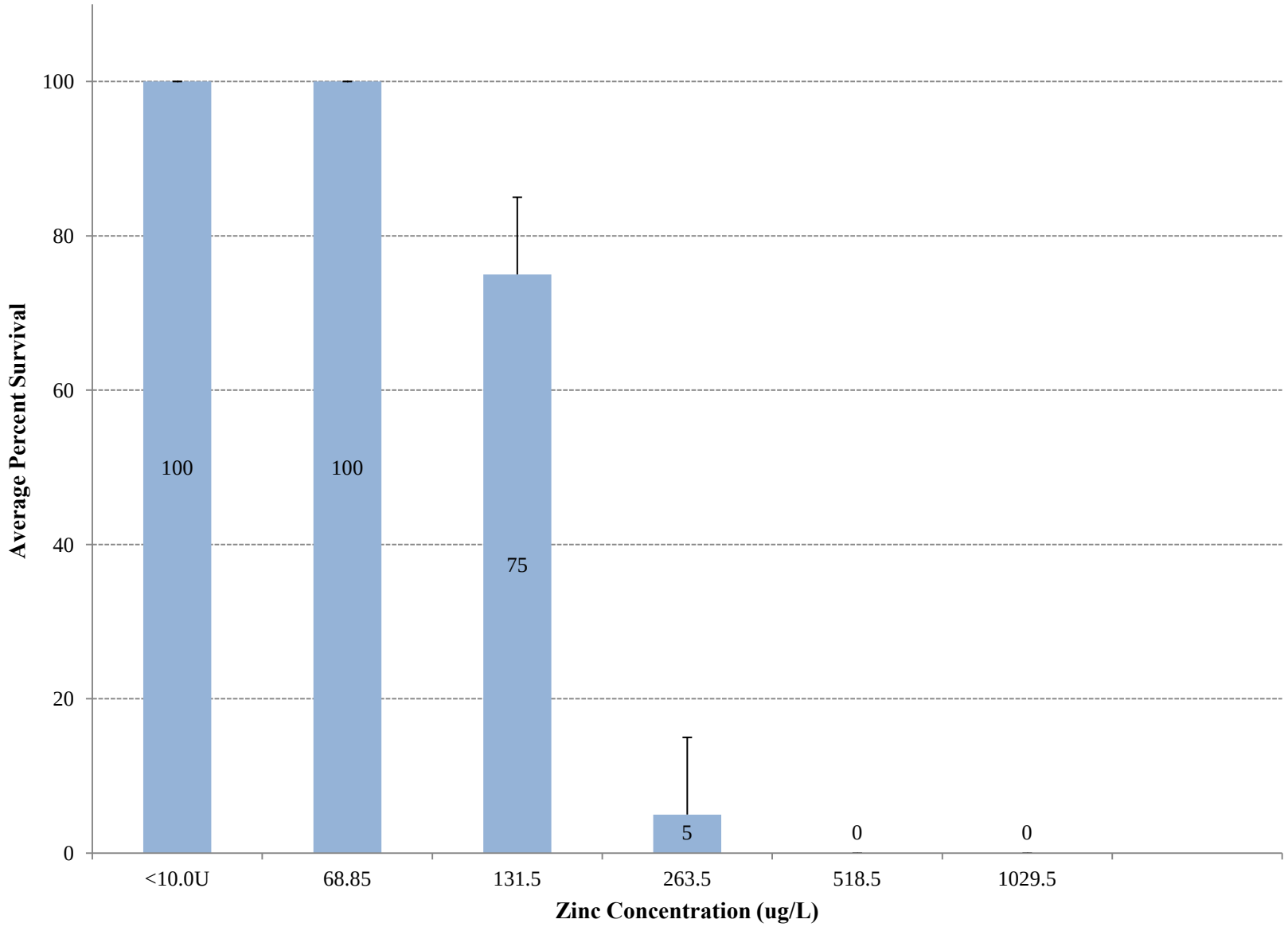


Figure 3.3-1
November 2012 Upper Animas River
Acute Surface Water Toxicity Test Using *O. mykiss*
Average Percent Survival + Percent SD per Location

* = Samples are statistically different when compared to the corresponding control.

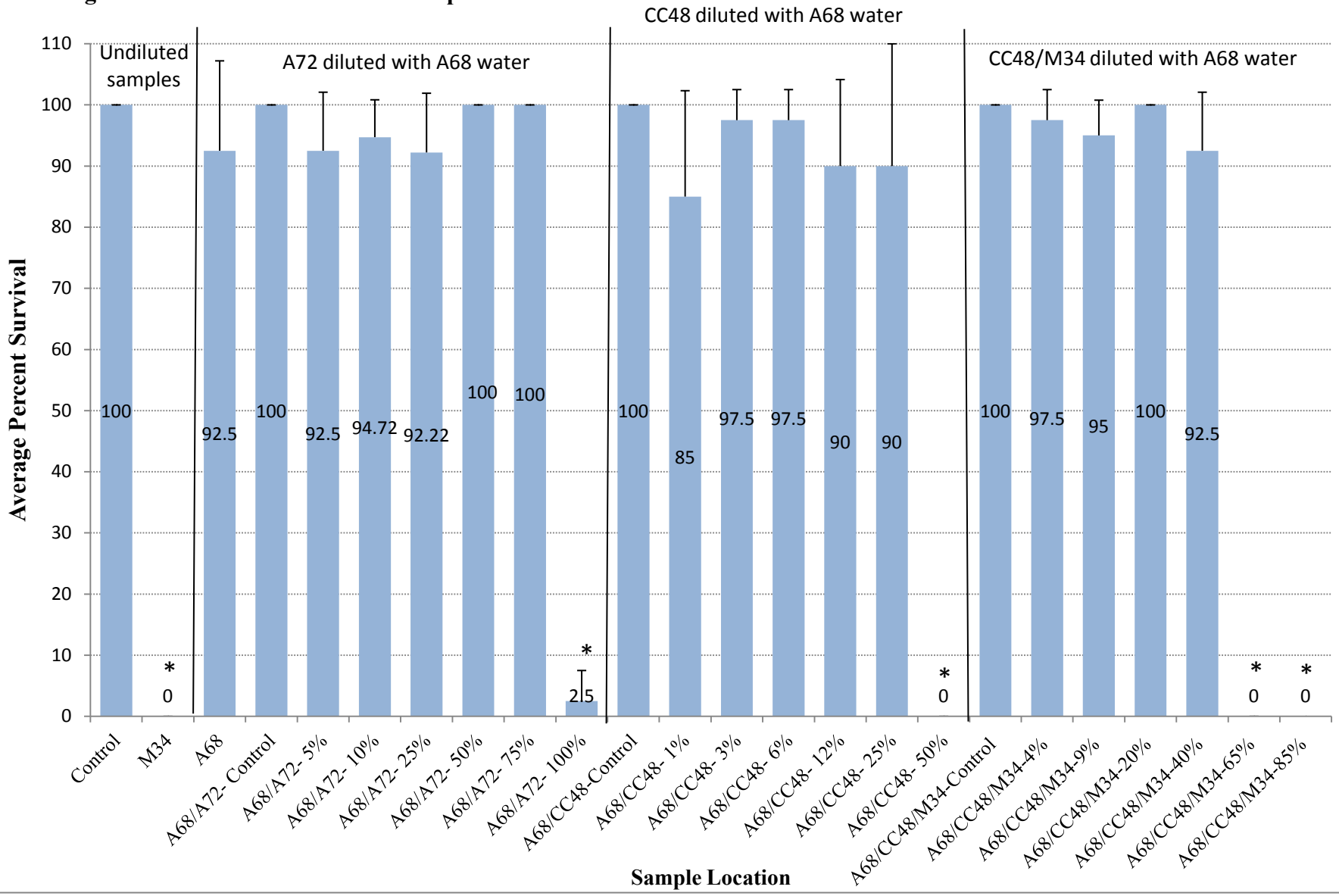


Figure 3.4-1
November 2012 Acute Reference Toxicity Test Using *O. mykiss* and Zinc Sulfate ($ZnSO_4$)
Average Percent Survival + Percent SD per Zinc Concentration

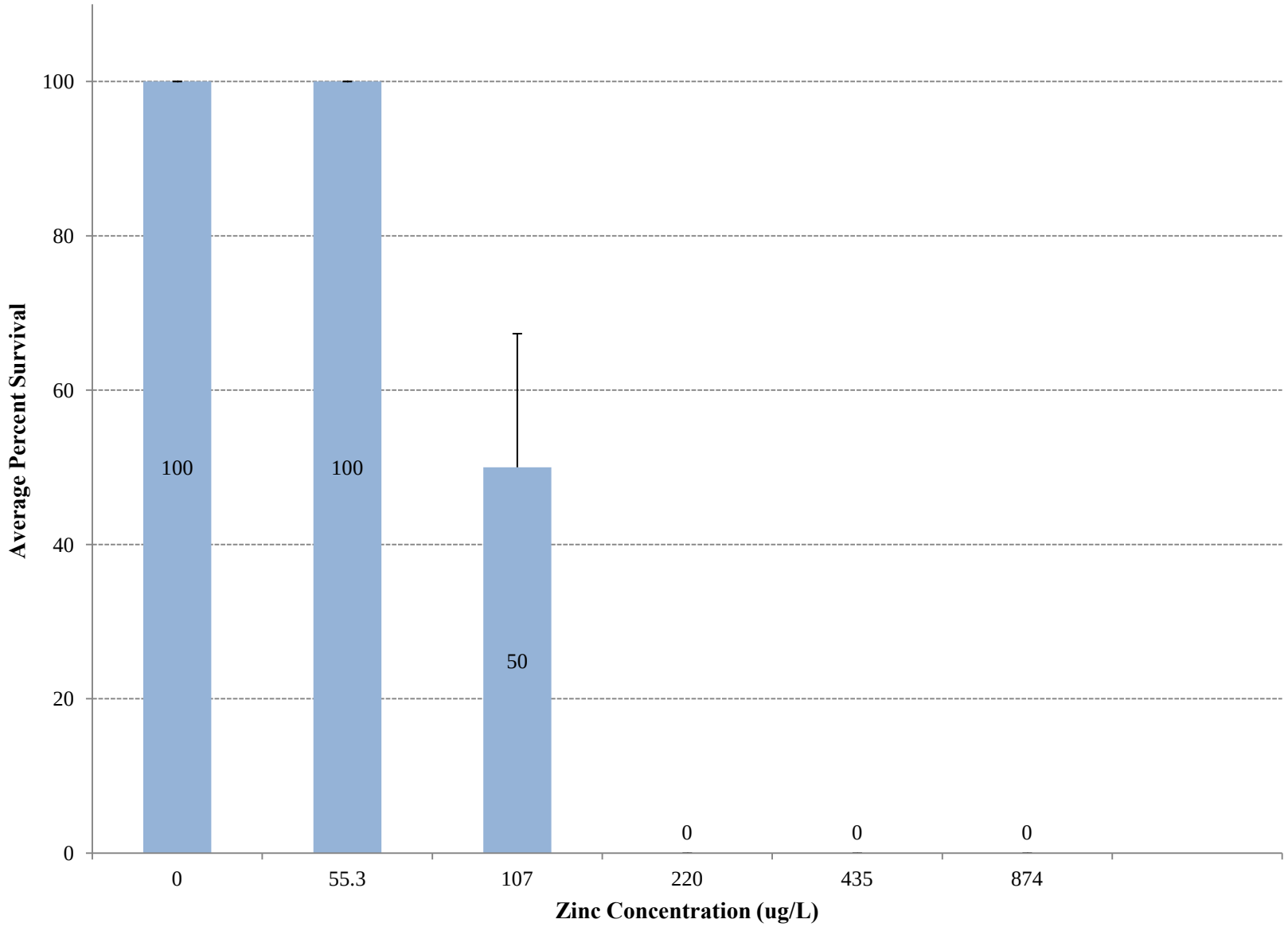
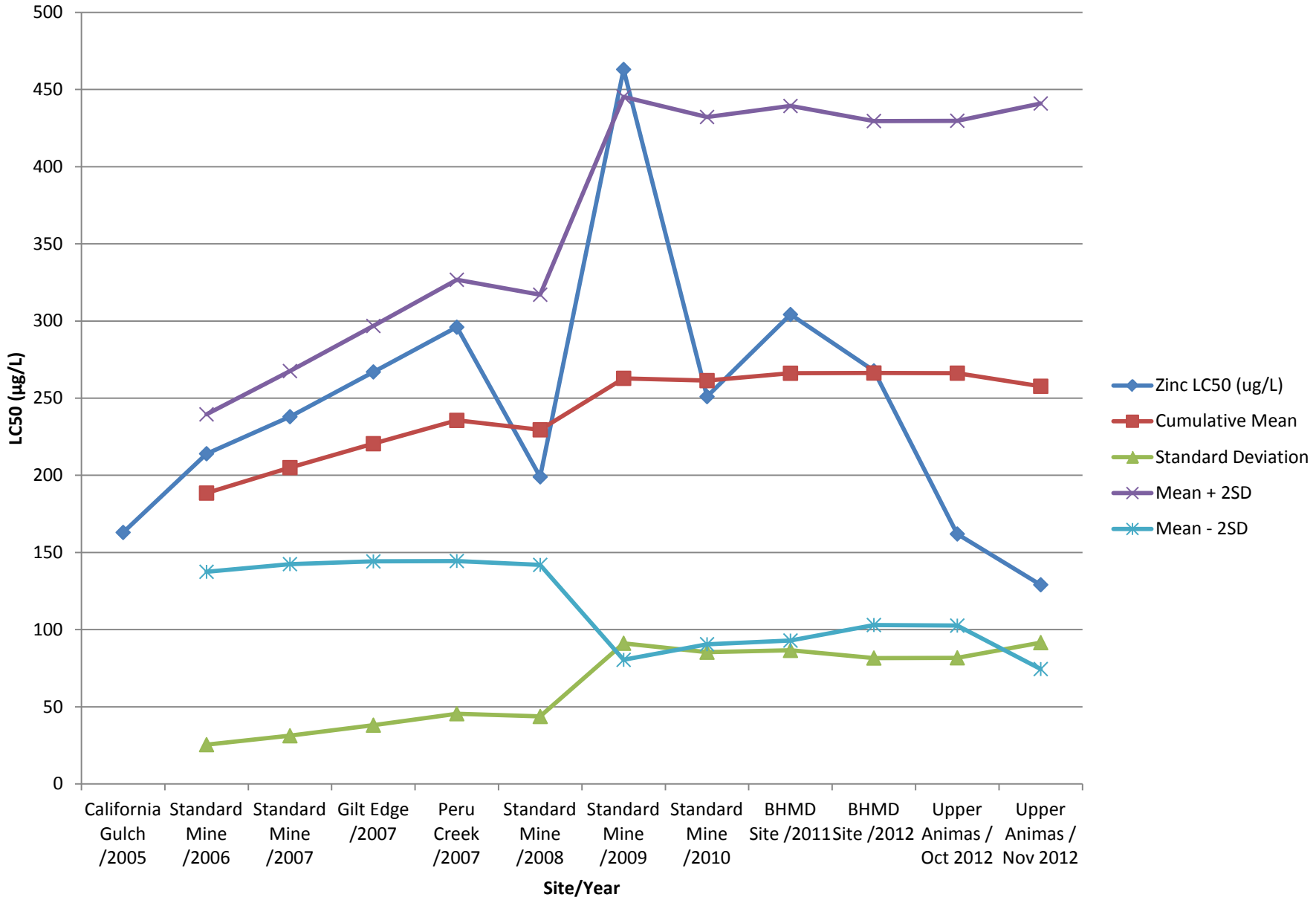


Figure 3.5-1 Zinc LC_{50} Reference Chart



Appendix A
October 2012 Upper Animas River Superfund Site
Site Water Toxicity Test and Reference Toxicity Test
Daily Water Chemistries

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Profile Test

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-01	No. Alive	10	10	10	10	10
Control-01	pH	7.3	7.1	7.3	7.4	7.5
Control-01	Temp °(C)	11.91	11.63	11.77	11.97	11.66
Control-01	D.O. (mg/L)	7.76	7.93	7.76	7.9	8.14
Control-01	Conductivity (us/cm)	310.9	315.4	316.8	319.5	319.3
Control-01	Alkalinity (mg $CaCO_3$/L)	59.4	-	-	-	61
Control-01	Hardness (mg /L)	96	-	-	-	95

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-02	No. Alive	10	10	10	10	10
Control-02	pH	7.4	7.2	7.3	7.4	7.6
Control-02	Temp °(C)	11.8	11.61	11.65	11.82	11.6
Control-02	D.O. (mg/L)	8.31	7.87	7.76	7.95	8.06
Control-02	Conductivity (us/cm)	312.2	314.7	318.3	318.8	320.5
Control-02	Alkalinity (mg $CaCO_3$/L)	59.4	-	-	-	61
Control-02	Hardness (mg /L)	96	-	-	-	95

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-03	No. Alive	10	10	10	10	10
Control-03	pH	7.4	7.3	7.3	7.4	7.6
Control-03	Temp °(C)	11.76	11.62	11.64	11.83	11.63
Control-03	D.O. (mg/L)	8.48	7.89	7.76	7.99	8.11
Control-03	Conductivity (us/cm)	309.9	315.5	318.5	319.1	320.9
Control-03	Alkalinity (mg $CaCO_3$/L)	59.4	-	-	-	61
Control-03	Hardness (mg /L)	96	-	-	-	95

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-04	No. Alive	10	10	10	10	10
Control-04	pH	7.4	7.4	7.4	7.4	7.6
Control-04	Temp °(C)	11.79	11.61	11.65	11.82	11.64
Control-04	D.O. (mg/L)	8.52	8.05	7.83	8.13	8.12
Control-04	Conductivity (us/cm)	311.2	315.4	318.6	320.4	321.7
Control-04	Alkalinity (mg $CaCO_3$/L)	59.4	-	-	-	61
Control-04	Hardness (mg /L)	96	-	-	-	95

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
Baker-01	No. Alive	10	10	10	10	10
Baker-01	pH	7.1	7.2	7.1	7.3	7.4
Baker-01	Temp °(C)	12.49	11.69	11.76	11.92	11.69
Baker-01	D.O. (mg/L)	8.63	7.18	7.37	7.39	7.55
Baker-01	Conductivity (us/cm)	427.4	430	435.9	433.3	434.7
Baker-01	Alkalinity (mg $CaCO_3$/L)	26.5	-	-	-	31.8
Baker-01	Hardness (mg /L)	206	-	-	-	197

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
Baker-02	No. Alive	10	10	10	10	10
Baker-02	pH	7.1	7.3	7.1	7.4	7.4
Baker-02	Temp °(C)	11.79	11.61	11.65	11.86	11.66
Baker-02	D.O. (mg/L)	8.64	7.4	7.47	7.57	7.77
Baker-02	Conductivity (us/cm)	423.1	429	431.7	431	432.6
Baker-02	Alkalinity (mg $CaCO_3$/L)	26.5	-	-	-	31.8
Baker-02	Hardness (mg /L)	206	-	-	-	197

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
Baker-03	No. Alive	10	10	10	10	10
Baker-03	pH	7.1	7.3	7.1	7.4	7.4
Baker-03	Temp °(C)	11.79	11.58	11.58	11.78	11.6
Baker-03	D.O. (mg/L)	8.69	7.42	7.66	7.68	7.97
Baker-03	Conductivity (us/cm)	424	428.8	432.3	431.5	431.6
Baker-03	Alkalinity (mg $CaCO_3$/L)	26.5	-	-	-	31.8
Baker-03	Hardness (mg /L)	206	-	-	-	197

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
Baker-04	No. Alive	10	10	10	10	10
Baker-04	pH	7.1	7.2	7.2	7.3	7.4
Baker-04	Temp °(C)	11.76	11.55	11.59	11.8	11.58
Baker-04	D.O. (mg/L)	8.69	7.62	7.71	7.81	7.96
Baker-04	Conductivity (us/cm)	422	430	431.8	431.2	431.5
Baker-04	Alkalinity (mg $CaCO_3$/L)	26.5	-	-	-	31.8
Baker-04	Hardness (mg /L)	206	-	-	-	197

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A75B-01	No. Alive	10	10	10	10	10
A75B-01	pH	7.1	7.3	7.1	7.3	7.4
A75B-01	Temp °(C)	11.76	11.52	11.6	11.78	11.69
A75B-01	D.O. (mg/L)	8.7	8.24	8.1	8.09	8.05
A75B-01	Conductivity (us/cm)	432	438.5	438.1	440.4	440.5
A75B-01	Alkalinity (mg $CaCO_3$/L)	17.1	-	-	-	20.5
A75B-01	Hardness (mg /L)	208	-	-	-	205

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A75B-02	No. Alive	10	10	10	10	10
A75B-02	pH	7.1	7.2	7.1	7.2	7.4
A75B-02	Temp °(C)	11.77	11.56	11.59	11.78	11.6
A75B-02	D.O. (mg/L)	8.73	8.16	7.87	8.04	8.06
A75B-02	Conductivity (us/cm)	433.6	437.8	440.1	439.2	440.9
A75B-02	Alkalinity (mg $CaCO_3$/L)	17.1	-	-	-	20.5
A75B-02	Hardness (mg /L)	208	-	-	-	205

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A75B-03	No. Alive	10	10	10	10	10
A75B-03	pH	7.1	7.2	7.1	7.2	7.3
A75B-03	Temp °(C)	11.77	11.56	11.59	11.77	11.61
A75B-03	D.O. (mg/L)	8.73	8.12	7.85	7.95	7.99
A75B-03	Conductivity (us/cm)	433.8	438	439	438.5	438.8
A75B-03	Alkalinity (mg $CaCO_3$/L)	17.1	-	-	-	20.5
A75B-03	Hardness (mg /L)	208	-	-	-	205

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A75B-04	No. Alive	10	10	10	10	10
A75B-04	pH	7.1	7.2	7.1	7.2	7.3
A75B-04	Temp °(C)	11.75	11.55	11.58	11.78	11.6
A75B-04	D.O. (mg/L)	8.69	7.82	7.83	8	8.13
A75B-04	Conductivity (us/cm)	430.6	438.8	439.8	440.1	440.5
A75B-04	Alkalinity (mg $CaCO_3$/L)	17.1	-	-	-	20.5
A75B-04	Hardness (mg /L)	208	-	-	-	205

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73B-01	No. Alive	10	10	10	10	10
A73B-01	pH	6.3	6.9	6.8	7	7.1
A73B-01	Temp °(C)	11.7	11.56	11.56	11.78	11.57
A73B-01	D.O. (mg/L)	8.69	7.98	8.2	8.29	8.33
A73B-01	Conductivity (us/cm)	505	509.9	512.2	512.6	515
A73B-01	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	<5.00U
A73B-01	Hardness (mg /L)	243	-	-	-	239

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73B-02	No. Alive	10	10	10	10	10
A73B-02	pH	6.1	6.8	6.6	6.9	6.9
A73B-02	Temp °(C)	11.67	11.55	11.61	11.77	11.58
A73B-02	D.O. (mg/L)	8.72	8	8.07	8.29	8.27
A73B-02	Conductivity (us/cm)	502.8	510.1	511.3	511.3	512.2
A73B-02	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	<5.00U
A73B-02	Hardness (mg /L)	243	-	-	-	239

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73B-03	No. Alive	10	10	10	10	10
A73B-03	pH	6.1	6.7	6.5	6.8	6.7
A73B-03	Temp °(C)	11.69	11.55	11.59	11.74	11.59
A73B-03	D.O. (mg/L)	8.72	7.89	8.02	8.22	8.13
A73B-03	Conductivity (us/cm)	501.9	508.7	510.7	511.3	511.1
A73B-03	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	<5.00U
A73B-03	Hardness (mg /L)	243	-	-	-	239

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73B-04	No. Alive	10	10	10	10	10
A73B-04	pH	6.1	6.6	6.5	6.7	6.7
A73B-04	Temp °(C)	11.75	11.56	11.58	11.77	11.59
A73B-04	D.O. (mg/L)	8.71	7.94	8	8.1	8.2
A73B-04	Conductivity (us/cm)	504	507.3	510.5	509.1	510.3
A73B-04	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	<5.00U
A73B-04	Hardness (mg /L)	243	-	-	-	239

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A56-01	No. Alive	10	10	10	10	10
A56-01	pH	6.9	7.1	7.1	7.5	7
A56-01	Temp °(C)	12.02	11.59	11.65	11.84	11.57
A56-01	D.O. (mg/L)	7.91	7.82	8.16	7.99	8.38
A56-01	Conductivity (us/cm)	350.4	358.1	358.9	359.2	360.9
A56-01	Alkalinity (mg $CaCO_3$/L)	37.8	-	-	-	40.9
A56-01	Hardness (mg /L)	170	-	-	-	166

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A56-02	No. Alive	10	10	10	10	10
A56-02	pH	7	7.1	7.2	7.6	7.2
A56-02	Temp °(C)	11.71	11.6	11.58	11.8	11.6
A56-02	D.O. (mg/L)	8.4	7.59	8.24	8.28	8.4
A56-02	Conductivity (us/cm)	351.2	356.7	359.2	358.2	359.9
A56-02	Alkalinity (mg $CaCO_3$/L)	37.8	-	-	-	40.9
A56-02	Hardness (mg /L)	170	-	-	-	166

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A56-03	No. Alive	10	10	10	10	10
A56-03	pH	7	7.2	7.2	7.5	7.1
A56-03	Temp °(C)	11.73	11.59	11.59	11.79	11.57
A56-03	D.O. (mg/L)	8.57	7.67	8.21	8.28	8.28
A56-03	Conductivity (us/cm)	352.6	356.6	358.9	359.8	360.2
A56-03	Alkalinity (mg $CaCO_3$/L)	37.8	-	-	-	40.9
A56-03	Hardness (mg /L)	170	-	-	-	166

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A56-04	No. Alive	10	10	10	10	10
A56-04	pH	7.1	7.2	7.2	7.5	7.1
A56-04	Temp °(C)	11.76	11.59	11.6	11.77	11.53
A56-04	D.O. (mg/L)	8.6	7.74	7.92	8.07	8.16
A56-04	Conductivity (us/cm)	353.1	356.4	359.1	357.6	358.4
A56-04	Alkalinity (mg $CaCO_3$/L)	37.8	-	-	-	40.9
A56-04	Hardness (mg /L)	170	-	-	-	166

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A72-01	No. Alive	10	10	9	0	-
A72-01	pH	5.5	6.1	6.2	6.2	-
A72-01	Temp °(C)	11.94	11.57	11.59	11.8	-
A72-01	D.O. (mg/L)	8.13	8.23	8.47	8.54	-
A72-01	Conductivity (us/cm)	607.2	612.5	612.3	614.1	-
A72-01	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	<5.00U	-
A72-01	Hardness (mg /L)	299	-	-	296	-

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A72-02	No. Alive	10	10	8	0	-
A72-02	pH	5.5	6.1	6.1	6.1	-
A72-02	Temp °(C)	11.88	11.57	11.61	11.79	-
A72-02	D.O. (mg/L)	8.29	8.29	7.99	8.61	-
A72-02	Conductivity (us/cm)	605.6	613.1	616.6	615.3	-
A72-02	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	<5.00U	-
A72-02	Hardness (mg /L)	299	-	-	296	-

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A72-03	No. Alive	10	10	4	0	-
A72-03	pH	5.5	6.1	6.1	5.9	-
A72-03	Temp °(C)	11.73	11.6	11.59	11.78	-
A72-03	D.O. (mg/L)	8.51	8.17	8.21	8.67	-
A72-03	Conductivity (us/cm)	607.7	613	618.6	610	-
A72-03	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	<5.00U	-
A72-03	Hardness (mg /L)	299	-	-	296	-

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A72-04	No. Alive	10	10	7	0	-
A72-04	pH	5.5	6.1	6.1	5.9	-
A72-04	Temp °(C)	11.73	11.59	11.6	11.8	-
A72-04	D.O. (mg/L)	8.63	8.21	8.41	8.71	-
A72-04	Conductivity (us/cm)	603.3	613.3	616.3	612.6	-
A72-04	Alkalinity (mg $CaCO_3$/L)	<5.00U			<5.00U	
A72-04	Hardness (mg /L)	299			296	

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-01	No. Alive	10	10	10	10	10
A68-01	pH	7.2	7.4	7.4	7.1	7.3
A68-01	Temp °(C)	11.77	11.75	11.85	11.95	11.86
A68-01	D.O. (mg/L)	8.41	8.34	8.4	7.99	8.08
A68-01	Conductivity (us/cm)	379.9	384.1	386	382.6	385
A68-01	Alkalinity (mg $CaCO_3$/L)	35.8	-	-	-	42.7
A68-01	Hardness (mg /L)	183	-	-	-	180

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-02	No. Alive	10	10	10	10	10
A68-02	pH	7.2	7.3	7.4	7.2	7.4
A68-02	Temp °(C)	11.78	11.74	11.83	11.93	11.82
A68-02	D.O. (mg/L)	8.37	8.32	8.44	8.07	8.14
A68-02	Conductivity (us/cm)	382.5	385.7	386.9	386.7	386.1
A68-02	Alkalinity (mg $CaCO_3$/L)	35.8	-	-	-	42.7
A68-02	Hardness (mg /L)	183	-	-	-	180

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-03	No. Alive	10	10	10	10	10
A68-03	pH	7.2	7.3	7.4	7.3	7.4
A68-03	Temp °(C)	11.76	11.81	11.83	11.93	11.81
A68-03	D.O. (mg/L)	8.3	7.98	8.24	8.01	8.06
A68-03	Conductivity (us/cm)	380.9	385.1	386.9	386.3	388.7
A68-03	Alkalinity (mg $CaCO_3$/L)	35.8	-	-	-	42.7
A68-03	Hardness (mg /L)	183	-	-	-	180

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-04	No. Alive	10	10	10	10	10
A68-04	pH	7.3	7.3	7.4	7.4	7.4
A68-04	Temp °(C)	11.78	11.82	11.83	11.91	11.8
A68-04	D.O. (mg/L)	8.24	8.03	7.84	7.87	7.92
A68-04	Conductivity (us/cm)	379.8	385	388.7	387.6	388.6
A68-04	Alkalinity (mg $CaCO_3$/L)	35.8	-	-	-	42.7
A68-04	Hardness (mg /L)	183	-	-	-	180

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Serial dilution of M34/CC48 with A56

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-control-01	No. Alive	10	10	10	10	10
34/48/56-control-01	pH	7.6	7.4	7.5	7.5	7.6
34/48/56-control-01	Temp °(C)	11.79	11.63	11.68	11.9	11.8
34/48/56-control-01	D.O. (mg/L)	7.73	7.87	8.32	8.4	8.08
34/48/56-control-01	Conductivity (us/cm)	309.6	316.5	319.1	319	320.9
34/48/56-control-01	Alkalinity (mg $CaCO_3$/L)	*	-	-	-	*
34/48/56-control-01	Hardness (mg /L)	*	-	-	-	*

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-control-02	No. Alive	10	10	10	10	10
34/48/56-control-02	pH	7.4	7.4	7.5	7.6	7.7
34/48/56-control-02	Temp °(C)	11.69	11.63	11.69	11.86	11.68
34/48/56-control-02	D.O. (mg/L)	7.82	7.86	8.27	8.41	8.07
34/48/56-control-02	Conductivity (us/cm)	309.9	315.3	318.8	319.6	320.9
34/48/56-control-02	Alkalinity (mg $CaCO_3$/L)	*	-	-	-	*
34/48/56-control-02	Hardness (mg /L)	*	-	-	-	*

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-control-03	No. Alive	10	10	10	10	10
34/48/56-control-03	pH	7.4	7.4	7.5	7.6	7.7
34/48/56-control-03	Temp °(C)	11.65	11.62	11.67	11.85	11.66
34/48/56-control-03	D.O. (mg/L)	7.79	8.06	8.25	8.26	8.32
34/48/56-control-03	Conductivity (us/cm)	311.9	315	318.5	319.2	320.5
34/48/56-control-03	Alkalinity (mg $CaCO_3$/L)	*	-	-	-	*
34/48/56-control-03	Hardness (mg /L)	*	-	-	-	*

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-control-04	No. Alive	10	10	10	10	10
34/48/56-control-04	pH	7.4	7.4	7.4	7.5	7.7
34/48/56-control-04	Temp °(C)	11.63	11.64	11.65	11.85	11.67
34/48/56-control-04	D.O. (mg/L)	7.88	7.84	8.13	8.21	8.17
34/48/56-control-04	Conductivity (us/cm)	311.4	314.9	320.1	318.9	321
34/48/56-control-04	Alkalinity (mg $CaCO_3$/L)	*	-	-	-	*
34/48/56-control-04	Hardness (mg /L)	*	-	-	-	*

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-6.25%-01	No. Alive	10	10	10	10	10
34/48/56-6.25%-01	pH	7.3	7.1	7.4	7.4	7.6
34/48/56-6.25%-01	Temp °(C)	11.68	11.62	11.64	11.86	11.67
34/48/56-6.25%-01	D.O. (mg/L)	7.92	7.54	8.27	8.3	7.99
34/48/56-6.25%-01	Conductivity (us/cm)	382.3	384.4	386.1	386.8	388.8
34/48/56-6.25%-01	Alkalinity (mg $CaCO_3$/L)	32.3	-	-	-	37.1
34/48/56-6.25%-01	Hardness (mg /L)	193	-	-	-	177

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-6.25%-02	No. Alive	10	10	10	10	10
34/48/56-6.25%-02	pH	7.2	7.2	7.3	7.4	7.5
34/48/56-6.25%-02	Temp °(C)	11.65	11.63	11.66	11.87	11.66
34/48/56-6.25%-02	D.O. (mg/L)	7.97	7.69	8.11	8.25	8.04
34/48/56-6.25%-02	Conductivity (us/cm)	377.2	380.7	385	384	385.6
34/48/56-6.25%-02	Alkalinity (mg $CaCO_3$/L)	32.3	-	-	-	37.1
34/48/56-6.25%-02	Hardness (mg /L)	193	-	-	-	177

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-6.25%-03	No. Alive	10	10	10	10	10
34/48/56-6.25%-03	pH	7.3	7.2	7.4	7.4	7.5
34/48/56-6.25%-03	Temp °(C)	11.65	11.65	11.66	11.85	11.66
34/48/56-6.25%-03	D.O. (mg/L)	8.13	7.82	8.19	8.24	8.25
34/48/56-6.25%-03	Conductivity (us/cm)	380.6	382.4	385.2	384.9	387
34/48/56-6.25%-03	Alkalinity (mg $CaCO_3$/L)	32.3	-	-	-	37.1
34/48/56-6.25%-03	Hardness (mg /L)	193	-	-	-	177

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-6.25%-04	No. Alive	10	10	10	10	10
34/48/56-6.25%-04	pH	7.3	7.2	7.4	7.4	7.5
34/48/56-6.25%-04	Temp °(C)	11.66	11.64	11.66	11.85	11.65
34/48/56-6.25%-04	D.O. (mg/L)	8.2	7.76	8.19	8.31	8.31
34/48/56-6.25%-04	Conductivity (us/cm)	377	383	385.5	385	386
34/48/56-6.25%-04	Alkalinity (mg $CaCO_3$/L)	32.3	-	-	-	37.1
34/48/56-6.25%-04	Hardness (mg /L)	193	-	-	-	177

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-12.5%-01	No. Alive	10	10	10	10	10
34/48/56-12.5%-01	pH	7.2	7.2	7.3	7.3	7.5
34/48/56-12.5%-01	Temp °(C)	11.65	11.61	11.68	11.84	11.66
34/48/56-12.5%-01	D.O. (mg/L)	8.25	8.12	7.93	8.29	8.36
34/48/56-12.5%-01	Conductivity (us/cm)	405.9	408	412.7	410.5	413.6
34/48/56-12.5%-01	Alkalinity (mg $CaCO_3$/L)	27.5	-	-	-	32
34/48/56-12.5%-01	Hardness (mg /L)	194	-	-	-	192

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-12.5%-02	No. Alive	10	10	10	10	10
34/48/56-12.5%-02	pH	7.2	7.3	7.2	7.3	7.4
34/48/56-12.5%-02	Temp °(C)	11.65	11.63	11.67	11.83	11.66
34/48/56-12.5%-02	D.O. (mg/L)	8.29	8.17	7.86	8.06	7.94
34/48/56-12.5%-02	Conductivity (us/cm)	405.5	409.8	413.3	411	412.3
34/48/56-12.5%-02	Alkalinity (mg $CaCO_3$/L)	27.5	-	-	-	32
34/48/56-12.5%-02	Hardness (mg /L)	194	-	-	-	192

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-12.5%-03	No. Alive	10	10	10	10	10
34/48/56-12.5%-03	pH	7.2	7.3	7.2	7.3	7.4
34/48/56-12.5%-03	Temp °(C)	11.64	11.62	11.68	11.85	11.65
34/48/56-12.5%-03	D.O. (mg/L)	8.32	8.3	7.7	7.85	7.82
34/48/56-12.5%-03	Conductivity (us/cm)	408	408.9	412	410.5	409.4
34/48/56-12.5%-03	Alkalinity (mg $CaCO_3$/L)	27.5	-	-	-	32
34/48/56-12.5%-03	Hardness (mg /L)	194	-	-	-	192

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-12.5%-04	No. Alive	10	10	10	10	10
34/48/56-12.5%-04	pH	7.2	7.2	7.3	7.3	7.4
34/48/56-12.5%-04	Temp °(C)	11.66	11.62	11.67	11.85	11.66
34/48/56-12.5%-04	D.O. (mg/L)	8.31	8.28	7.93	7.86	8.18
34/48/56-12.5%-04	Conductivity (us/cm)	404.6	408.3	412.7	410.4	412.1
34/48/56-12.5%-04	Alkalinity (mg $CaCO_3$/L)	27.5	-	-	-	32
34/48/56-12.5%-04	Hardness (mg /L)	194	-	-	-	192

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-25%-01	No. Alive	10	10	10	10	10
34/48/56-25%-01	pH	7.1	7.1	7.2	7.2	7.4
34/48/56-25%-01	Temp °(C)	11.66	11.66	11.68	11.88	11.67
34/48/56-25%-01	D.O. (mg/L)	8.23	7.76	8.07	8.28	8.27
34/48/56-25%-01	Conductivity (us/cm)	456.6	458.5	461.7	462.9	465.4
34/48/56-25%-01	Alkalinity (mg $CaCO_3$/L)	17.5	-	-	-	19.5
34/48/56-25%-01	Hardness (mg /L)	220	-	-	-	217

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-25%-02	No. Alive	10	10	10	10	10
34/48/56-25%-02	pH	7.1	7.1	7.2	7.2	7.4
34/48/56-25%-02	Temp °(C)	11.66	11.66	11.67	11.87	11.59
34/48/56-25%-02	D.O. (mg/L)	8.15	7.84	8.06	8.17	8.29
34/48/56-25%-02	Conductivity (us/cm)	452.2	457.9	463.4	461.8	464.4
34/48/56-25%-02	Alkalinity (mg $CaCO_3$/L)	17.5	-	-	-	19.5
34/48/56-25%-02	Hardness (mg /L)	220	-	-	-	217

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-25%-03	No. Alive	10	10	10	10	10
34/48/56-25%-03	pH	7.1	7.1	7.1	7.2	7.3
34/48/56-25%-03	Temp °(C)	11.68	11.66	11.66	11.86	11.66
34/48/56-25%-03	D.O. (mg/L)	8.21	7.9	8.08	8.05	8.27
34/48/56-25%-03	Conductivity (us/cm)	456.1	458	464.8	461.1	465.4
34/48/56-25%-03	Alkalinity (mg $CaCO_3$/L)	17.5	-	-	-	19.5
34/48/56-25%-03	Hardness (mg /L)	220	-	-	-	217

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-25%-04	No. Alive	10	10	10	10	10
34/48/56-25%-04	pH	7	7.1	7.1	7.1	7.4
34/48/56-25%-04	Temp °(C)	11.67	11.65	11.66	11.86	11.66
34/48/56-25%-04	D.O. (mg/L)	8.24	7.75	8.1	7.99	8.29
34/48/56-25%-04	Conductivity (us/cm)	458.8	458.2	463	460.9	464.1
34/48/56-25%-04	Alkalinity (mg $CaCO_3$/L)	17.5	-	-	-	19.5
34/48/56-25%-04	Hardness (mg /L)	220	-	-	-	217

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-50%-01	No. Alive	10	10	10	10	10
34/48/56-50%-01	pH	6.2	6.5	6.7	6.9	7.1
34/48/56-50%-01	Temp °(C)	11.66	11.66	11.69	11.87	11.67
34/48/56-50%-01	D.O. (mg/L)	8.25	8.1	7.84	8.55	8.48
34/48/56-50%-01	Conductivity (us/cm)	559.1	563.6	569.4	567.1	569.1
34/48/56-50%-01	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	5.82
34/48/56-50%-01	Hardness (mg /L)	270	-	-	-	272

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-50%-02	No. Alive	10	10	10	10	10
34/48/56-50%-02	pH	6.2	6.5	6.7	6.8	7
34/48/56-50%-02	Temp °(C)	11.66	11.67	11.65	11.91	11.69
34/48/56-50%-02	D.O. (mg/L)	8.28	7.95	7.84	8.35	8.54
34/48/56-50%-02	Conductivity (us/cm)	563.2	564	568.8	568.1	568.9
34/48/56-50%-02	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	5.82
34/48/56-50%-02	Hardness (mg /L)	270	-	-	-	272

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-50%-03	No. Alive	10	10	10	9	9
34/48/56-50%-03	pH	6.2	6.5	6.6	6.7	6.9
34/48/56-50%-03	Temp °(C)	11.67	11.67	11.65	11.89	11.69
34/48/56-50%-03	D.O. (mg/L)	8.28	7.96	8.1	8.31	8.43
34/48/56-50%-03	Conductivity (us/cm)	556	563	569.3	565.6	565.5
34/48/56-50%-03	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	5.82
34/48/56-50%-03	Hardness (mg /L)	270	-	-	-	272

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/56-50%-04	No. Alive	10	10	10	10	10
34/48/56-50%-04	pH	6.1	6.5	6.6	6.7	6.9
34/48/56-50%-04	Temp °(C)	11.68	11.67	11.68	11.88	11.69
34/48/56-50%-04	D.O. (mg/L)	8.24	8.16	8.23	8.35	8.49
34/48/56-50%-04	Conductivity (us/cm)	555.3	563.3	568.1	566.7	568.4
34/48/56-50%-04	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	5.82
34/48/56-50%-04	Hardness (mg /L)	270	-	-	-	272

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-100%-01	No. Alive	10	10	0	-	-
34/48/56-100%-01	pH	3.9	4.5	4.2	-	-
34/48/56-100%-01	Temp °(C)	11.68	11.67	11.69	-	-
34/48/56-100%-01	D.O. (mg/L)	8.32	8.51	8.58	-	-
34/48/56-100%-01	Conductivity (us/cm)	814.1	798.6	841.3	-	-
34/48/56-100%-01	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	<5.00U	-	-
34/48/56-100%-01	Hardness (mg /L)	382	-	385	-	-

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-100%-02	No. Alive	10	4	0	-	-
34/48/56-100%-02	pH	3.9	4.5	4.1	-	-
34/48/56-100%-02	Temp °(C)	11.67	11.65	11.69	-	-
34/48/56-100%-02	D.O. (mg/L)	8.33	8.43	8.61	-	-
34/48/56-100%-02	Conductivity (us/cm)	818.9	802.4	816.7	-	-
34/48/56-100%-02	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	<5.00U	-	-
34/48/56-100%-02	Hardness (mg /L)	382	-	385	-	-

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-100%-03	No. Alive	10	2	0	-	-
34/48/56-100%-03	pH	3.8	4.1	4.1	-	-
34/48/56-100%-03	Temp °(C)	11.7	11.69	11.65	-	-
34/48/56-100%-03	D.O. (mg/L)	8.22	8.37	8.67	-	-
34/48/56-100%-03	Conductivity (us/cm)	836	822.4	816	-	-
34/48/56-100%-03	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	<5.00U	-	-
34/48/56-100%-03	Hardness (mg /L)	382	-	385	-	-

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/56-100%-04	No. Alive	10	7	0	-	-
34/48/56-100%-04	pH	3.8	4.3	4.2	-	-
34/48/56-100%-04	Temp °(C)	11.72	11.7	11.71	-	-
34/48/56-100%-04	D.O. (mg/L)	8.17	8.19	8.63	-	-
34/48/56-100%-04	Conductivity (us/cm)	825.4	807.5	817.6	-	-
34/48/56-100%-04	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	<5.00U	-	-
34/48/56-100%-04	Hardness (mg /L)	382	-	385	-	-

Serial dilution of M34/CC48 with A68

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/68-control-01	No. Alive	10	10	10	10	10
34/48/68-control-01	pH	7.2	7	7.1	7.6	7.3
34/48/68-control-01	Temp °(C)	12.05	11.76	12.05	11.95	11.82
34/48/68-control-01	D.O. (mg/L)	7.74	7.54	7.7	7.66	7.85
34/48/68-control-01	Conductivity (us/cm)	308.4	314.9	315.4	318.1	321.3
34/48/68-control-01	Alkalinity (mg $CaCO_3$/L)	*	-	-	-	72.2
34/48/68-control-01	Hardness (mg /L)	*	-	-	-	94

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/68-control-02	No. Alive	10	10	10	10	10
34/48/68-control-02	pH	7.2	7.1	7.2	7.6	7.4
34/48/68-control-02	Temp °(C)	12.01	11.72	11.74	11.91	11.73
34/48/68-control-02	D.O. (mg/L)	7.79	7.69	8.07	8.1	7.78
34/48/68-control-02	Conductivity (us/cm)	287.5	315.3	318.5	319.1	321.4
34/48/68-control-02	Alkalinity (mg $CaCO_3$/L)	*	-	-	-	72.2
34/48/68-control-02	Hardness (mg /L)	*	-	-	-	94

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/68-control-03	No. Alive	10	10	10	10	10
34/48/68-control-03	pH	7.2	7.1	7.3	7.6	7.6
34/48/68-control-03	Temp °(C)	11.91	11.71	11.74	11.91	11.71
34/48/68-control-03	D.O. (mg/L)	7.88	7.96	8.08	8.22	8.15
34/48/68-control-03	Conductivity (us/cm)	310.8	314.7	318	318.6	320.4
34/48/68-control-03	Alkalinity (mg $CaCO_3$/L)	*	-	-	-	72.2
34/48/68-control-03	Hardness (mg /L)	*	-	-	-	94

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/68-control-04	No. Alive	10	10	10	10	10
34/48/68-control-04	pH	7.3	7.1	7.3	7.6	7.6
34/48/68-control-04	Temp °(C)	11.88	11.72	11.73	11.91	11.72
34/48/68-control-04	D.O. (mg/L)	7.87	7.87	7.94	8.09	8.13
34/48/68-control-04	Conductivity (us/cm)	311.2	314	318.4	318.7	320.6
34/48/68-control-04	Alkalinity (mg $CaCO_3$/L)	*	-	-	-	72.2
34/48/68-control-04	Hardness (mg /L)	*	-	-	-	94

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-6.25%-01	No. Alive	10	10	10	10	10
34/48/68-6.25%-01	pH	7.3	7	7.4	7.3	7.7
34/48/68-6.25%-01	Temp °(C)	11.84	11.76	11.91	11.73	11.91
34/48/68-6.25%-01	D.O. (mg/L)	8.12	6.29	7.9	7.7	8.04
34/48/68-6.25%-01	Conductivity (us/cm)	406.2	426.9	415.3	412.3	414.4
34/48/68-6.25%-01	Alkalinity (mg $CaCO_3$/L)	31.6	-	-	-	35.7
34/48/68-6.25%-01	Hardness (mg /L)	180	-	-	-	194

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-6.25%-02	No. Alive	10	10	10	10	10
34/48/68-6.25%-02	pH	7.3	7.1	7.4	7.3	7.6
34/48/68-6.25%-02	Temp °(C)	11.76	11.75	11.9	11.73	11.8
34/48/68-6.25%-02	D.O. (mg/L)	8.3	6.47	7.75	7.61	7.78
34/48/68-6.25%-02	Conductivity (us/cm)	406.6	423.8	414.4	411.5	414.3
34/48/68-6.25%-02	Alkalinity (mg $CaCO_3$/L)	31.6	-	-	-	35.7
34/48/68-6.25%-02	Hardness (mg /L)	180	-	-	-	194

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-6.25%-03	No. Alive	10	10	10	10	10
34/48/68-6.25%-03	pH	7.3	7.1	7.3	7.3	7.6
34/48/68-6.25%-03	Temp °(C)	11.75	11.76	11.86	11.72	11.81
34/48/68-6.25%-03	D.O. (mg/L)	8.37	6.87	7.86	7.77	7.61
34/48/68-6.25%-03	Conductivity (us/cm)	406.1	424.1	416.5	415.9	413
34/48/68-6.25%-03	Alkalinity (mg $CaCO_3$/L)	31.6	-	-	-	35.7
34/48/68-6.25%-03	Hardness (mg /L)	180	-	-	-	194

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-6.25%-04	No. Alive	10	10	10	10	10
34/48/68-6.25%-04	pH	7.4	7.1	7.3	7.3	7.5
34/48/68-6.25%-04	Temp °(C)	11.72	11.77	11.89	11.7	11.81
34/48/68-6.25%-04	D.O. (mg/L)	8.4	7.18	7.78	7.66	7.61
34/48/68-6.25%-04	Conductivity (us/cm)	405.9	423	415.6	419.9	413
34/48/68-6.25%-04	Alkalinity (mg $CaCO_3$/L)	31.6	-	-	-	35.7
34/48/68-6.25%-04	Hardness (mg /L)	180	-	-	-	194

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-12.5%-01	No. Alive	10	10	10	10	10
34/48/68-12.5%-01	pH	7.3	7.3	7.4	7.3	7.6
34/48/68-12.5%-01	Temp °(C)	11.75	11.77	11.93	11.74	11.82
34/48/68-12.5%-01	D.O. (mg/L)	8.47	7.88	8.18	7.74	8.3
34/48/68-12.5%-01	Conductivity (us/cm)	430	449	440.7	442.9	443.1
34/48/68-12.5%-01	Alkalinity (mg $CaCO_3$/L)	31.2	-	-	-	28.1
34/48/68-12.5%-01	Hardness (mg /L)	196	-	-	-	203

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-12.5%-02	No. Alive	10	10	10	10	10
34/48/68-12.5%-02	pH	7.3	7.2	7.4	7.3	7.6
34/48/68-12.5%-02	Temp °(C)	11.73	11.77	11.93	11.73	11.8
34/48/68-12.5%-02	D.O. (mg/L)	8.5	8.03	8.25	8.03	8.02
34/48/68-12.5%-02	Conductivity (us/cm)	429.7	446.8	440.4	442.4	440.2
34/48/68-12.5%-02	Alkalinity (mg $CaCO_3$/L)	31.2	-	-	-	28.1
34/48/68-12.5%-02	Hardness (mg /L)	196	-	-	-	203

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-12.5%-03	No. Alive	10	10	10	10	10
34/48/68-12.5%-03	pH	7.2	7.2	7.4	7.4	7.5
34/48/68-12.5%-03	Temp °(C)	11.67	11.77	11.93	11.72	11.81
34/48/68-12.5%-03	D.O. (mg/L)	8.57	7.86	8.21	8.18	7.99
34/48/68-12.5%-03	Conductivity (us/cm)	429.6	447.9	440.1	444.3	441.7
34/48/68-12.5%-03	Alkalinity (mg $CaCO_3$/L)	31.2	-	-	-	28.1
34/48/68-12.5%-03	Hardness (mg /L)	196	-	-	-	203

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-12.5%-04	No. Alive	10	10	10	10	10
34/48/68-12.5%-04	pH	7.2	7.2	7.3	7.4	7.5
34/48/68-12.5%-04	Temp °(C)	11.68	11.76	11.92	11.74	11.81
34/48/68-12.5%-04	D.O. (mg/L)	8.56	7.81	8.1	8.31	7.78
34/48/68-12.5%-04	Conductivity (us/cm)	429.9	449.4	442	443.7	441.2
34/48/68-12.5%-04	Alkalinity (mg $CaCO_3$/L)	31.2	-	-	-	28.1
34/48/68-12.5%-04	Hardness (mg /L)	196	-	-	-	203

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/68-25%-01	No. Alive	10	10	10	10	10
34/48/68-25%-01	pH	7.1	7.2	7.3	7.3	7.4
34/48/68-25%-01	Temp °(C)	11.8	11.76	11.81	11.73	11.8
34/48/68-25%-01	D.O. (mg/L)	8.55	7.84	8.24	8.29	7.77
34/48/68-25%-01	Conductivity (us/cm)	480.8	497	489.2	490.4	491.1
34/48/68-25%-01	Alkalinity (mg $CaCO_3$/L)	17.6	-	-	-	19.5
34/48/68-25%-01	Hardness (mg /L)	231	-	-	-	230

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/68-25%-02	No. Alive	10	10	10	10	10
34/48/68-25%-02	pH	6.9	7.1	7.2	7.3	7.5
34/48/68-25%-02	Temp °(C)	11.77	11.77	11.91	11.72	11.82
34/48/68-25%-02	D.O. (mg/L)	8.54	8.02	8.01	8.12	8.07
34/48/68-25%-02	Conductivity (us/cm)	479.2	496.8	489	493.1	492.1
34/48/68-25%-02	Alkalinity (mg $CaCO_3$/L)	17.6	-	-	-	19.5
34/48/68-25%-02	Hardness (mg /L)	231	-	-	-	230

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/68-25%-03	No. Alive	10	10	10	10	10
34/48/68-25%-03	pH	7	7.2	7.3	7.3	7.4
34/48/68-25%-03	Temp °(C)	11.74	11.75	11.92	11.72	11.84
34/48/68-25%-03	D.O. (mg/L)	8.55	7.79	7.94	8.05	8.01
34/48/68-25%-03	Conductivity (us/cm)	480	495.9	489	491.8	490.1
34/48/68-25%-03	Alkalinity (mg $CaCO_3$/L)	17.6	-	-	-	19.5
34/48/68-25%-03	Hardness (mg /L)	231	-	-	-	230

Replicate I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
34/48/68-25%-04	No. Alive	10	10	10	10	10
34/48/68-25%-04	pH	6.9	7.1	7.2	7.3	7.5
34/48/68-25%-04	Temp °(C)	11.73	11.76	11.94	11.72	11.85
34/48/68-25%-04	D.O. (mg/L)	8.57	8.05	8.08	8.23	7.9
34/48/68-25%-04	Conductivity (us/cm)	480	497.9	488	490.2	486.2
34/48/68-25%-04	Alkalinity (mg $CaCO_3$/L)	17.6	-	-	-	19.5
34/48/68-25%-04	Hardness (mg /L)	231	-	-	-	230

Appendix A 1: Upper Animas October 2012
Aquatic Toxicity Test
Site Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms per replicate: 10	
End Date	10/26/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA,CL,LC

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-50%-01	No. Alive	10	10	10	7	3
34/48/68-50%-01	pH	6.1	6.9	7.1	7.1	7.1
34/48/68-50%-01	Temp °(C)	11.94	11.79	11.79	11.74	11.86
34/48/68-50%-01	D.O. (mg/L)	8.5	7.9	8.3	8.23	7.97
34/48/68-50%-01	Conductivity (us/cm)	574.7	590	582.3	588.7	590.1
34/48/68-50%-01	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	5.00
34/48/68-50%-01	Hardness (mg /L)	278	-	-	-	278

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-50%-02	No. Alive	10	10	8	5	2
34/48/68-50%-02	pH	5.9	6.9	6.9	7	7.1
34/48/68-50%-02	Temp °(C)	11.66	11.77	11.78	11.74	11.84
34/48/68-50%-02	D.O. (mg/L)	8.53	7.94	8.48	8.43	8.11
34/48/68-50%-02	Conductivity (us/cm)	572.7	591.4	584.6	587.4	589.2
34/48/68-50%-02	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	5.00
34/48/68-50%-02	Hardness (mg /L)	278	-	-	-	278

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-50%-03	No. Alive	10	10	10	8	6
34/48/68-50%-03	pH	6	6.9	6.9	6.9	6.9
34/48/68-50%-03	Temp °(C)	11.6	11.77	11.89	11.75	11.9
34/48/68-50%-03	D.O. (mg/L)	8.58	7.8	8.33	8.57	8.21
34/48/68-50%-03	Conductivity (us/cm)	572.7	592	585.1	589.9	588.3
34/48/68-50%-03	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	5.00
34/48/68-50%-03	Hardness (mg /L)	278	-	-	-	278

Replicate I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
34/48/68-50%-04	No. Alive	10	10	10	8	4
34/48/68-50%-04	pH	6.1	6.9	6.9	6.9	6.9
34/48/68-50%-04	Temp °(C)	11.59	11.77	11.91	11.69	11.87
34/48/68-50%-04	D.O. (mg/L)	8.61	8.03	8.37	8.63	7.92
34/48/68-50%-04	Conductivity (us/cm)	572	588.2	582	587.2	591.2
34/48/68-50%-04	Alkalinity (mg $CaCO_3$/L)	<5.00U	-	-	-	5.00
34/48/68-50%-04	Hardness (mg /L)	278	-	-	-	278

* No data available

Qualifiers:

U= Non Detect

Prepared by: EC 3/6/13

QC'd by: BGK 3/13/13

Appendix A 2: October 2012 Aquatic Toxicity Test
Reference Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms	10
End Date	10/26/12	No. of Replicates	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
Control-01	No. Alive	10	10	10	10	10
Control-01	pH	7.4	7.5	7.6	7.6	7.6
Control-01	Temp °(C)	11.73	11.85	11.91	11.94	11.64
Control-01	D.O. (mg/L)	8.33	8.18	8.14	7.99	8.42
Control-01	Conductivity (us/cm)	309.6	315.2	317.9	317.7	318.4
Control-01	Alkalinity (mg $CaCO_3$/L)	56.6	-	-	-	70.5
Control-01	Hardness (mg/L)	96	-	-	-	94

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
Control-02	No. Alive	10	10	10	10	10
Control-02	pH	7.5	7.6	7.6	7.6	7.6
Control-02	Temp °(C)	11.68	11.83	11.88	11.88	11.65
Control-02	D.O. (mg/L)	8.66	8.27	8.27	8.25	8.44
Control-02	Conductivity (us/cm)	308.4	316.2	318.5	319	320
Control-02	Alkalinity (mg $CaCO_3$/L)	56.6	-	-	-	70.5
Control-02	Hardness (mg/L)	96	-	-	-	94

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
Control-03	No. Alive	10	10	10	10	10
Control-03	pH	7.5	7.6	7.6	7.6	7.7
Control-03	Temp °(C)	11.71	11.84	11.84	11.86	11.64
Control-03	D.O. (mg/L)	8.65	8.13	8.28	8.32	8.46
Control-03	Conductivity (us/cm)	310.1	315.8	317.4	317.7	319.3
Control-03	Alkalinity (mg $CaCO_3$/L)	56.6	-	-	-	70.5
Control-03	Hardness (mg/L)	96	-	-	-	94

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
Control-04	No. Alive	10	10	10	10	10
Control-04	pH	7.6	7.6	7.6	7.6	7.6
Control-04	Temp °(C)	11.72	11.84	11.85	11.83	11.63
Control-04	D.O. (mg/L)	8.64	7.73	8.12	8.25	8.33
Control-04	Conductivity (us/cm)	308	315.4	317.4	318.3	319.3
Control-04	Alkalinity (mg $CaCO_3$/L)	56.6	-	-	-	70.5
Control-04	Hardness (mg/L)	96	-	-	-	94

Appendix A 2: October 2012 Aquatic Toxicity Test
Reference Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms	10
End Date	10/26/12	No. of Replicates	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-01	No. Alive	10	10	10	10	10
6.25%-01	pH	7.5	7.5	7.6	7.6	7.6
6.25%-01	Temp °(C)	11.71	11.84	11.84	11.85	11.62
6.25%-01	D.O. (mg/L)	8.65	7.72	8.03	8.23	8.34
6.25%-01	Conductivity (us/cm)	311.6	316.8	318.4	318.8	320.2
6.25%-01	Alkalinity (mg $CaCO_3$/L)	60	-	-	-	63.8
6.25%-01	Hardness (mg/L)	96	-	-	-	97

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-02	No. Alive	10	10	10	10	10
6.25%-02	pH	7.5	7.6	7.5	7.6	7.6
6.25%-02	Temp °(C)	11.71	11.85	11.83	11.82	11.63
6.25%-02	D.O. (mg/L)	8.62	7.72	7.6	7.87	8.43
6.25%-02	Conductivity (us/cm)	308.1	315.5	317.7	317.6	318.9
6.25%-02	Alkalinity (mg $CaCO_3$/L)	60	-	-	-	63.8
6.25%-02	Hardness (mg/L)	96	-	-	-	97

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-03	No. Alive	10	10	10	10	10
6.25%-03	pH	7.6	7.5	7.5	7.5	7.6
6.25%-03	Temp °(C)	11.66	11.86	11.83	11.83	11.63
6.25%-03	D.O. (mg/L)	8.6	7.65	7.54	7.71	8.01
6.25%-03	Conductivity (us/cm)	307.7	316	318.4	317.9	319
6.25%-03	Alkalinity (mg $CaCO_3$/L)	60	-	-	-	63.8
6.25%-03	Hardness (mg/L)	96	-	-	-	97

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-04	No. Alive	10	10	10	10	10
6.25%-04	pH	7.6	7.6	7.6	7.6	7.6
6.25%-04	Temp °(C)	11.66	11.85	11.84	11.76	11.65
6.25%-04	D.O. (mg/L)	8.61	7.58	7.77	8.16	7.97
6.25%-04	Conductivity (us/cm)	311.5	316.4	318.9	319	319.9
6.25%-04	Alkalinity (mg $CaCO_3$/L)	60	-	-	-	63.8
6.25%-04	Hardness (mg/L)	96	-	-	-	97

Appendix A 2: October 2012 Aquatic Toxicity Test
Reference Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms	10
End Date	10/26/12	No. of Replicates	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
12.5%-01	No. Alive	10	10	8	8	8
12.5%-01	pH	7.6	7.5	7.6	7.6	7.6
12.5%-01	Temp °(C)	11.67	11.85	11.83	11.79	11.64
12.5%-01	D.O. (mg/L)	8.67	7.81	8.17	8.24	8.45
12.5%-01	Conductivity (us/cm)	311.4	317.5	319.7	316.5	318
12.5%-01	Alkalinity (mg $CaCO_3$/L)	56.7	-	-	-	66.3
12.5%-01	Hardness (mg/L)	96	-	-	-	91

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
12.5%-02	No. Alive	10	10	6	6	6
12.5%-02	pH	7.6	7.5	7.6	7.6	7.7
12.5%-02	Temp °(C)	11.65	11.86	11.84	11.75	11.64
12.5%-02	D.O. (mg/L)	8.67	7.76	8.2	8.25	8.52
12.5%-02	Conductivity (us/cm)	311.8	318.3	322.9	317.4	318.4
12.5%-02	Alkalinity (mg $CaCO_3$/L)	56.7	-	-	-	66.3
12.5%-02	Hardness (mg/L)	96	-	-	-	91

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
12.5%-03	No. Alive	10	10	8	8	8
12.5%-03	pH	7.6	7.5	7.6	7.6	7.7
12.5%-03	Temp °(C)	11.66	11.86	11.84	11.77	11.65
12.5%-03	D.O. (mg/L)	8.68	7.63	8.15	8.38	8.51
12.5%-03	Conductivity (us/cm)	309.8	317.8	321.8	319.6	320.1
12.5%-03	Alkalinity (mg $CaCO_3$/L)	56.7	-	-	-	66.3
12.5%-03	Hardness (mg/L)	96	-	-	-	91

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
12.5%-04	No. Alive	10	10	8	8	8
12.5%-04	pH	7.6	7.5	7.6	7.6	7.6
12.5%-04	Temp °(C)	11.67	11.86	11.85	11.77	11.64
12.5%-04	D.O. (mg/L)	8.69	7.78	8	8.32	8.44
12.5%-04	Conductivity (us/cm)	308.2	319.2	323.5	318.9	319.1
12.5%-04	Alkalinity (mg $CaCO_3$/L)	56.7	-	-	-	66.3
12.5%-04	Hardness (mg/L)	96	-	-	-	91

Appendix A 2: October 2012 Aquatic Toxicity Test
Reference Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms	10
End Date	10/26/12	No. of Replicates	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
25%-01	No. Alive	10	6	0	-	-
25%-01	pH	7.6	7.5	7.6	-	-
25%-01	Temp °(C)	11.69	11.86	11.77	-	-
25%-01	D.O. (mg/L)	8.68	7.82	8.32	-	-
25%-01	Conductivity (us/cm)	311.3	318.6	319.2	-	-
25%-01	Alkalinity (mg $CaCO_3$/L)	59.5		64	-	-
25%-01	Hardness (mg/L)	96		95	-	-

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
25%-02	No. Alive	10	10	0	-	-
25%-02	pH	7.6	7.4	7.7	-	-
25%-02	Temp °(C)	11.69	11.87	11.86	-	-
25%-02	D.O. (mg/L)	8.64	7.6	8.49	-	-
25%-02	Conductivity (us/cm)	308.2	320.4	324	-	-
25%-02	Alkalinity (mg $CaCO_3$/L)	59.5	-	64	-	-
25%-02	Hardness (mg/L)	96	-	95	-	-

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
25%-03	No. Alive	10	9	2	2	2
25%-03	pH	7.6	7.4	7.7	7.7	7.7
25%-03	Temp °(C)	11.7	11.87	11.88	11.75	11.67
25%-03	D.O. (mg/L)	8.62	6.83	8.51	8.51	8.6
25%-03	Conductivity (us/cm)	309.2	318.6	323.1	313.9	315.1
25%-03	Alkalinity (mg $CaCO_3$/L)	59.5	-	64	-	-
25%-03	Hardness (mg/L)	96	-	95	-	-

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
25%-04	No. Alive	10	7	0	-	-
25%-04	pH	7.6	7.4	7.8	-	-
25%-04	Temp °(C)	11.67	11.88	11.88	-	-
25%-04	D.O. (mg/L)	8.65	7.39	8.49	-	-
25%-04	Conductivity (us/cm)	311	319.5	319.3	-	-
25%-04	Alkalinity (mg $CaCO_3$/L)	59.5	-	64	-	-
25%-04	Hardness (mg/L)	96	-	95	-	-

Appendix A 2: October 2012 Aquatic Toxicity Test
Reference Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms	10
End Date	10/26/12	No. of Replicates	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
50%-01	No. Alive	10	7	0	-	-
50%-01	pH	7.6	7.4	7.7	-	-
50%-01	Temp °(C)	11.68	11.84	11.86	-	-
50%-01	D.O. (mg/L)	8.7	7.87	8.63	-	-
50%-01	Conductivity (us/cm)	308.9	319.5	316.4	-	-
50%-01	Alkalinity (mg $CaCO_3$/L)	58.4	-	62.4	-	-
50%-01	Hardness (mg/L)	96	-	95	-	-

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
50%-02	No. Alive	10	7	0	-	-
50%-02	pH	7.6	7.4	7.8	-	-
50%-02	Temp °(C)	11.7	11.88	11.88	-	-
50%-02	D.O. (mg/L)	8.67	7.42	8.63	-	-
50%-02	Conductivity (us/cm)	308.6	319.3	316	-	-
50%-02	Alkalinity (mg $CaCO_3$/L)	58.4	-	62.4	-	-
50%-02	Hardness (mg/L)	96	-	95	-	-

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
50%-03	No. Alive	10	9	0	-	-
50%-03	pH	7.6	7.4	7.7	-	-
50%-03	Temp °(C)	11.71	11.91	11.89	-	-
50%-03	D.O. (mg/L)	8.65	7.2	8.63	-	-
50%-03	Conductivity (us/cm)	308.9	319.5	322.8	-	-
50%-03	Alkalinity (mg $CaCO_3$/L)	58.4	-	62.4	-	-
50%-03	Hardness (mg/L)	96	-	95	-	-

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
50%-04	No. Alive	10	6	0	-	-
50%-04	pH	7.6	7.4	7.8	-	-
50%-04	Temp °(C)	11.68	11.91	11.88	-	-
50%-04	D.O. (mg/L)	8.68	7.87	8.57	-	-
50%-04	Conductivity (us/cm)	309.6	320.2	318.4	-	-
50%-04	Alkalinity (mg $CaCO_3$/L)	58.4	-	62.4	-	-
50%-04	Hardness (mg/L)	96	-	95	-	-

Appendix A 2: October 2012 Aquatic Toxicity Test
Reference Static Renewal Data Sheets

Start Date	10/22/12	No. Organisms	10
End Date	10/26/12	No. of Replicates	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
100%-01	No. Alive	10	4	0	-	-
100%-01	pH	7.6	7.4	7.7	-	-
100%-01	Temp °(C)	11.72	11.88	11.88	-	-
100%-01	D.O. (mg/L)	8.67	8	8.66	-	-
100%-01	Conductivity (us/cm)	309.8	319.5	315.8	-	-
100%-01	Alkalinity (mg $CaCO_3$/L)	60.5	-	59.7	-	-
100%-01	Hardness (mg/L)	96	-	94	-	-

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
100%-02	No. Alive	10	3	0	-	-
100%-02	pH	7.6	7.4	7.7	-	-
100%-02	Temp °(C)	11.69	11.88	11.89	-	-
100%-02	D.O. (mg/L)	8.69	8.15	8.6	-	-
100%-02	Conductivity (us/cm)	310.9	320.4	316	-	-
100%-02	Alkalinity (mg $CaCO_3$/L)	60.5	-	59.7	-	-
100%-02	Hardness (mg/L)	96	-	94	-	-

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
100%-03	No. Alive	10	5	0	-	-
100%-03	pH	7.6	7.5	7.8	-	-
100%-03	Temp °(C)	11.68	11.9	11.88	-	-
100%-03	D.O. (mg/L)	8.71	8.19	8.66	-	-
100%-03	Conductivity (us/cm)	311.9	319.7	318	-	-
100%-03	Alkalinity (mg $CaCO_3$/L)	60.5	-	59.7	-	-
100%-03	Hardness (mg/L)	96	-	94	-	-

Site I.D.	**Parameter**	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
100%-04	No. Alive	10	7	1	0	-
100%-04	pH	7.6	7.4	7.8	7.6	-
100%-04	Temp °(C)	11.67	11.9	11.9	11.79	-
100%-04	D.O. (mg/L)	8.8	8.09	8.66	8.7	-
100%-04	Conductivity (us/cm)	313.1	320.4	318.3	313.2	-
100%-04	Alkalinity (mg $CaCO_3$/L)	60.5	-	59.7	-	-
100%-04	Hardness (mg/L)	96	-	94	-	-

Appendix B
November 2012 Upper Animas River Superfund Site
Site Water Toxicity Test and Reference Toxicity Test
Daily Water Chemistries

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Profile Test

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-01	No. Alive	10	10	10	10	10
Control-01	pH	7.6	7.3	7.27	7.22	7.52
Control-01	Temp (°C)	11.87	11.83	11.62	11.97	11.74
Control-01	D.O. (mg/L)	8.59	7.61	8.01	8.33	8.15
Control-01	Conductivity (us/cm)	298.3	304.2	322	327.2	318.9
Control-01	Alkalinity (mg $CaCO_3$/L)	55.2	-	-	-	65.8
Control-01	Hardness (mg/L)	91	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-02	No. Alive	10	10	10	10	10
Control-02	pH	7.6	7.2	7.21	7.24	7.51
Control-02	Temp (°C)	11.71	11.82	11.83	11.94	11.79
Control-02	D.O. (mg/L)	8.71	7.51	8	8.27	8.03
Control-02	Conductivity (us/cm)	297.3	303.3	318	324.6	317.7
Control-02	Alkalinity (mg $CaCO_3$/L)	55.2	-	-	-	65.8
Control-02	Hardness (mg/L)	91	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-03	No. Alive	10	10	10	10	10
Control-03	pH	7.6	7.2	7.2	7.26	7.5
Control-03	Temp (°C)	11.71	11.82	11.61	11.89	11.74
Control-03	D.O. (mg/L)	8.71	7.68	8.2	8.11	8
Control-03	Conductivity (us/cm)	297.4	303.6	316	326.8	319.3
Control-03	Alkalinity (mg $CaCO_3$/L)	55.2	-	-	-	65.8
Control-03	Hardness (mg/L)	91	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-04	No. Alive	10	10	10	10	10
Control-04	pH	7.7	7.3	7.3	7.28	7.46
Control-04	Temp (°C)	11.74	11.82	11.52	11.88	11.77
Control-04	D.O. (mg/L)	8.72	7.95	7.7	8.03	7.77
Control-04	Conductivity (us/cm)	297.2	303.6	311	328.1	318.6
Control-04	Alkalinity (mg $CaCO_3$/L)	55.2	-	-	-	65.8
Control-04	Hardness (mg/L)	91	-	-	-	93

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
M34-01	No. Alive	10	9	0	-	-
M34-01	pH	5.5	6.5	6.87	-	-
M34-01	Temp (°C)	11.75	11.84	11.83	-	-
M34-01	D.O. (mg/L)	8.79	8.15	8.09	-	-
M34-01	Conductivity (us/cm)	574.2	600.8	621	-	-
M34-01	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	8.16	-	-
M34-01	Hardness (mg/L)	276	-	282	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
M34-02	No. Alive	10	8	1	0	-
M34-02	pH	5.5	6.4	6.67	6.61	-
M34-02	Temp (°C)	11.7	11.8	11.87	11.82	-
M34-02	D.O. (mg/L)	8.81	8.37	8	8.7	-
M34-02	Conductivity (us/cm)	577	602.4	627	622.3	-
M34-02	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	8.16	-
M34-02	Hardness (mg/L)	276	-	-	282	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
M34-03	No. Alive	10	10	1	1	0
M34-03	pH	5.4	6.5	6.71	6.54	6.35
M34-03	Temp (°C)	11.69	11.86	11.9	11.76	11.67
M34-03	D.O. (mg/L)	8.81	8.32	7.87	8.74	8.33
M34-03	Conductivity (us/cm)	577.2	608.1	629	632.1	591.9
M34-03	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	8.16
M34-03	Hardness (mg/L)	276	-	-	-	282

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
M34-04	No. Alive	10	8	1	0	-
M34-04	pH	5.4	6.4	6.61	6.48	-
M34-04	Temp (°C)	11.75	11.85	11.83	11.73	-
M34-04	D.O. (mg/L)	8.8	8.18	8.01	8.75	-
M34-04	Conductivity (us/cm)	577.4	609.1	629	633.1	-
M34-04	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	8.16	-
M34-04	Hardness (mg/L)	276	-	-	282	-

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-01	No. Alive	10	10	10	9	9
A68-01	pH	7.4	7	6.93	7.08	6.29
A68-01	Temp (°C)	11.7	11.85	11.68	11.76	11.65
A68-01	D.O. (mg/L)	8.73	7.6	8.05	8.18	8
A68-01	Conductivity (us/cm)	378.4	389.6	406	413.5	393.9
A68-01	Alkalinity (mg $CaCO_3$/L)	37.6	-	-	-	47
A68-01	Hardness (mg/L)	181	-	-	-	177

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-02	No. Alive	10	10	9	8	8
A68-02	pH	7.4	7	6.98	7.05	6.61
A68-02	Temp (°C)	11.68	11.85	11.59	11.79	11.62
A68-02	D.O. (mg/L)	8.79	7.54	8.05	7.4	8
A68-02	Conductivity (us/cm)	378.6	388.3	406	421.3	395.8
A68-02	Alkalinity (mg $CaCO_3$/L)	37.6	-	-	-	47
A68-02	Hardness (mg/L)	181	-	-	-	177

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-03	No. Alive	10	10	10	10	10
A68-03	pH	7.4	7	6.93	7.06	6.6
A68-03	Temp (°C)	11.66	11.86	11.58	11.79	11.59
A68-03	D.O. (mg/L)	8.79	7.09	8.32	7.41	7.82
A68-03	Conductivity (us/cm)	378.7	388.7	405	413.3	395.2
A68-03	Alkalinity (mg $CaCO_3$/L)	37.6	-	-	-	47
A68-03	Hardness (mg/L)	181	-	-	-	177

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-04	No. Alive	10	10	10	10	10
A68-04	pH	7.4	6.9	6.97	7.05	6.61
A68-04	Temp (°C)	11.68	11.87	11.57	11.79	11.6
A68-04	D.O. (mg/L)	8.8	6.62	6.97	7.53	7.66
A68-04	Conductivity (us/cm)	378.5	387.6	404	414.3	395.1
A68-04	Alkalinity (mg $CaCO_3$/L)	37.6	-	-	-	47
A68-04	Hardness (mg/L)	181	-	-	-	177

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Serial dilution of A72 with A68

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-100%-Rep1	No. Alive	10	10	3	2	0
A68/A72-100%-Rep1	pH	5.6	6.5	6.84	6.8	6.23
A68/A72-100%-Rep1	Temp (°C)	12.2	11.77	11.7	11.91	11.58
A68/A72-100%-Rep1	D.O. (mg/L)	8.66	8.33	8.06	8.63	8.67
A68/A72-100%-Rep1	Conductivity (us/cm)	602.2	632.3	664	672	624.7
A68/A72-100%-Rep1	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	<5.00 U
A68/A72-100%-Rep1	Hardness (mg/L)	298	-	-	-	298

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-100%-Rep2	No. Alive	10	10	5	4	1
A68/A72-100%-Rep2	pH	5.6	6.3	6.72	6.79	6
A68/A72-100%-Rep2	Temp (°C)	12.21	11.77	11.62	11.91	11.62
A68/A72-100%-Rep2	D.O. (mg/L)	8.62	8.37	8.35	8.53	8.71
A68/A72-100%-Rep2	Conductivity (us/cm)	602.4	623.9	660	672.2	627.1
A68/A72-100%-Rep2	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	<5.00 U
A68/A72-100%-Rep2	Hardness (mg/L)	298	-	-	-	298

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-100%-Rep3	No. Alive	10	10	5	4	0
A68/A72-100%-Rep3	pH	5.6	6.3	6.66	6.79	5.81
A68/A72-100%-Rep3	Temp (°C)	12.24	11.76	11.6	11.91	11.62
A68/A72-100%-Rep3	D.O. (mg/L)	8.63	8.24	8.43	8.47	8.71
A68/A72-100%-Rep3	Conductivity (us/cm)	602.3	626.1	655	667.5	626.7
A68/A72-100%-Rep3	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	<5.00 U
A68/A72-100%-Rep3	Hardness (mg/L)	298	-	-	-	298

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-100%-Rep4	No. Alive	10	10	5	3	0
A68/A72-100%-Rep4	pH	5.6	6.3	6.64	6.77	5.61
A68/A72-100%-Rep4	Temp (°C)	12.25	11.78	11.58	11.91	11.59
A68/A72-100%-Rep4	D.O. (mg/L)	8.68	8.36	8.54	8.69	8.75
A68/A72-100%-Rep4	Conductivity (us/cm)	603	626.2	665	678.4	628
A68/A72-100%-Rep4	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	<5.00 U
A68/A72-100%-Rep4	Hardness (mg/L)	298	-	-	-	298

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
A68/A72-75%-Rep1	No. Alive	10	9	9	9	9	1 Jumper
A68/A72-75%-Rep1	pH	6.7	6.5	6.93	6.91	6.85	
A68/A72-75%-Rep1	Temp (°C)	12.04	11.7	11.75	11.89	11.58	
A68/A72-75%-Rep1	D.O. (mg/L)	8.71	8.23	8.26	8.16	8.35	
A68/A72-75%-Rep1	Conductivity (us/cm)	547	560.6	582.6	597	566.4	
A68/A72-75%-Rep1	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	7.5	
A68/A72-75%-Rep1	Hardness (mg/L)	250	-	-	-	267	

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
A68/A72-75%-Rep2	No. Alive	10	9	9	9	9	1 Jumper
A68/A72-75%-Rep2	pH	6.5	6.4	6.88	6.89	6.82	
A68/A72-75%-Rep2	Temp (°C)	12.02	11.7	11.72	11.88	11.59	
A68/A72-75%-Rep2	D.O. (mg/L)	8.74	8.09	8.11	8.21	8.3	
A68/A72-75%-Rep2	Conductivity (us/cm)	546.4	559.5	582	591.9	569.4	
A68/A72-75%-Rep2	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	7.5	
A68/A72-75%-Rep2	Hardness (mg/L)	250	-	-	-	267	

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-75%-Rep3	No. Alive	10	10	10	10	10
A68/A72-75%-Rep3	pH	6.4	6.6	6.86	6.88	6.79
A68/A72-75%-Rep3	Temp (°C)	12.02	11.73	11.76	11.87	11.61
A68/A72-75%-Rep3	D.O. (mg/L)	8.74	7.98	6.96	8.02	8.09
A68/A72-75%-Rep3	Conductivity (us/cm)	546.4	564.9	580	595.8	569.8
A68/A72-75%-Rep3	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	7.5
A68/A72-75%-Rep3	Hardness (mg/L)	250	-	-	-	267

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-75%-Rep4	No. Alive	10	10	10	10	10
A68/A72-75%-Rep4	pH	6.4	6.6	6.84	6.88	6.77
A68/A72-75%-Rep4	Temp (°C)	12.1	11.72	11.72	11.88	11.6
A68/A72-75%-Rep4	D.O. (mg/L)	8.72	8.06	7.6	8.31	8.13
A68/A72-75%-Rep4	Conductivity (us/cm)	546.9	557.5	577.4	587.3	577.4
A68/A72-75%-Rep4	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	7.5
A68/A72-75%-Rep4	Hardness (mg/L)	250	-	-	-	267

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-50%-Rep1	No. Alive	10	10	10	10	10
A68/A72-50%-Rep1	pH	7.2	7.3	7.2	6.99	6.9
A68/A72-50%-Rep1	Temp (°C)	11.96	11.67	11.86	11.87	11.6
A68/A72-50%-Rep1	D.O. (mg/L)	8.78	7.8	7.87	8.03	8.19
A68/A72-50%-Rep1	Conductivity (us/cm)	489.6	499.2	515	527.4	512.3
A68/A72-50%-Rep1	Alkalinity (mg $CaCO_3$/L)	16.6	-	-	-	17.5
A68/A72-50%-Rep1	Hardness (mg/L)	238	-	-	-	238

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-50%-Rep2	No. Alive	10	10	10	10	10
A68/A72-50%-Rep2	pH	7.2	7.3	7.1	6.96	6.89
A68/A72-50%-Rep2	Temp (°C)	11.96	11.68	11.85	11.87	11.6
A68/A72-50%-Rep2	D.O. (mg/L)	8.79	7.87	7.96	7.97	8.14
A68/A72-50%-Rep2	Conductivity (us/cm)	489.7	499.7	520	532.5	513.4
A68/A72-50%-Rep2	Alkalinity (mg $CaCO_3$/L)	16.6	-	-	-	17.5
A68/A72-50%-Rep2	Hardness (mg/L)	238	-	-	-	238

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
A68/A72-50%-Rep3	No. Alive	10	9	9	9	9	1 Jumper
A68/A72-50%-Rep3	pH	7.1	7.3	7	6.97	6.89	
A68/A72-50%-Rep3	Temp (°C)	12	11.66	11.84	11.87	11.64	
A68/A72-50%-Rep3	D.O. (mg/L)	8.8	7.97	8.36	8.05	8.16	
A68/A72-50%-Rep3	Conductivity (us/cm)	490	499.6	523.5	532.5	509.8	
A68/A72-50%-Rep3	Alkalinity (mg $CaCO_3$/L)	16.6	-	-	-	17.5	
A68/A72-50%-Rep3	Hardness (mg/L)	238	-	-	-	238	

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-50%-Rep4	No. Alive	10	10	10	10	10
A68/A72-50%-Rep4	pH	7.1	7.3	6.99	6.93	6.88
A68/A72-50%-Rep4	Temp (°C)	12.07	11.67	11.84	11.86	11.63
A68/A72-50%-Rep4	D.O. (mg/L)	8.77	7.87	8.28	8.19	8.14
A68/A72-50%-Rep4	Conductivity (us/cm)	489.8	499.6	518	527	507.7
A68/A72-50%-Rep4	Alkalinity (mg $CaCO_3$/L)	16.6	-	-	-	17.5
A68/A72-50%-Rep4	Hardness (mg/L)	238	-	-	-	238

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-25%-Rep1	No. Alive	10	10	10	8	8
A68/A72-25%-Rep1	pH	7.5	7.4	7.24	7	6.93
A68/A72-25%-Rep1	Temp (°C)	12.18	11.65	11.88	11.85	11.58
A68/A72-25%-Rep1	D.O. (mg/L)	8.76	7.58	8.1	7.51	8.37
A68/A72-25%-Rep1	Conductivity (us/cm)	435.3	445.4	471	486.8	459.1
A68/A72-25%-Rep1	Alkalinity (mg $CaCO_3$/L)	25.9	-	-	-	33.4
A68/A72-25%-Rep1	Hardness (mg/L)	209	-	-	-	209

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-25%-Rep2	No. Alive	10	10	10	10	10
A68/A72-25%-Rep2	pH	7.4	7.4	7.15	7	6.92
A68/A72-25%-Rep2	Temp (°C)	12.21	11.65	11.88	11.85	11.6
A68/A72-25%-Rep2	D.O. (mg/L)	8.75	7.35	8.31	7.74	8.4
A68/A72-25%-Rep2	Conductivity (us/cm)	435.4	445.4	467	480.9	460.6
A68/A72-25%-Rep2	Alkalinity (mg $CaCO_3$/L)	25.9	-	-	-	33.4
A68/A72-25%-Rep2	Hardness (mg/L)	209	-	-	-	209

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
A68/A72-25%-Rep3	No. Alive	10	9	9	8	8	1 Jumper
A68/A72-25%-Rep3	pH	7.4	7.4	7.12	7.02	6.92	
A68/A72-25%-Rep3	Temp (°C)	12.22	11.66	11.88	11.86	11.66	
A68/A72-25%-Rep3	D.O. (mg/L)	8.74	7.47	8.23	7.62	7.65	
A68/A72-25%-Rep3	Conductivity (us/cm)	435.3	447.4	470	481	455.4	
A68/A72-25%-Rep3	Alkalinity (mg $CaCO_3$/L)	25.9	-	-	-	33.4	
A68/A72-25%-Rep3	Hardness (mg/L)	209	-	-	-	209	

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-25%-Rep4	No. Alive	10	10	10	10	10
A68/A72-25%-Rep4	pH	7.4	7.4	7.06	7.02	6.92
A68/A72-25%-Rep4	Temp (°C)	12.35	11.66	11.89	11.84	11.6
A68/A72-25%-Rep4	D.O. (mg/L)	8.74	7.76	8.24	7.59	7.54
A68/A72-25%-Rep4	Conductivity (us/cm)	435	445.5	454	464.6	447.9
A68/A72-25%-Rep4	Alkalinity (mg $CaCO_3$/L)	25.9	-	-	-	33.4
A68/A72-25%-Rep4	Hardness (mg/L)	209	-	-	-	209

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
A68/A72-10%-Rep1	No. Alive	10	9	8	8	8	1 Jumper
A68/A72-10%-Rep1	pH	7.7	7.4	7.16	7.1	6.94	
A68/A72-10%-Rep1	Temp (°C)	11.82	11.64	11.83	11.85	11.63	
A68/A72-10%-Rep1	D.O. (mg/L)	8.79	8.01	8.3	8.37	8.25	
A68/A72-10%-Rep1	Conductivity (us/cm)	401.3	414.9	453	443.1	420	
A68/A72-10%-Rep1	Alkalinity (mg $CaCO_3$/L)	29.9	-	-	-	33.8	
A68/A72-10%-Rep1	Hardness (mg/L)	193	-	-	-	192	

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
A68/A72-10%-Rep2	No. Alive	10	10	10	8	8	2 Jumpers
A68/A72-10%-Rep2	pH	7.6	7.5	7.17	7.1	6.96	
A68/A72-10%-Rep2	Temp (°C)	11.81	11.66	11.84	11.85	11.64	
A68/A72-10%-Rep2	D.O. (mg/L)	8.82	7.76	8.24	8.34	8.25	
A68/A72-10%-Rep2	Conductivity (us/cm)	401.2	413.4	433	444.2	420.2	
A68/A72-10%-Rep2	Alkalinity (mg $CaCO_3$/L)	29.9	-	-	-	33.8	
A68/A72-10%-Rep2	Hardness (mg/L)	193	-	-	-	192	

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-10%-Rep3	No. Alive	10	10	10	9	9
A68/A72-10%-Rep3	pH	7.6	7.4	7.06	7.1	6.95
A68/A72-10%-Rep3	Temp (°C)	11.82	11.63	11.84	11.85	11.6
A68/A72-10%-Rep3	D.O. (mg/L)	8.84	7.55	8.06	8.05	8.28
A68/A72-10%-Rep3	Conductivity (us/cm)	401.4	414.9	433	443.7	419.8
A68/A72-10%-Rep3	Alkalinity (mg $CaCO_3$/L)	29.9	-	-	-	33.8
A68/A72-10%-Rep3	Hardness (mg/L)	193	-	-	-	192

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-10%-Rep4	No. Alive	10	10	10	10	10
A68/A72-10%-Rep4	pH	7.6	7.4	7.06	7.07	6.94
A68/A72-10%-Rep4	Temp (°C)	11.89	11.64	11.86	11.83	11.66
A68/A72-10%-Rep4	D.O. (mg/L)	8.87	7.76	7.87	8.34	8.24
A68/A72-10%-Rep4	Conductivity (us/cm)	401.3	414.1	432	440	420.5
A68/A72-10%-Rep4	Alkalinity (mg $CaCO_3$/L)	29.9	-	-	-	33.8
A68/A72-10%-Rep4	Hardness (mg/L)	193	-	-	-	192

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-5%-Rep1	No. Alive	10	10	10	10	10
A68/A72-5%-Rep1	pH	7.8	7.4	7.19	7.1	6.88
A68/A72-5%-Rep1	Temp (°C)	12.27	11.67	11.81	11.84	11.72
A68/A72-5%-Rep1	D.O. (mg/L)	8.36	7.37	7.2	7.91	7.98
A68/A72-5%-Rep1	Conductivity (us/cm)	392.6	407.1	442	436.6	413.8
A68/A72-5%-Rep1	Alkalinity (mg $CaCO_3$/L)	38.5	-	-	-	39.2
A68/A72-5%-Rep1	Hardness (mg/L)	187	-	-	-	187

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-5%-Rep2	No. Alive	10	10	10	8	8
A68/A72-5%-Rep2	pH	7.8	7.4	7.17	7.1	6.98
A68/A72-5%-Rep2	Temp (°C)	12.21	11.64	11.83	11.85	11.73
A68/A72-5%-Rep2	D.O. (mg/L)	8.75	7.39	7.83	8.06	8.12
A68/A72-5%-Rep2	Conductivity (us/cm)	390.4	402.2	422	436.7	410.5
A68/A72-5%-Rep2	Alkalinity (mg $CaCO_3$/L)	38.5	-	-	-	39.2
A68/A72-5%-Rep2	Hardness (mg/L)	187	-	-	-	187

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-5%-Rep3	No. Alive	10	10	10	10	10
A68/A72-5%-Rep3	pH	7.8	7.4	7.16	7.1	6.9
A68/A72-5%-Rep3	Temp (°C)	12.18	11.59	11.83	11.82	11.67
A68/A72-5%-Rep3	D.O. (mg/L)	8.78	7.32	7.57	8.18	8.09
A68/A72-5%-Rep3	Conductivity (us/cm)	391.4	402.5	419	429.3	412.5
A68/A72-5%-Rep3	Alkalinity (mg $CaCO_3$/L)	38.5	-	-	-	39.2
A68/A72-5%-Rep3	Hardness (mg/L)	187	-	-	-	187

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-5%-Rep4	No. Alive	10	10	10	9	9
A68/A72-5%-Rep4	pH	7.8	7.5	7.17	7.1	6.96
A68/A72-5%-Rep4	Temp (°C)	12.27	11.63	11.83	11.84	11.65
A68/A72-5%-Rep4	D.O. (mg/L)	8.78	7.64	7.89	8.34	8.25
A68/A72-5%-Rep4	Conductivity (us/cm)	390.8	401.2	418	430.2	412.1
A68/A72-5%-Rep4	Alkalinity (mg $CaCO_3$/L)	38.5	-	-	-	39.2
A68/A72-5%-Rep4	Hardness (mg/L)	187	-	-	-	187

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-Control-Rep1	No. Alive	10	10	10	10	10
A68/A72-Control-Rep1	pH	7.4	7.6	7.48	7.3	7.05
A68/A72-Control-Rep1	Temp (°C)	11.63	11.79	11.9	11.87	11.93
A68/A72-Control-Rep1	D.O. (mg/L)	7.42	7.74	8.32	8.1	7.88
A68/A72-Control-Rep1	Conductivity (us/cm)	301.5	307.7	326	337.4	321.8
A68/A72-Control-Rep1	Alkalinity (mg $CaCO_3$/L)	63.1	-	-	-	72.9
A68/A72-Control-Rep1	Hardness (mg/L)	92	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-Control-Rep2	No. Alive	10	10	10	10	10
A68/A72-Control-Rep2	pH	7.4	7.6	7.5	7.3	7.07
A68/A72-Control-Rep2	Temp (°C)	11.6	11.65	11.83	11.85	11.89
A68/A72-Control-Rep2	D.O. (mg/L)	6.38	7.61	7.97	7.86	7.82
A68/A72-Control-Rep2	Conductivity (us/cm)	299.9	306.6	323	333.9	320.7
A68/A72-Control-Rep2	Alkalinity (mg $CaCO_3$/L)	63.1	-	-	-	72.9
A68/A72-Control-Rep2	Hardness (mg/L)	92	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-Control-Rep3	No. Alive	10	10	10	10	10
A68/A72-Control-Rep3	pH	7.3	7.6	7.43	7.31	7.08
A68/A72-Control-Rep3	Temp (°C)	11.62	11.64	11.81	11.86	11.85
A68/A72-Control-Rep3	D.O. (mg/L)	6.19	7.76	8.16	7.64	7.57
A68/A72-Control-Rep3	Conductivity (us/cm)	299.6	306	325.8	336.6	320.9
A68/A72-Control-Rep3	Alkalinity (mg $CaCO_3$/L)	63.1	-	-	-	72.9
A68/A72-Control-Rep3	Hardness (mg/L)	92	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/A72-Control-Rep4	No. Alive	10	10	10	10	10
A68/A72-Control-Rep4	pH	7.3	7.6	7.35	7.3	7.09
A68/A72-Control-Rep4	Temp (°C)	11.6	11.64	11.8	11.84	11.8
A68/A72-Control-Rep4	D.O. (mg/L)	6.04	7.62	8.28	7.63	7.4
A68/A72-Control-Rep4	Conductivity (us/cm)	299.2	304.8	324.6	336.2	321.4
A68/A72-Control-Rep4	Alkalinity (mg $CaCO_3$/L)	63.1	-	-	-	72.9
A68/A72-Control-Rep4	Hardness (mg/L)	92	-	-	-	93

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Serial dilution of CC48 with A68

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
A68/CC48-Control-Rep1	No. Alive	10	9	9	9	9	1 Jumper
A68/CC48-Control-Rep1	pH	7.6	7.5	7.29	7.2	7.24	
A68/CC48-Control-Rep1	Temp (°C)	15.42	11.62	11.63	11.72	11.9	
A68/CC48-Control-Rep1	D.O. (mg/L)	7.75	7.88	7.9	8.11	8.02	
A68/CC48-Control-Rep1	Conductivity (us/cm)	299.1	306.2	323	329.8	318.1	
A68/CC48-Control-Rep1	Alkalinity (mg $CaCO_3$/L)	62.4	-	-	-	68.7	
A68/CC48-Control-Rep1	Hardness (mg/L)	92	-	-	-	93	

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-Control-Rep2	No. Alive	10	10	10	10	10
A68/CC48-Control-Rep2	pH	7.6	7.7	7.3	7.22	7.4
A68/CC48-Control-Rep2	Temp (°C)	14.67	11.56	11.59	11.71	11.87
A68/CC48-Control-Rep2	D.O. (mg/L)	7.77	8.3	8.13	7.91	7.5
A68/CC48-Control-Rep2	Conductivity (us/cm)	299	304.4	323	332.5	331
A68/CC48-Control-Rep2	Alkalinity (mg $CaCO_3$/L)	62.4	-	-	-	68.7
A68/CC48-Control-Rep2	Hardness (mg/L)	92	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-Control-Rep3	No. Alive	10	10	10	10	10
A68/CC48-Control-Rep3	pH	7.7	7.8	7.34	7.24	7.4
A68/CC48-Control-Rep3	Temp (°C)	15.24	11.54	11.58	11.62	11.84
A68/CC48-Control-Rep3	D.O. (mg/L)	7.85	8.18	8.29	8.3	8.11
A68/CC48-Control-Rep3	Conductivity (us/cm)	298.8	304.4	324	333.9	334
A68/CC48-Control-Rep3	Alkalinity (mg $CaCO_3$/L)	62.4	-	-	-	68.7
A68/CC48-Control-Rep3	Hardness (mg/L)	92	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-Control-Rep4	No. Alive	10	10	10	10	10
A68/CC48-Control-Rep4	pH	7.7	7.8	7.35	7.25	7.18
A68/CC48-Control-Rep4	Temp (°C)	14.48	11.55	11.58	11.61	11.92
A68/CC48-Control-Rep4	D.O. (mg/L)	7.89	8.37	8.09	8.28	8.14
A68/CC48-Control-Rep4	Conductivity (us/cm)	298.6	304.3	324	334.2	331
A68/CC48-Control-Rep4	Alkalinity (mg $CaCO_3$/L)	62.4	-	-	-	68.7
A68/CC48-Control-Rep4	Hardness (mg/L)	92	-	-	-	93

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-50%-Rep1	No. Alive	10	0	-	-	-
A68/CC48-50%-Rep1	pH	4.8	5.2	-	-	-
A68/CC48-50%-Rep1	Temp (°C)	12.45	11.65	-	-	-
A68/CC48-50%-Rep1	D.O. (mg/L)	8.68	8.73	-	-	-
A68/CC48-50%-Rep1	Conductivity (us/cm)	732.6	760.5	-	-	-
A68/CC48-50%-Rep1	Alkalinity (mg $CaCO_3$/L)	<5.00 U	<5.00 U	-	-	-
A68/CC48-50%-Rep1	Hardness (mg/L)	368	371	-	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-50%-Rep2	No. Alive	10	0	-	-	-
A68/CC48-50%-Rep2	pH	4.8	5.2	-	-	-
A68/CC48-50%-Rep2	Temp (°C)	12.2	11.63	-	-	-
A68/CC48-50%-Rep2	D.O. (mg/L)	8.72	8.67	-	-	-
A68/CC48-50%-Rep2	Conductivity (us/cm)	736.5	768.6	-	-	-
A68/CC48-50%-Rep2	Alkalinity (mg $CaCO_3$/L)	<5.00 U	<5.00 U	-	-	-
A68/CC48-50%-Rep2	Hardness (mg/L)	368	371	-	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-50%-Rep3	No. Alive	10	0	-	-	-
A68/CC48-50%-Rep3	pH	4.8	5.2	-	-	-
A68/CC48-50%-Rep3	Temp (°C)	12.04	11.65	-	-	-
A68/CC48-50%-Rep3	D.O. (mg/L)	8.76	8.7	-	-	-
A68/CC48-50%-Rep3	Conductivity (us/cm)	735.8	761.9	-	-	-
A68/CC48-50%-Rep3	Alkalinity (mg $CaCO_3$/L)	<5.00 U	<5.00 U	-	-	-
A68/CC48-50%-Rep3	Hardness (mg/L)	368	371	-	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-50%-Rep4	No. Alive	10	0	-	-	-
A68/CC48-50%-Rep4	pH	4.8	5.2	-	-	-
A68/CC48-50%-Rep4	Temp (°C)	12.21	11.63	-	-	-
A68/CC48-50%-Rep4	D.O. (mg/L)	8.73	8.67	-	-	-
A68/CC48-50%-Rep4	Conductivity (us/cm)	737	772.6	-	-	-
A68/CC48-50%-Rep4	Alkalinity (mg $CaCO_3$/L)	<5.00 U	<5.00 U	-	-	-
A68/CC48-50%-Rep4	Hardness (mg/L)	368	371	-	-	-

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-25%-Rep1	No. Alive	10	10	10	6	6
A68/CC48-25%-Rep1	pH	6.4	6.9	7.09	6.98	6.98
A68/CC48-25%-Rep1	Temp (°C)	12.12	11.68	11.83	11.64	11.86
A68/CC48-25%-Rep1	D.O. (mg/L)	8.78	8.15	8.31	8.2	8.38
A68/CC48-25%-Rep1	Conductivity (us/cm)	554.6	566.9	599.7	612.4	578
A68/CC48-25%-Rep1	Alkalinity (mg $CaCO_3$/L)	10.2	-	-	-	13.4
A68/CC48-25%-Rep1	Hardness (mg/L)	272	-	-	-	269

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-25%-Rep2	No. Alive	10	10	10	10	10
A68/CC48-25%-Rep2	pH	6.3	6.9	7	6.96	6.96
A68/CC48-25%-Rep2	Temp (°C)	12.17	11.63	11.84	11.65	11.85
A68/CC48-25%-Rep2	D.O. (mg/L)	8.81	8.17	8.12	7.93	8.34
A68/CC48-25%-Rep2	Conductivity (us/cm)	553.6	565.8	600	611.8	572
A68/CC48-25%-Rep2	Alkalinity (mg $CaCO_3$/L)	10.2	-	-	-	13.4
A68/CC48-25%-Rep2	Hardness (mg/L)	272	-	-	-	269

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-25%-Rep3	No. Alive	10	10	10	10	10
A68/CC48-25%-Rep3	pH	6.2	6.9	6.98	6.95	6.96
A68/CC48-25%-Rep3	Temp (°C)	12.78	11.62	11.83	11.64	11.83
A68/CC48-25%-Rep3	D.O. (mg/L)	8.53	8.24	8.27	7.65	8.14
A68/CC48-25%-Rep3	Conductivity (us/cm)	548.1	565.9	599.8	609.4	568.5
A68/CC48-25%-Rep3	Alkalinity (mg $CaCO_3$/L)	10.2	-	-	-	13.4
A68/CC48-25%-Rep3	Hardness (mg/L)	272	-	-	-	269

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-25%-Rep4	No. Alive	10	10	10	10	10
A68/CC48-25%-Rep4	pH	6.2	6.9	6.96	6.93	6.94
A68/CC48-25%-Rep4	Temp (°C)	12.34	11.65	11.84	11.64	11.38
A68/CC48-25%-Rep4	D.O. (mg/L)	8.67	8.26	8.23	7.1	8.14
A68/CC48-25%-Rep4	Conductivity (us/cm)	552.9	567.2	601.2	614.1	571.1
A68/CC48-25%-Rep4	Alkalinity (mg $CaCO_3$/L)	10.2	-	-	-	13.4
A68/CC48-25%-Rep4	Hardness (mg/L)	272	-	-	-	269

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-12%-Rep1	No. Alive	10	10	10	9	9
A68/CC48-12%-Rep1	pH	7.1	7.2	7.05	7.06	7.06
A68/CC48-12%-Rep1	Temp (°C)	12.62	11.64	11.79	11.65	11.94
A68/CC48-12%-Rep1	D.O. (mg/L)	8.59	7.85	8.05	7.96	7.84
A68/CC48-12%-Rep1	Conductivity (us/cm)	464.6	475.5	500	508.6	484.1
A68/CC48-12%-Rep1	Alkalinity (mg $CaCO_3$/L)	22.4	-	-	-	32
A68/CC48-12%-Rep1	Hardness (mg/L)	226	-	-	-	225

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-12%-Rep2	No. Alive	10	10	10	10	10
A68/CC48-12%-Rep2	pH	7.1	7.2	7.05	7.04	7.05
A68/CC48-12%-Rep2	Temp (°C)	12.1	11.63	11.78	11.61	11.9
A68/CC48-12%-Rep2	D.O. (mg/L)	8.62	7.83	8.11	7.85	8.01
A68/CC48-12%-Rep2	Conductivity (us/cm)	465.4	476.1	505	519.9	490.4
A68/CC48-12%-Rep2	Alkalinity (mg $CaCO_3$/L)	22.4	-	-	-	32
A68/CC48-12%-Rep2	Hardness (mg/L)	226	-	-	-	225

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-12%-Rep3	No. Alive	10	10	10	10	10
A68/CC48-12%-Rep3	pH	7.1	7.2	7.06	7.05	7.07
A68/CC48-12%-Rep3	Temp (°C)	12.5	11.62	11.79	11.62	11.88
A68/CC48-12%-Rep3	D.O. (mg/L)	8.5	7.38	8.13	7.77	7.45
A68/CC48-12%-Rep3	Conductivity (us/cm)	467.8	476.4	505	509.3	486.7
A68/CC48-12%-Rep3	Alkalinity (mg $CaCO_3$/L)	22.4	-	-	-	32
A68/CC48-12%-Rep3	Hardness (mg/L)	226	-	-	-	225

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-12%-Rep4	No. Alive	10	10	8	7	7
A68/CC48-12%-Rep4	pH	7	7.2	7.06	7.03	7.04
A68/CC48-12%-Rep4	Temp (°C)	12.19	11.62	11.78	11.01	11.88
A68/CC48-12%-Rep4	D.O. (mg/L)	8.43	7.93	8.34	8.26	7.53
A68/CC48-12%-Rep4	Conductivity (us/cm)	466.1	479.7	513.9	531.1	484
A68/CC48-12%-Rep4	Alkalinity (mg $CaCO_3$/L)	22.4	-	-	-	32
A68/CC48-12%-Rep4	Hardness (mg/L)	226	-	-	-	225

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-6%-Rep1	No. Alive	10	10	9	9	9
A68/CC48-6%-Rep1	pH	7.4	7.4	7.07	7.08	7.08
A68/CC48-6%-Rep1	Temp (°C)	12.04	11.62	11.69	11.6	11.94
A68/CC48-6%-Rep1	D.O. (mg/L)	8.83	7.94	7.13	8.41	7.84
A68/CC48-6%-Rep1	Conductivity (us/cm)	422.7	435.7	460	466.6	441.3
A68/CC48-6%-Rep1	Alkalinity (mg $CaCO_3$/L)	29.1	-	-	-	36.8
A68/CC48-6%-Rep1	Hardness (mg/L)	204	-	-	-	201

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-6%-Rep2	No. Alive	10	10	10	10	10
A68/CC48-6%-Rep2	pH	7.3	7.2	7.04	7.09	7.08
A68/CC48-6%-Rep2	Temp (°C)	11.88	11.61	11.77	11.62	11.93
A68/CC48-6%-Rep2	D.O. (mg/L)	8.85	7.1	7.25	8.16	7.99
A68/CC48-6%-Rep2	Conductivity (us/cm)	422.6	431.4	456	465.1	443.8
A68/CC48-6%-Rep2	Alkalinity (mg $CaCO_3$/L)	29.1	-	-	-	36.8
A68/CC48-6%-Rep2	Hardness (mg/L)	204	-	-	-	201

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-6%-Rep3	No. Alive	10	10	10	10	10
A68/CC48-6%-Rep3	pH	7.2	7.2	7.13	7.09	7.09
A68/CC48-6%-Rep3	Temp (°C)	11.81	11.6	11.71	11.61	11.93
A68/CC48-6%-Rep3	D.O. (mg/L)	8.89	7.36	7.97	7.98	8.23
A68/CC48-6%-Rep3	Conductivity (us/cm)	422	432	458	467.2	439.7
A68/CC48-6%-Rep3	Alkalinity (mg $CaCO_3$/L)	29.1	-	-	-	36.8
A68/CC48-6%-Rep3	Hardness (mg/L)	204	-	-	-	201

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-6%-Rep4	No. Alive	10	10	10	10	10
A68/CC48-6%-Rep4	pH	7.3	7.2	7.07	7.08	7.09
A68/CC48-6%-Rep4	Temp (°C)	11.82	11.59	11.74	11.6	11.92
A68/CC48-6%-Rep4	D.O. (mg/L)	8.87	7.13	7.57	8.04	8.26
A68/CC48-6%-Rep4	Conductivity (us/cm)	423.9	435	463	473.7	443
A68/CC48-6%-Rep4	Alkalinity (mg $CaCO_3$/L)	29.1	-	-	-	36.8
A68/CC48-6%-Rep4	Hardness (mg/L)	204	-	-	-	201

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-3%-Rep1	No. Alive	10	10	10	10	10
A68/CC48-3%-Rep1	pH	7.4	7.2	7.12	7.03	7.09
A68/CC48-3%-Rep1	Temp (°C)	11.91	11.61	11.63	11.62	11.95
A68/CC48-3%-Rep1	D.O. (mg/L)	8.87	6.59	8.12	7.56	8.07
A68/CC48-3%-Rep1	Conductivity (us/cm)	401.5	410.8	437	447.2	422.4
A68/CC48-3%-Rep1	Alkalinity (mg $CaCO_3$/L)	35.9	-	-	-	36.2
A68/CC48-3%-Rep1	Hardness (mg/L)	193	-	-	-	182

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
A68/CC48-3%-Rep2	No. Alive	10	10	10	9	9	1 Jumper
A68/CC48-3%-Rep2	pH	7.4	7.3	7.03	7.06	7.1	
A68/CC48-3%-Rep2	Temp (°C)	12.01	11.58	11.63	11.6	11.93	
A68/CC48-3%-Rep2	D.O. (mg/L)	8.82	7.14	8.1	8.24	8.27	
A68/CC48-3%-Rep2	Conductivity (us/cm)	399.9	410.6	437	448.1	420.8	
A68/CC48-3%-Rep2	Alkalinity (mg $CaCO_3$/L)	35.9	-	-	-	36.2	
A68/CC48-3%-Rep2	Hardness (mg/L)	193	-	-	-	182	

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-3%-Rep3	No. Alive	10	10	9	9	9
A68/CC48-3%-Rep3	pH	7.4	7.3	7.11	7.08	7.11
A68/CC48-3%-Rep3	Temp (°C)	12.06	11.56	11.63	11.58	11.93
A68/CC48-3%-Rep3	D.O. (mg/L)	8.84	7.11	8.22	8.3	8.23
A68/CC48-3%-Rep3	Conductivity (us/cm)	401.3	411	437	446.4	418.8
A68/CC48-3%-Rep3	Alkalinity (mg $CaCO_3$/L)	35.9	-	-	-	36.2
A68/CC48-3%-Rep3	Hardness (mg/L)	193	-	-	-	182

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-3%-Rep4	No. Alive	10	10	10	10	10
A68/CC48-3%-Rep4	pH	7.4	7.2	7.12	7.1	7.1
A68/CC48-3%-Rep4	Temp (°C)	12.1	11.59	11.65	11.61	11.95
A68/CC48-3%-Rep4	D.O. (mg/L)	8.82	6.72	7.92	8	8.12
A68/CC48-3%-Rep4	Conductivity (us/cm)	401.7	410.4	432	439.8	419
A68/CC48-3%-Rep4	Alkalinity (mg $CaCO_3$/L)	35.9	-	-	-	36.2
A68/CC48-3%-Rep4	Hardness (mg/L)	193	-	-	-	182

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-1%-Rep1	No. Alive	10	10	9	9	9
A68/CC48-1%-Rep1	pH	7.6	7.4	7.13	7.02	7.1
A68/CC48-1%-Rep1	Temp (°C)	11.43	11.44	11.62	11.64	11.93
A68/CC48-1%-Rep1	D.O. (mg/L)	8.54	8.13	7.92	7.79	7.44
A68/CC48-1%-Rep1	Conductivity (us/cm)	390.5	396.5	421	432.8	407
A68/CC48-1%-Rep1	Alkalinity (mg $CaCO_3$/L)	33.1				39.4
A68/CC48-1%-Rep1	Hardness (mg/L)	184				183

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-1%-Rep2	No. Alive	10	10	9	9	9
A68/CC48-1%-Rep2	pH	7.5	7.4	7.1	6.99	7.08
A68/CC48-1%-Rep2	Temp (°C)	11.56	11.58	11.61	11.64	11.9
A68/CC48-1%-Rep2	D.O. (mg/L)	8.71	7.62	7.82	7.53	7.5
A68/CC48-1%-Rep2	Conductivity (us/cm)	386.2	397.7	423	434.4	412.6
A68/CC48-1%-Rep2	Alkalinity (mg $CaCO_3$/L)	33.1	-	-	-	39.4
A68/CC48-1%-Rep2	Hardness (mg/L)	184	-	-	-	183

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-1%-Rep3	No. Alive	10	10	10	10	10
A68/CC48-1%-Rep3	pH	7.5	7.4	7.09	7.04	7.09
A68/CC48-1%-Rep3	Temp (°C)	11.54	11.58	11.61	11.63	11.91
A68/CC48-1%-Rep3	D.O. (mg/L)	8.84	7.63	7.66	7.04	7.74
A68/CC48-1%-Rep3	Conductivity (us/cm)	386.3	396.8	419	426.6	408.8
A68/CC48-1%-Rep3	Alkalinity (mg $CaCO_3$/L)	33.1	-	-	-	39.4
A68/CC48-1%-Rep3	Hardness (mg/L)	184	-	-	-	183

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48-1%-Rep4	No. Alive	10	10	8	6	6
A68/CC48-1%-Rep4	pH	7.4	7.3	7.07	6.99	7.1
A68/CC48-1%-Rep4	Temp (°C)	11.67	11.58	11.61	11.59	11.92
A68/CC48-1%-Rep4	D.O. (mg/L)	8.87	6.92	7.68	8.16	8.07
A68/CC48-1%-Rep4	Conductivity (us/cm)	386.4	396.2	422	431.6	405.4
A68/CC48-1%-Rep4	Alkalinity (mg $CaCO_3$/L)	33.1	-	-	-	39.4
A68/CC48-1%-Rep4	Hardness (mg/L)	184	-	-	-	183

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Serial dilution of M34/CC48 with A68

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-85%-Rep1	No. Alive	10	0	-	-	-
A68/CC48/M34-85%-Rep1	pH	4.8	5.1	-	-	-
A68/CC48/M34-85%-Rep1	Temp (°C)	11.69	11.82	-	-	-
A68/CC48/M34-85%-Rep1	D.O. (mg/L)	8.25	8.5	-	-	-
A68/CC48/M34-85%-Rep1	Conductivity (us/cm)	695.5	719.8	-	-	-
A68/CC48/M34-85%-Rep1	Alkalinity (mg $CaCO_3$/L)	<5.00 U	<5.00 U	-	-	-
A68/CC48/M34-85%-Rep1	Hardness (mg/L)	328	341	-	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-85%-Rep2	No. Alive	10	0	-	-	-
A68/CC48/M34-85%-Rep2	pH	4.8	5.1	-	-	-
A68/CC48/M34-85%-Rep2	Temp (°C)	11.66	11.84	-	-	-
A68/CC48/M34-85%-Rep2	D.O. (mg/L)	8.14	8.6	-	-	-
A68/CC48/M34-85%-Rep2	Conductivity (us/cm)	697.4	724.5	-	-	-
A68/CC48/M34-85%-Rep2	Alkalinity (mg $CaCO_3$/L)	<5.00 U	<5.00 U	-	-	-
A68/CC48/M34-85%-Rep2	Hardness (mg/L)	328	341	-	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-85%-Rep3	No. Alive	10	0	-	-	-
A68/CC48/M34-85%-Rep3	pH	4.7	5.1	-	-	-
A68/CC48/M34-85%-Rep3	Temp (°C)	11.67	11.84	-	-	-
A68/CC48/M34-85%-Rep3	D.O. (mg/L)	8.09	8.46	-	-	-
A68/CC48/M34-85%-Rep3	Conductivity (us/cm)	694.3	719.2	-	-	-
A68/CC48/M34-85%-Rep3	Alkalinity (mg $CaCO_3$/L)	<5.00 U	<5.00 U	-	-	-
A68/CC48/M34-85%-Rep3	Hardness (mg/L)	328	341	-	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-85%-Rep4	No. Alive	10	0	-	-	-
A68/CC48/M34-85%-Rep4	pH	4.7	5.1	-	-	-
A68/CC48/M34-85%-Rep4	Temp (°C)	11.66	11.86	-	-	-
A68/CC48/M34-85%-Rep4	D.O. (mg/L)	7.56	8.53	-	-	-
A68/CC48/M34-85%-Rep4	Conductivity (us/cm)	698.8	722.2	-	-	-
A68/CC48/M34-85%-Rep4	Alkalinity (mg $CaCO_3$/L)	<5.00 U	<5.00 U	-	-	-
A68/CC48/M34-85%-Rep4	Hardness (mg/L)	328	341	-	-	-

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-65%-Rep1	No. Alive	10	7	3	1	0
A68/CC48/M34-65%-Rep1	pH	5.7	6.3	6.93	6.85	6.49
A68/CC48/M34-65%-Rep1	Temp (°C)	11.67	11.82	11.58	11.72	11.75
A68/CC48/M34-65%-Rep1	D.O. (mg/L)	7.96	7.92	8.03	8.62	8.61
A68/CC48/M34-65%-Rep1	Conductivity (us/cm)	615.5	641.5	685	688.5	632.7
A68/CC48/M34-65%-Rep1	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	<5.00 U
A68/CC48/M34-65%-Rep1	Hardness (mg/L)	296	-	-	-	302

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-65%-Rep2	No. Alive	10	9	3	1	0
A68/CC48/M34-65%-Rep2	pH	5.6	6.4	6.93	6.83	6.42
A68/CC48/M34-65%-Rep2	Temp (°C)	11.64	11.82	11.58	11.75	11.73
A68/CC48/M34-65%-Rep2	D.O. (mg/L)	7.92	8.14	8.03	8.65	8.71
A68/CC48/M34-65%-Rep2	Conductivity (us/cm)	615.8	646.3	685	699.6	634.1
A68/CC48/M34-65%-Rep2	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	<5.00 U
A68/CC48/M34-65%-Rep2	Hardness (mg/L)	296	-	-	-	302

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-65%-Rep3	No. Alive	10	9	2	2	0
A68/CC48/M34-65%-Rep3	pH	5.6	6.4	6.93	6.82	5.83
A68/CC48/M34-65%-Rep3	Temp (°C)	11.64	11.83	11.58	11.75	11.68
A68/CC48/M34-65%-Rep3	D.O. (mg/L)	7.89	8.22	8.03	8.67	8.6
A68/CC48/M34-65%-Rep3	Conductivity (us/cm)	614.5	641.1	685	685	640.6
A68/CC48/M34-65%-Rep3	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	<5.00 U
A68/CC48/M34-65%-Rep3	Hardness (mg/L)	296	-	-	-	302

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-65%-Rep4	No. Alive	10	10	4	4	0
A68/CC48/M34-65%-Rep4	pH	5.6	6.5	6.93	6.81	5.64
A68/CC48/M34-65%-Rep4	Temp (°C)	11.61	11.83	11.58	11.77	11.68
A68/CC48/M34-65%-Rep4	D.O. (mg/L)	7.99	8.3	8.03	8.67	8.78
A68/CC48/M34-65%-Rep4	Conductivity (us/cm)	613.1	642.1	685	692.6	639.6
A68/CC48/M34-65%-Rep4	Alkalinity (mg $CaCO_3$/L)	<5.00 U	-	-	-	<5.00 U
A68/CC48/M34-65%-Rep4	Hardness (mg/L)	296	-	-	-	302

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-40%-Rep1	No. Alive	10	10	10	10	9
A68/CC48/M34-40%-Rep1	pH	7.1	6.9	7.07	7.04	7.01
A68/CC48/M34-40%-Rep1	Temp (°C)	11.68	11.78	11.71	11.72	11.73
A68/CC48/M34-40%-Rep1	D.O. (mg/L)	7.78	7.81	8.02	7.78	7.43
A68/CC48/M34-40%-Rep1	Conductivity (us/cm)	524.5	533.7	569	575.9	543.5
A68/CC48/M34-40%-Rep1	Alkalinity (mg $CaCO_3$/L)	10.8	-	-	-	12.5
A68/CC48/M34-40%-Rep1	Hardness (mg/L)	244	-	-	-	250

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-40%-Rep2	No. Alive	10	10	10	10	10
A68/CC48/M34-40%-Rep2	pH	7.1	6.9	7.03	7.02	7
A68/CC48/M34-40%-Rep2	Temp (°C)	11.67	11.78	11.68	11.71	11.7
A68/CC48/M34-40%-Rep2	D.O. (mg/L)	7.69	7.82	8.09	7.79	7.45
A68/CC48/M34-40%-Rep2	Conductivity (us/cm)	524.7	533.9	568	575.6	530.4
A68/CC48/M34-40%-Rep2	Alkalinity (mg $CaCO_3$/L)	10.8	-	-	-	12.5
A68/CC48/M34-40%-Rep2	Hardness (mg/L)	244	-	-	-	250

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-40%-Rep3	No. Alive	10	10	10	10	8
A68/CC48/M34-40%-Rep3	pH	7.1	6.9	7.01	7.01	6.99
A68/CC48/M34-40%-Rep3	Temp (°C)	11.62	11.8	11.63	11.72	11.3
A68/CC48/M34-40%-Rep3	D.O. (mg/L)	7.88	7.63	8.1	7.63	7.52
A68/CC48/M34-40%-Rep3	Conductivity (us/cm)	523.9	534.4	572	575.6	530.2
A68/CC48/M34-40%-Rep3	Alkalinity (mg $CaCO_3$/L)	10.8	-	-	-	12.5
A68/CC48/M34-40%-Rep3	Hardness (mg/L)	244	-	-	-	250

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-40%-Rep4	No. Alive	10	10	10	10	10
A68/CC48/M34-40%-Rep4	pH	7	6.9	7	7.01	6.97
A68/CC48/M34-40%-Rep4	Temp (°C)	11.62	11.8	11.66	11.72	11.66
A68/CC48/M34-40%-Rep4	D.O. (mg/L)	7.97	7.64	8.02	7.63	7.98
A68/CC48/M34-40%-Rep4	Conductivity (us/cm)	524.5	533.8	568	575.6	545.6
A68/CC48/M34-40%-Rep4	Alkalinity (mg $CaCO_3$/L)	10.8	-	-	-	12.5
A68/CC48/M34-40%-Rep4	Hardness (mg/L)	244	-	-	-	250

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-20%-Rep1	No. Alive	10	10	10	10	10
A68/CC48/M34-20%-Rep1	pH	7.3	7.1	7.12	7.11	7.08
A68/CC48/M34-20%-Rep1	Temp (°C)	11.71	11.77	11.78	11.7	11.65
A68/CC48/M34-20%-Rep1	D.O. (mg/L)	7.91	7.78	8.06	7.82	8.07
A68/CC48/M34-20%-Rep1	Conductivity (us/cm)	451.9	459.8	492	499.3	469.1
A68/CC48/M34-20%-Rep1	Alkalinity (mg $CaCO_3$/L)	25.2	-	-	-	26
A68/CC48/M34-20%-Rep1	Hardness (mg/L)	213	-	-	-	217

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-20%-Rep2	No. Alive	10	10	10	10	10
A68/CC48/M34-20%-Rep2	pH	7.3	7.1	7.12	7.11	7.07
A68/CC48/M34-20%-Rep2	Temp (°C)	11.68	11.77	11.77	11.7	11.68
A68/CC48/M34-20%-Rep2	D.O. (mg/L)	7.2	7.84	8.18	8.07	8.28
A68/CC48/M34-20%-Rep2	Conductivity (us/cm)	451.9	459.7	487	495.3	471.1
A68/CC48/M34-20%-Rep2	Alkalinity (mg $CaCO_3$/L)	25.2	-	-	-	26
A68/CC48/M34-20%-Rep2	Hardness (mg/L)	213	-	-	-	217

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-20%-Rep3	No. Alive	10	10	10	10	10
A68/CC48/M34-20%-Rep3	pH	7.2	7.1	7.12	7.11	7.08
A68/CC48/M34-20%-Rep3	Temp (°C)	11.66	11.77	11.72	11.7	11.66
A68/CC48/M34-20%-Rep3	D.O. (mg/L)	7.99	7.66	8.03	8.09	8.42
A68/CC48/M34-20%-Rep3	Conductivity (us/cm)	452	458.6	487	495.4	470.6
A68/CC48/M34-20%-Rep3	Alkalinity (mg $CaCO_3$/L)	25.2	-	-	-	26
A68/CC48/M34-20%-Rep3	Hardness (mg/L)	213	-	-	-	217

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-20%-Rep4	No. Alive	10	10	10	10	10
A68/CC48/M34-20%-Rep4	pH	7.2	7.1	7.12	7.09	7.07
A68/CC48/M34-20%-Rep4	Temp (°C)	11.62	11.79	11.72	11.71	11.7
A68/CC48/M34-20%-Rep4	D.O. (mg/L)	7.96	7.52	8.11	7.83	8.18
A68/CC48/M34-20%-Rep4	Conductivity (us/cm)	451.5	461.2	488	493.5	469.5
A68/CC48/M34-20%-Rep4	Alkalinity (mg $CaCO_3$/L)	25.2	-	-	-	26
A68/CC48/M34-20%-Rep4	Hardness (mg/L)	213	-	-	-	217

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-9%-Rep1	No. Alive	10	10	10	10	10
A68/CC48/M34-9%-Rep1	pH	7.4	7.2	7.15	7.16	7.07
A68/CC48/M34-9%-Rep1	Temp (°C)	11.79	11.74	11.84	11.67	11.74
A68/CC48/M34-9%-Rep1	D.O. (mg/L)	7.64	7.65	8.11	8.02	7.91
A68/CC48/M34-9%-Rep1	Conductivity (us/cm)	413	422.2	446	453.6	430.9
A68/CC48/M34-9%-Rep1	Alkalinity (mg $CaCO_3$/L)	28.2	-	-	-	38.9
A68/CC48/M34-9%-Rep1	Hardness (mg/L)	199	-	-	-	196

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-9%-Rep2	No. Alive	10	10	9	9	9
A68/CC48/M34-9%-Rep2	pH	7.3	7.3	7.16	7.14	7.07
A68/CC48/M34-9%-Rep2	Temp (°C)	11.74	11.73	11.81	11.66	11.77
A68/CC48/M34-9%-Rep2	D.O. (mg/L)	7.69	8.05	8.26	8.08	8.1
A68/CC48/M34-9%-Rep2	Conductivity (us/cm)	412.5	421.4	448	456.4	429.6
A68/CC48/M34-9%-Rep2	Alkalinity (mg $CaCO_3$/L)	28.2	-	-	-	38.9
A68/CC48/M34-9%-Rep2	Hardness (mg/L)	199	-	-	-	196

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-9%-Rep3	No. Alive	10	10	10	10	10
A68/CC48/M34-9%-Rep3	pH	7.3	7.2	7.17	7.15	7.09
A68/CC48/M34-9%-Rep3	Temp (°C)	11.76	11.73	11.79	11.66	11.68
A68/CC48/M34-9%-Rep3	D.O. (mg/L)	7.6	7.65	8.28	8.17	8.31
A68/CC48/M34-9%-Rep3	Conductivity (us/cm)	412.4	419.7	443	450	427.5
A68/CC48/M34-9%-Rep3	Alkalinity (mg $CaCO_3$/L)	28.2	-	-	-	38.9
A68/CC48/M34-9%-Rep3	Hardness (mg/L)	199	-	-	-	196

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-9%-Rep4	No. Alive	10	10	10	9	9
A68/CC48/M34-9%-Rep4	pH	7.3	7.2	7.15	7.15	7.1
A68/CC48/M34-9%-Rep4	Temp (°C)	11.7	11.77	11.78	11.68	11.67
A68/CC48/M34-9%-Rep4	D.O. (mg/L)	7.65	7.73	7.69	8.04	7.94
A68/CC48/M34-9%-Rep4	Conductivity (us/cm)	412.8	421.2	445	455.3	428.4
A68/CC48/M34-9%-Rep4	Alkalinity (mg $CaCO_3$/L)	28.2	-	-	-	38.9
A68/CC48/M34-9%-Rep4	Hardness (mg/L)	199	-	-	-	196

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates: 4	
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-4%-Rep1	No. Alive	10	10	10	10	10
A68/CC48/M34-4%-Rep1	pH	7.4	7.3	7.18	7.17	7.07
A68/CC48/M34-4%-Rep1	Temp (°C)	11.89	11.68	11.91	11.67	11.91
A68/CC48/M34-4%-Rep1	D.O. (mg/L)	7.53	8	8.46	8.41	8.37
A68/CC48/M34-4%-Rep1	Conductivity (us/cm)	394.7	403.2	428	434.9	412.4
A68/CC48/M34-4%-Rep1	Alkalinity (mg $CaCO_3$/L)	34.9	-	-	-	40.8
A68/CC48/M34-4%-Rep1	Hardness (mg/L)	185	-	-	-	187

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
A68/CC48/M34-4%-Rep2	No. Alive	10	9	9	9	9	1 Jumper
A68/CC48/M34-4%-Rep2	pH	7.4	7.3	7.21	7.18	7.06	
A68/CC48/M34-4%-Rep2	Temp (°C)	11.82	11.71	11.88	11.66	11.79	
A68/CC48/M34-4%-Rep2	D.O. (mg/L)	7.76	8.09	8.19	8.34	8.31	
A68/CC48/M34-4%-Rep2	Conductivity (us/cm)	394.6	401.4	421	427.2	408	
A68/CC48/M34-4%-Rep2	Alkalinity (mg $CaCO_3$/L)	34.9	-	-	-	40.8	
A68/CC48/M34-4%-Rep2	Hardness (mg/L)	185	-	-	-	187	

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-4%-Rep3	No. Alive	10	10	10	10	10
A68/CC48/M34-4%-Rep3	pH	7.4	7.3	7.17	7.16	7.07
A68/CC48/M34-4%-Rep3	Temp (°C)	11.79	11.72	11.87	11.68	11.75
A68/CC48/M34-4%-Rep3	D.O. (mg/L)	7.72	7.96	8.03	8.21	8.02
A68/CC48/M34-4%-Rep3	Conductivity (us/cm)	394.9	403.5	426	435.7	412.5
A68/CC48/M34-4%-Rep3	Alkalinity (mg $CaCO_3$/L)	34.9	-	-	-	40.8
A68/CC48/M34-4%-Rep3	Hardness (mg/L)	185	-	-	-	187

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-4%-Rep4	No. Alive	10	10	10	9	9
A68/CC48/M34-4%-Rep4	pH	7.4	7.3	7.16	7.16	7.08
A68/CC48/M34-4%-Rep4	Temp (°C)	11.77	11.71	11.88	11.68	11.71
A68/CC48/M34-4%-Rep4	D.O. (mg/L)	7.77	7.66	7.61	8.04	7.7
A68/CC48/M34-4%-Rep4	Conductivity (us/cm)	394.5	404.2	427	436.7	411.1
A68/CC48/M34-4%-Rep4	Alkalinity (mg $CaCO_3$/L)	34.9	-	-	-	40.8
A68/CC48/M34-4%-Rep4	Hardness (mg/L)	185	-	-	-	187

Appendix B 1: Upper Animas November 2012

Aquatic Toxicity Test

Site Static Renewal Data Sheets

Start Date	11/02/12		No. Organisms per replicate: 10
End Date	11/06/12		No. of Replicates: 4
Organism	Juvenile *O.mykiss* (rainbow trout) (0.84 grams)	Analysts	SA,CL,LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-Control-Rep1	No. Alive	10	10	10	10	10
A68/CC48/M34-Control-Rep1	pH	7.7	7.4	7.28	7.33	7.33
A68/CC48/M34-Control-Rep1	Temp (°C)	12.14	11.75	12.02	11.68	12.12
A68/CC48/M34-Control-Rep1	D.O. (mg/L)	7.19	7.81	8.06	8.08	7.77
A68/CC48/M34-Control-Rep1	Conductivity (us/cm)	298.1	302.8	317	323.8	319.5
A68/CC48/M34-Control-Rep1	Alkalinity (mg $CaCO_3$/L)	54.8	-	-	-	63.4
A68/CC48/M34-Control-Rep1	Hardness (mg/L)	91	-	-	-	92

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-Control-Rep2	No. Alive	10	10	10	10	10
A68/CC48/M34-Control-Rep2	pH	7.6	7.4	7.36	7.34	7.35
A68/CC48/M34-Control-Rep2	Temp (°C)	12.01	11.72	11.92	11.71	11.91
A68/CC48/M34-Control-Rep2	D.O. (mg/L)	6.97	8.1	8.08	8.11	7.21
A68/CC48/M34-Control-Rep2	Conductivity (us/cm)	299.1	305.8	319	327.9	319.1
A68/CC48/M34-Control-Rep2	Alkalinity (mg $CaCO_3$/L)	54.8	-	-	-	63.4
A68/CC48/M34-Control-Rep2	Hardness (mg/L)	91	-	-	-	92

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-Control-Rep3	No. Alive	10	10	10	10	10
A68/CC48/M34-Control-Rep3	pH	7.6	7.5	7.41	7.37	7.36
A68/CC48/M34-Control-Rep3	Temp (°C)	12.08	11.71	11.9	11.65	11.88
A68/CC48/M34-Control-Rep3	D.O. (mg/L)	6.71	8.14	8.15	8.11	7.92
A68/CC48/M34-Control-Rep3	Conductivity (us/cm)	298.7	304	318	326.9	320.8
A68/CC48/M34-Control-Rep3	Alkalinity (mg $CaCO_3$/L)	54.8	-	-	-	63.4
A68/CC48/M34-Control-Rep3	Hardness (mg/L)	91	-	-	-	92

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/CC48/M34-Control-Rep4	No. Alive	10	10	10	10	10
A68/CC48/M34-Control-Rep4	pH	7.6	7.5	7.39	7.37	7.37
A68/CC48/M34-Control-Rep4	Temp (°C)	11.98	11.71	11.91	11.68	11.91
A68/CC48/M34-Control-Rep4	D.O. (mg/L)	6.69	7.93	7.39	8.01	7.91
A68/CC48/M34-Control-Rep4	Conductivity (us/cm)	298.9	304.1	318	325.2	323.6
A68/CC48/M34-Control-Rep4	Alkalinity (mg $CaCO_3$/L)	54.8	-	-	-	63.4
A68/CC48/M34-Control-Rep4	Hardness (mg/L)	91	-	-	-	92

Prepared by: EC 3/8/13
Reviewed by: EB 3/13/13

Appendix B 2: November 2012 Aquatic Toxicity Test

Reference Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates:	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-01	No. Alive	10	10	10	10	10
Control-01	pH	8	7.4	7.4	7.4	7.47
Control-01	Temp (°C)	13.9	11.91	11.76	11.71	11.74
Control-01	D.O. (mg/L)	7.81	7.74	8.3	8.18	8.31
Control-01	Conductivity (us/cm)	302	308.5	317	319	319.8
Control-01	Alkalinity (mg $CaCO_3$/L)	61.9	-	-	-	70.5
Control-01	Hardness (mg/L)	91	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-02	No. Alive	10	10	10	10	10
Control-02	pH	8	7.5	7.5	7.4	7.47
Control-02	Temp (°C)	13.79	11.94	11.92	11.67	11.75
Control-02	D.O. (mg/L)	8.17	7.67	8.03	8.26	8.2
Control-02	Conductivity (us/cm)	298.9	304.6	311.3	319.4	318.6
Control-02	Alkalinity (mg $CaCO_3$/L)	61.9	-	-	-	70.5
Control-02	Hardness (mg/L)	91	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-03	No. Alive	10	10	10	10	10
Control-03	pH	8	7.4	7.5	7.4	7.46
Control-03	Temp (°C)	13.7	11.92	11.63	11.68	11.77
Control-03	D.O. (mg/L)	8.14	7.21	8.02	8.09	8.03
Control-03	Conductivity (us/cm)	298.5	303.9	316.5	316.9	318.9
Control-03	Alkalinity (mg $CaCO_3$/L)	61.9	-	-	-	70.5
Control-03	Hardness (mg/L)	91	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-04	No. Alive	10	10	10	10	10
Control-04	pH	8	7.4	7.4	7.4	7.45
Control-04	Temp (°C)	13.75	11.9	11.63	11.69	11.77
Control-04	D.O. (mg/L)	8.15	6.62	7.95	8.12	8.12
Control-04	Conductivity (us/cm)	298.1	303.9	317.9	317.7	318.3
Control-04	Alkalinity (mg $CaCO_3$/L)	61.9	-	-	-	70.5
Control-04	Hardness (mg/L)	91	-	-	-	93

Appendix B 2: November 2012 Aquatic Toxicity Test

Reference Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate: 10	
End Date	11/06/12	No. of Replicates:	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-01	No. Alive	10	10	10	10	10
6.25%-01	pH	8	7.5	7.6	7.3	7.46
6.25%-01	Temp (°C)	13.64	11.91	11.65	11.73	11.76
6.25%-01	D.O. (mg/L)	8.17	6.69	8.24	8.26	8.35
6.25%-01	Conductivity (us/cm)	297.8	303.7	321	319.5	318.1
6.25%-01	Alkalinity (mg $CaCO_3$/L)	58.9	-	-	-	63.4
6.25%-01	Hardness (mg/L)	90	-	-	-	92

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-02	No. Alive	10	10	10	10	10
6.25%-02	pH	8.1	7.4	7.5	7.3	7.46
6.25%-02	Temp (°C)	13.71	11.92	11.62	11.69	11.75
6.25%-02	D.O. (mg/L)	8.17	7.5	8.17	8.39	8.35
6.25%-02	Conductivity (us/cm)	297.6	304.6	320	321.2	320.1
6.25%-02	Alkalinity (mg $CaCO_3$/L)	58.9	-	-	-	63.4
6.25%-02	Hardness (mg/L)	90	-	-	-	92

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-03	No. Alive	10	10	10	10	10
6.25%-03	pH	8	7.4	7.6	7.3	7.46
6.25%-03	Temp (°C)	13.67	11.91	11.63	11.7	11.78
6.25%-03	D.O. (mg/L)	8.19	6.74	8.16	8.35	8.15
6.25%-03	Conductivity (us/cm)	297.7	304.5	321	319.8	318.7
6.25%-03	Alkalinity (mg $CaCO_3$/L)	58.9	-	-	-	63.4
6.25%-03	Hardness (mg/L)	90	-	-	-	92

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-04	No. Alive	10	10	10	10	10
6.25%-04	pH	8.1	7.4	7.6	7.3	7.45
6.25%-04	Temp (°C)	13.73	11.89	11.65	11.72	11.78
6.25%-04	D.O. (mg/L)	8.22	6.85	8.17	8.21	8.13
6.25%-04	Conductivity (us/cm)	296.3	304.3	320.7	318.3	317.3
6.25%-04	Alkalinity (mg $CaCO_3$/L)	58.9	-	-	-	63.4
6.25%-04	Hardness (mg/L)	90	-	-	-	92

Appendix B 2: November 2012 Aquatic Toxicity Test

Reference Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate:	10
End Date	11/06/12	No. of Replicates:	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
12.5%-01	No. Alive	10	10	5	5	5
12.5%-01	pH	8	7.6	7.5	7.3	7.46
12.5%-01	Temp (°C)	13.74	11.89	11.63	11.74	11.79
12.5%-01	D.O. (mg/L)	8.18	7.8	8.16	8.58	8.55
12.5%-01	Conductivity (us/cm)	298.4	309.1	329	315.7	314.1
12.5%-01	Alkalinity (mg $CaCO_3$/L)	61.4	-	-	-	63.6
12.5%-01	Hardness (mg/L)	91	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
12.5%-02	No. Alive	10	10	9	8	8
12.5%-02	pH	8	7.6	7.6	7.3	7.46
12.5%-02	Temp (°C)	13.69	11.88	11.65	11.73	11.8
12.5%-02	D.O. (mg/L)	8.2	7.8	8.36	8.34	8.5
12.5%-02	Conductivity (us/cm)	297.8	308	328	320.1	318.8
12.5%-02	Alkalinity (mg $CaCO_3$/L)	61.4	-	-	-	63.6
12.5%-02	Hardness (mg/L)	91	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
12.5%-03	No. Alive	10	10	9	9	9
12.5%-03	pH	8.2	7.5	7.5	7.3	7.43
12.5%-03	Temp (°C)	13.66	11.89	11.67	11.73	11.82
12.5%-03	D.O. (mg/L)	8.21	7.75	8.22	8.37	7.93
12.5%-03	Conductivity (us/cm)	297.7	306.5	324	320	316.7
12.5%-03	Alkalinity (mg $CaCO_3$/L)	61.4	-	-	-	63.6
12.5%-03	Hardness (mg/L)	91	-	-	-	93

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
12.5%-04	No. Alive	10	9	9	8	8
12.5%-04	pH	8.1	7.5	7.5	7.3	7.43
12.5%-04	Temp (°C)	13.86	11.86	11.67	11.75	11.81
12.5%-04	D.O. (mg/L)	8.22	7.34	8.17	8.41	8.12
12.5%-04	Conductivity (us/cm)	297.8	306	322.9	321	315.4
12.5%-04	Alkalinity (mg $CaCO_3$/L)	61.4	-	-	-	63.6
12.5%-04	Hardness (mg/L)	91	-	-	-	93

Appendix B 2: November 2012 Aquatic Toxicity Test

Reference Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate:	10
End Date	11/06/12	No. of Replicates:	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
25%-01	No. Alive	10	10	0	-	-
25%-01	pH	8	7.5	7.2	-	-
25%-01	Temp (°C)	13.79	11.85	11.64	-	-
25%-01	D.O. (mg/L)	8.22	7.79	8.62	-	-
25%-01	Conductivity (us/cm)	297.9	307.3	333.6	-	-
25%-01	Alkalinity (mg $CaCO_3$/L)	58.2	-	-	60.4	-
25%-01	Hardness (mg/L)	91	-	-	94	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
25%-02	No. Alive	10	9	1	0	-
25%-02	pH	8	7.4	7.19	7.3	-
25%-02	Temp (°C)	13.89	11.82	11.68	11.76	-
25%-02	D.O. (mg/L)	8.21	7.15	8.62	8.78	-
25%-02	Conductivity (us/cm)	297.8	310.7	328.7	315.2	-
25%-02	Alkalinity (mg $CaCO_3$/L)	58.2	-	-	60.4	-
25%-02	Hardness (mg/L)	91	-	-	94	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
25%-03	No. Alive	10	8	1	0	-
25%-03	pH	8	7.4	7.31	7.31	-
25%-03	Temp (°C)	13.74	11.8	11.7	11.77	-
25%-03	D.O. (mg/L)	8.2	6.88	8.56	8.79	-
25%-03	Conductivity (us/cm)	297.8	308.7	324.8	312.9	-
25%-03	Alkalinity (mg $CaCO_3$/L)	58.2	-	-	60.4	-
25%-03	Hardness (mg/L)	91	-	-	94	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
25%-04	No. Alive	10	10	2	0	-
25%-04	pH	8	7.4	7.22	7.3	-
25%-04	Temp (°C)	13.86	11.76	11.68	11.76	-
25%-04	D.O. (mg/L)	8.22	6.66	8.61	8.78	-
25%-04	Conductivity (us/cm)	297.8	309.6	335	312.9	-
25%-04	Alkalinity (mg $CaCO_3$/L)	58.2	-	-	60.4	-
25%-04	Hardness (mg/L)	91	-	-	94	-

Appendix B 2: November 2012 Aquatic Toxicity Test

Reference Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate:	10
End Date	11/06/12	No. of Replicates:	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
50%-01	No. Alive	10	6	0	-	-
50%-01	pH	8	7.4	7.24	-	-
50%-01	Temp (°C)	12.95	11.75	11.71	-	-
50%-01	D.O. (mg/L)	8.28	7.29	8.61	-	-
50%-01	Conductivity (us/cm)	297.3	311.7	323.4	-	-
50%-01	Alkalinity (mg $CaCO_3$/L)	57.7	-	61.8	-	-
50%-01	Hardness (mg/L)	91	-	94	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
50%-02	No. Alive	10	10	0	-	-
50%-02	pH	8	7.4	7.25	-	-
50%-02	Temp (°C)	12.7	11.7	11.73	-	-
50%-02	D.O. (mg/L)	8.32	7.4	8.64	-	-
50%-02	Conductivity (us/cm)	297.2	311.4	331.4	-	-
50%-02	Alkalinity (mg $CaCO_3$/L)	57.7	-	61.8	-	-
50%-02	Hardness (mg/L)	91	-	94	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
50%-03	No. Alive	10	9	0	-	-
50%-03	pH	8.1	7.4	7.27	-	-
50%-03	Temp (°C)	12.79	11.68	11.72	-	-
50%-03	D.O. (mg/L)	8.3	7.38	8.62	-	-
50%-03	Conductivity (us/cm)	297.2	310.4	330.2	-	-
50%-03	Alkalinity (mg $CaCO_3$/L)	57.7	-	61.8	-	-
50%-03	Hardness (mg/L)	91	-	94	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
50%-04	No. Alive	10	6	0	-	-	1 Jumper
50%-04	pH	8	7.4	7.29	-	-	
50%-04	Temp (°C)	13.74	11.66	11.73	-	-	
50%-04	D.O. (mg/L)	8.25	7.49	8.74	-	-	
50%-04	Conductivity (us/cm)	297.8	310.7	324.6	-	-	
50%-04	Alkalinity (mg $CaCO_3$/L)	57.7	-	61.8	-	-	
50%-04	Hardness (mg/L)	91	-	94	-	-	

Appendix B 2: November 2012 Aquatic Toxicity Test

Reference Static Renewal Data Sheets

Start Date	11/02/12	No. Organisms per replicate:	10
End Date	11/06/12	No. of Replicates:	4
Organism	Juvenile *O.mykiss* (rainbow trout)	Analysts	SA, CL, LC

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
100%-01	No. Alive	10	5	0	-	-	2 Jumpers
100%-01	pH	8	7.4	6.5	-	-	
100%-01	Temp (°C)	12.61	11.68	12.08	-	-	
100%-01	D.O. (mg/L)	8.31	7.63	8.55	-	-	
100%-01	Conductivity (us/cm)	297.3	311.9	322	-	-	
100%-01	Alkalinity (mg $CaCO_3$/L)	60.5	-	56.2	-	-	
100%-01	Hardness (mg/L)	90	-	94	-	-	

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
100%-02	No. Alive	10	5	0	-	-
100%-02	pH	8	7.4	6.6	-	-
100%-02	Temp (°C)	12.71	11.67	11.87	-	-
100%-02	D.O. (mg/L)	8.32	7.35	8.6	-	-
100%-02	Conductivity (us/cm)	297.3	311.9	*	-	-
100%-02	Alkalinity (mg $CaCO_3$/L)	60.5	-	56.2	-	-
100%-02	Hardness (mg/L)	90	-	94	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
100%-03	No. Alive	10	4	0	-	-
100%-03	pH	8	7.3	6.9	-	-
100%-03	Temp (°C)	12.62	11.65	11.92	-	-
100%-03	D.O. (mg/L)	8.37	6.74	6.48	-	-
100%-03	Conductivity (us/cm)	297.1	313.2	322	-	-
100%-03	Alkalinity (mg $CaCO_3$/L)	60.5	-	56.2	-	-
100%-03	Hardness (mg/L)	90	-	94	-	-

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
100%-04	No. Alive	10	5	0	-	-	1 Jumper
100%-04	pH	8	7.3	6.9	-	-	
100%-04	Temp (°C)	12.68	11.65	11.97	-	-	
100%-04	D.O. (mg/L)	8.37	6.36	8.65	-	-	
100%-04	Conductivity (us/cm)	297.1	310.5	324	-	-	
100%-04	Alkalinity (mg $CaCO_3$/L)	60.5	-	56.2	-	-	
100%-04	Hardness (mg/L)	90	-	94	-	-	

* No data available

Prepared by: EC 3/8/13

Reviewed by: EB 3/13/13

Attachment 1
October 2012 Upper Animas River Surface Water Toxicity Report
CETIS Analytical Reports

CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Start Date: 22 Oct-12 **Species:** Oncorhynchus mykiss **Sample Code:** Control
End Date: 26 Oct-12 **Protocol:** EPA/821/R-02-012 (2002) **Sample Source:** Upper Animas River
Sample Date: 22 Oct-12 **Material:** Lab Control **Sample Station:** Control

Batch Note: R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED)

Sample Code	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
Control	1	1	10	10	10	10	10	
Control	2	25	10	10	10	10	10	
Control	3	26	10	10	10	10	10	
Control	4	15	10	10	10	10	10	
A56	1	23	10	10	10	10	10	
A56	2	13	10	10	10	10	10	
A56	3	7	10	10	10	10	10	
A56	4	9	10	10	10	10	10	
A68	1	27	10	10	10	10	10	
A68	2	2	10	10	10	10	10	
A68	3	24	10	10	10	10	10	
A68	4	20	10	10	10	10	10	
A72	1	5	10	10	9	0	0	
A72	2	17	10	10	8	0	0	
A72	3	16	10	10	4	0	0	
A72	4	28	10	10	7	0	0	
A73B	1	11	10	10	10	10	10	
A73B	2	14	10	10	10	10	10	
A73B	3	8	10	10	10	10	10	
A73B	4	19	10	10	10	10	10	
A75B	1	22	10	10	10	10	10	
A75B	2	12	10	10	10	10	10	
A75B	3	10	10	10	10	10	10	
A75B	4	6	10	10	10	10	10	
Baker Bridge	1	18	10	10	10	10	10	
Baker Bridge	2	4	10	10	10	10	10	
Baker Bridge	3	21	10	10	10	10	10	
Baker Bridge	4	3	10	10	10	10	10	

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	14-7261-3366	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Mar-13 12:51	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Sample Code	Sample Comments
Control	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A56	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A68	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A72	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A73B	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A75B	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
Baker Bridge	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run					2.5%

Steel Many-One Rank Test

Sample Code	vs	Sample Code	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
Control		A56	18	10	6	1	0.8571	Non-Significant Effect
		A68	18	10	6	1	0.8571	Non-Significant Effect
		A72	10	10	6	0	0.0480	Significant Effect
		A73B	18	10	6	1	0.8571	Non-Significant Effect
		A75B	18	10	6	1	0.8571	Non-Significant Effect
		Baker Bridge	18	10	6	1	0.8571	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	5.384915	0.8974859	6	65540	<0.0001	Significant Effect
Error	0	0	21			
Total	5.384915	0.8974859	27			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	65540	3.812	<0.0001	Unequal Variances

96h Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
Control	4	1	1	1	1	1	0	0	0.0%	0.0%
A56	4	1	1	1	1	1	0	0	0.0%	0.0%
A68	4	1	1	1	1	1	0	0	0.0%	0.0%
A72	4	0	0	0	0	0	0	0		100.0%
A73B	4	1	1	1	1	1	0	0	0.0%	0.0%
A75B	4	1	1	1	1	1	0	0	0.0%	0.0%
Baker Bridge	4	1	1	1	1	1	0	0	0.0%	0.0%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
Control	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
A56	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
A68	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
A72	4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.76%
A73B	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
A75B	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
Baker Bridge	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%

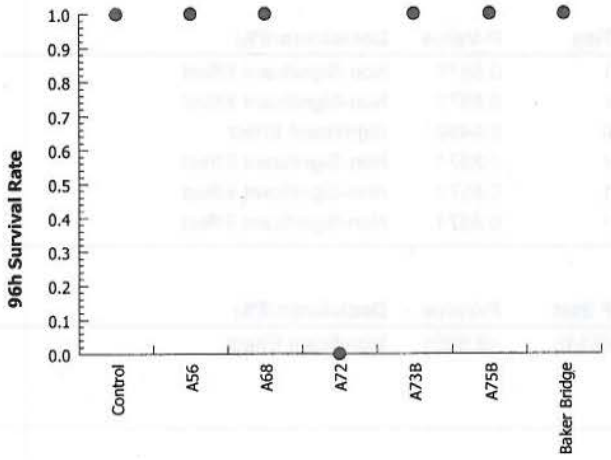
Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

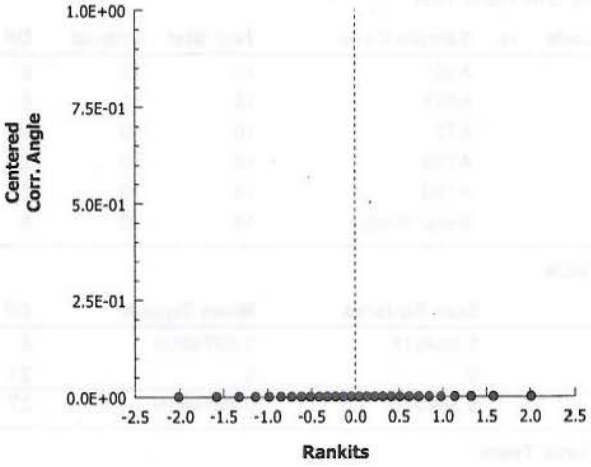
Analysis ID:	14-7261-3366	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Mar-13 12:51	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4
Control	1	1	1	1
A56	1	1	1	1
A68	1	1	1	1
A72	0	0	0	0
A73B	1	1	1	1
A75B	1	1	1	1
Baker Bridge	1	1	1	1

Graphics





Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	14-2444-3659	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Mar-13 12:51	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Sample Code	Sample Comments
Control	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A56	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A68	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A72	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A73B	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A75B	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
Baker Bridge	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run					2.5%

Steel Many-One Rank Test

Sample Code	vs	Sample Code	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
A56		A72	10	10	6	0	0.0350	Significant Effect
		A73B	18	10	6	1	0.8000	Non-Significant Effect
		A75B	18	10	6	1	0.8000	Non-Significant Effect
		Baker Bridge	18	10	6	1	0.8000	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	5.025921	1.25648	4	65540	<0.0001	Significant Effect
Error	0	0	15			
Total	5.025921	1.25648	19			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	65540	4.893	<0.0001	Unequal Variances

96h Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A56	4	1	1	1	1	1	0	0	0.0%	0.0%
A72	4	0	0	0	0	0	0	0		100.0%
A73B	4	1	1	1	1	1	0	0	0.0%	0.0%
A75B	4	1	1	1	1	1	0	0	0.0%	0.0%
Baker Bridge	4	1	1	1	1	1	0	0	0.0%	0.0%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A56	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
A72	4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.76%
A73B	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
A75B	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
Baker Bridge	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%

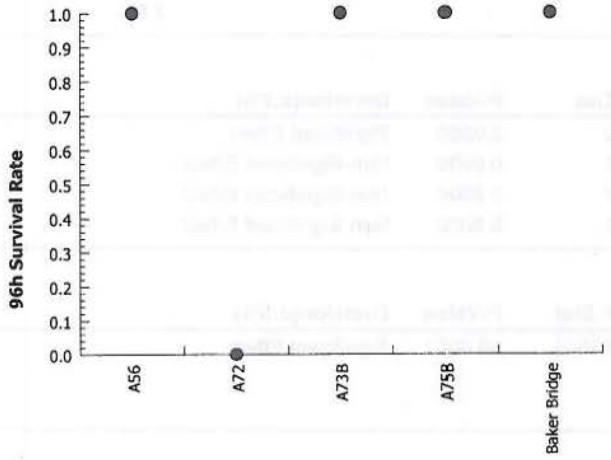
Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

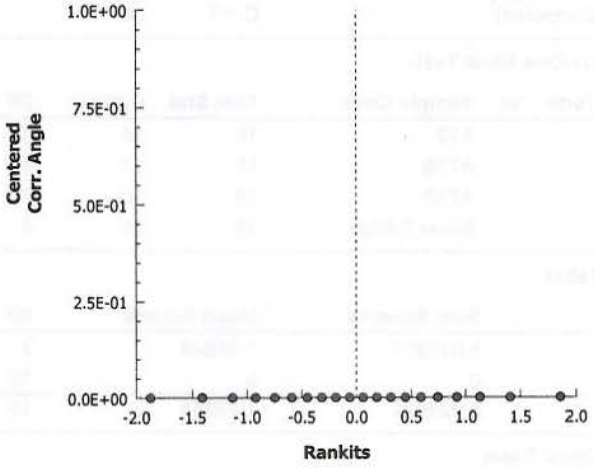
Analysis ID:	14-2444-3659	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Mar-13 12:51	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4
A56	1	1	1	1
A72	0	0	0	0
A73B	1	1	1	1
A75B	1	1	1	1
Baker Bridge	1	1	1	1

Graphics





Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	02-5955-8725	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Mar-13 12:51	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Sample Code	Sample Comments
Control	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A56	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A68	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A72	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A73B	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
A75B	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
Baker Bridge	R8: October 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run					2.5%

Steel Many-One Rank Test

Sample Code	vs	Sample Code	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
A68		A72	10	10	6	0	0.0350	Significant Effect
		A73B	18	10	6	1	0.8000	Non-Significant Effect
		A75B	18	10	6	1	0.8000	Non-Significant Effect
		Baker Bridge	18	10	6	1	0.8000	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	5.025921	1.25648	4	65540	<0.0001	Significant Effect
Error	0	0	15			
Total	5.025921	1.25648	19			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	65540	4.893	<0.0001	Unequal Variances

96h Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A68	4	1	1	1	1	1	0	0	0.0%	0.0%
A72	4	0	0	0	0	0	0	0		100.0%
A73B	4	1	1	1	1	1	0	0	0.0%	0.0%
A75B	4	1	1	1	1	1	0	0	0.0%	0.0%
Baker Bridge	4	1	1	1	1	1	0	0	0.0%	0.0%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A68	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
A72	4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.76%
A73B	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
A75B	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
Baker Bridge	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%

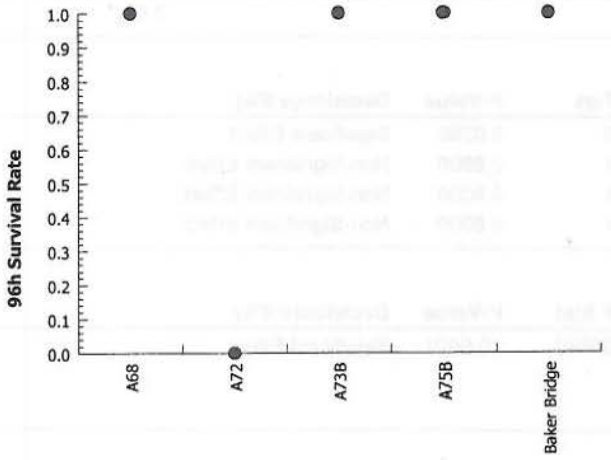
Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

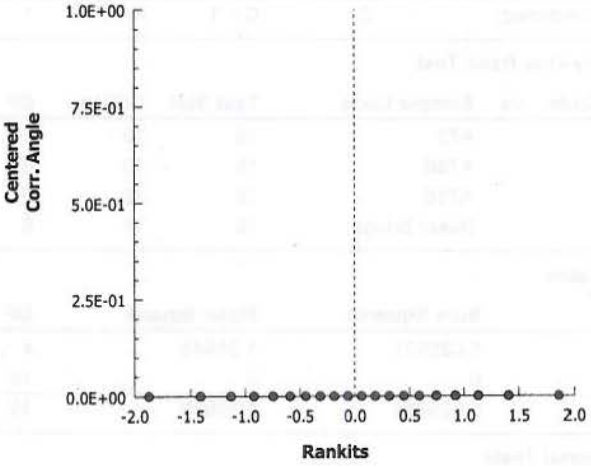
Analysis ID:	02-5955-8725	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Mar-13 12:51	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4
A68	1	1	1	1
A72	0	0	0	0
A73B	1	1	1	1
A75B	1	1	1	1
Baker Bridge	1	1	1	1

Graphics





CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Start Date: 22 Oct-12 **Species:** Oncorhynchus mykiss **Sample Code:** 34/48/56 6.25%
End Date: 26 Oct-12 **Protocol:** EPA/821/R-02-012 (2002) **Sample Source:** Upper Animas River
Sample Date: 22 Oct-12 **Material:** Mining Discharge/Runoff **Sample Station:** M34/CC48/A56 6.25%

Batch Note: R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A56 water)

Sample Code	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
M34/CC48/A56CON	1	22	10	10	10	10	10	
M34/CC48/A56CON	2	10	10	10	10	10	10	
M34/CC48/A56CON	3	11	10	10	10	10	10	
M34/CC48/A56CON	4	14	10	10	10	10	10	
34/48/56 6.25%	1	13	10	10	10	10	10	
34/48/56 6.25%	2	2	10	10	10	10	10	
34/48/56 6.25%	3	7	10	10	10	10	10	
34/48/56 6.25%	4	8	10	10	10	10	10	
34/48/56 12.5%	1	19	10	10	10	10	10	
34/48/56 12.5%	2	17	10	10	10	10	10	
34/48/56 12.5%	3	3	10	10	10	10	10	
34/48/56 12.5%	4	18	10	10	10	10	10	
34/48/56 25%	1	1	10	10	10	10	10	
34/48/56 25%	2	23	10	10	10	10	10	
34/48/56 25%	3	6	10	10	10	10	10	
34/48/56 25%	4	9	10	10	10	10	10	
34/48/56 50%	1	21	10	10	10	10	10	
34/48/56 50%	2	15	10	10	10	10	10	
34/48/56 50%	3	20	10	10	10	9	9	
34/48/56 50%	4	24	10	10	10	10	10	
34/48/56 100%	1	5	10	10	0	0	0	
34/48/56 100%	2	16	10	4	0	0	0	
34/48/56 100%	3	4	10	2	0	0	0	
34/48/56 100%	4	12	10	7	0	0	0	

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	07-7333-0804	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Mar-13 13:50	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Sample Code	Sample Comments
M34/CC48/A56CON	R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A56 water).
34/48/56 6.25%	R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A56 water).
34/48/56 12.5%	R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A56 water).
34/48/56 25%	R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A56 water).
34/48/56 50%	R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A56 water).
34/48/56 100%	R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A56 water).

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run				N/A	4.57%

Steel Many-One Rank Test

Sample Code	vs	Sample Code	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
M34/CC48/A56CO		34/48/56 6.25%	18	10	6	1	0.8333	Non-Significant Effect
		34/48/56 12.5%	18	10	6	1	0.8333	Non-Significant Effect
		34/48/56 25%	18	10	6	1	0.8333	Non-Significant Effect
		34/48/56 50%	16	10	6	1	0.6105	Non-Significant Effect
		34/48/56 100%	10	10	6	0	0.0417	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	5.172787	1.034557	5	934.9	<0.0001	Significant Effect
Error	0.0199195	0.001106639	18			
Total	5.192707	1.035664	23			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	1	4.248	0.4457	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.4634	0.884	<0.0001	Non-normal Distribution

96h Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
M34/CC48/A56CON	4	1	1	1	1	1	0	0	0.0%	0.0%
34/48/56 6.25%	4	1	1	1	1	1	0	0	0.0%	0.0%
34/48/56 12.5%	4	1	1	1	1	1	0	0	0.0%	0.0%
34/48/56 25%	4	1	1	1	1	1	0	0	0.0%	0.0%
34/48/56 50%	4	0.975	0.956	0.994	0.9	1	0.025	0.05	5.13%	2.5%
34/48/56 100%	4	0	0	0	0	0	0	0		100.0%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
M34/CC48/A56CON	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
34/48/56 6.25%	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
34/48/56 12.5%	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
34/48/56 25%	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
34/48/56 50%	4	1.371	1.34	1.402	1.249	1.412	0.04074	0.08149	5.94%	2.89%
34/48/56 100%	4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.76%

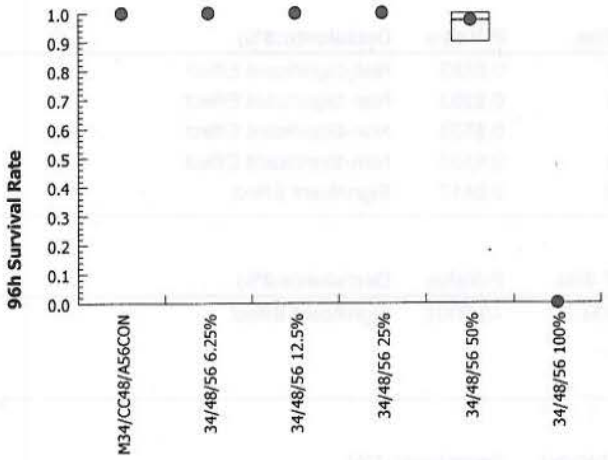
Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

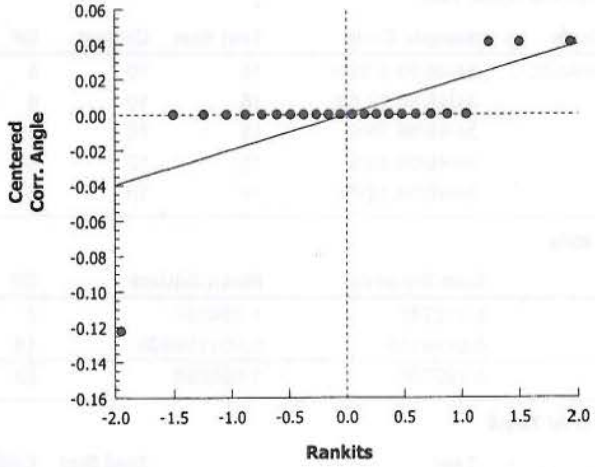
Analysis ID:	07-7333-0804	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Mar-13 13:50	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4
M34/CC48/A56CON	1	1	1	1
34/48/56 6.25%	1	1	1	1
34/48/56 12.5%	1	1	1	1
34/48/56 25%	1	1	1	1
34/48/56 50%	1	1	0.9	1
34/48/56 100%	0	0	0	0

Graphics





CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Start Date: 22 Oct-12 **Species:** Oncorhynchus mykiss **Sample Code:** 34/48/68 CON
End Date: **Protocol:** EPA/821/R-02-012 (2002) **Sample Source:** Upper Animas River
Sample Date: 22 Oct-12 **Material:** Mining Discharge/Runoff **Sample Station:** M34/CC48/A68 Control

Batch Note: R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A68 water)

Conc-%	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
34/48/68 CON	1	11	10	10	10	10	10	
34/48/68 CON	2	13	10	10	10	10	10	
34/48/68 CON	3	14	10	10	10	10	10	
34/48/68 CON	4	6	10	10	10	10	10	
34/48/68 6.25%	1	12	10	10	10	10	10	
34/48/68 6.25%	2	8	10	10	10	10	10	
34/48/68 6.25%	3	10	10	10	10	10	10	
34/48/68 6.25%	4	16	10	10	10	10	10	
34/48/68 12.5%	1	4	10	10	10	10	10	
34/48/68 12.5%	2	15	10	10	10	10	10	
34/48/68 12.5%	3	7	10	10	10	10	10	
34/48/68 12.5%	4	5	10	10	10	10	10	
34/48/68 25%	1	17	10	10	10	10	10	
34/48/68 25%	2	2	10	10	10	10	10	
34/48/68 25%	3	3	10	10	10	10	10	
34/48/68 25%	4	20	10	10	10	10	10	
34/48/68 50%	1	9	10	10	10	7	3	
34/48/68 50%	2	1	10	10	8	5	2	
34/48/68 50%	3	19	10	10	10	8	6	
34/48/68 50%	4	18	10	10	10	8	4	

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	00-4654-0837	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Mar-13 16:51	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Sample Code	Sample Comments
34/48/68 CON	R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A68 water).
34/48/68 6.25%	R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A68 water).
34/48/68 12.5%	R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A68 water).
34/48/68 25%	R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A68 water).
34/48/68 50%	R8: October 2012 Upper Animas RBT Acute SW Tox Test (DILUTED with A68 water).

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run				N/A	8.31%

Steel Many-One Rank Test

Sample Code	vs	Sample Code	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
34/48/68 CON		34/48/68 6.25%	18	10	6	1	0.8000	Non-Significant Effect
		34/48/68 12.5%	18	10	6	1	0.8000	Non-Significant Effect
		34/48/68 25%	18	10	6	1	0.8000	Non-Significant Effect
		34/48/68 50%	10	10	6	0	0.0350	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1.841008	0.460252	4	71.49	<0.0001	Significant Effect
Error	0.09656602	0.006437735	15			
Total	1.937574	0.4666897	19			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	7.241	4.893	0.0019	Unequal Variances
Distribution	Shapiro-Wilk W Normality	0.5659	0.866	<0.0001	Non-normal Distribution

96h Survival Rate Summary

Conc-%	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
34/48/68 CON	4	1	1	1	1	1	0	0	0.0%	0.0%
34/48/68 6.25%	4	1	1	1	1	1	0	0	0.0%	0.0%
34/48/68 12.5%	4	1	1	1	1	1	0	0	0.0%	0.0%
34/48/68 25%	4	1	1	1	1	1	0	0	0.0%	0.0%
34/48/68 50%	4	0.375	0.31	0.44	0.2	0.6	0.08539	0.1708	45.54%	62.5%

Angular (Corrected) Transformed Summary

Conc-%	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
34/48/68 CON	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
34/48/68 6.25%	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
34/48/68 12.5%	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
34/48/68 25%	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
34/48/68 50%	4	0.6535	0.5853	0.7218	0.4636	0.8861	0.08971	0.1794	27.45%	53.72%

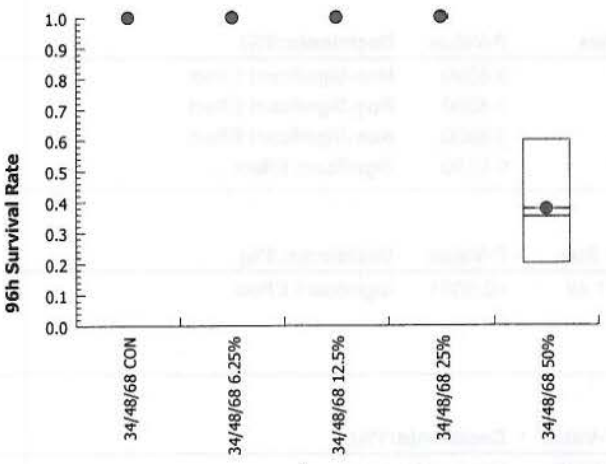
Fish 96-h Acute Survival Test — U.S. EPA Region 8 Lab

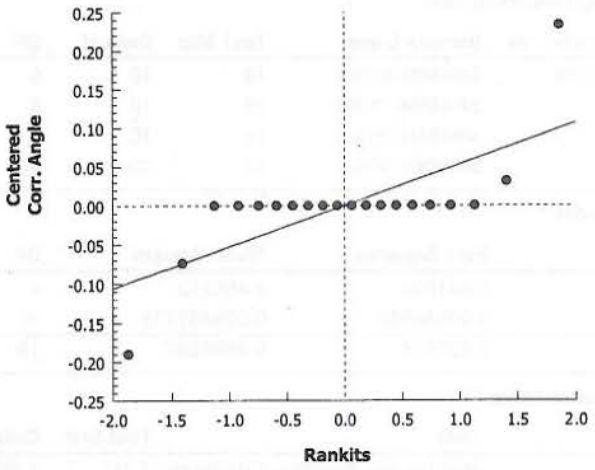
Analysis ID:	00-4654-0837	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Mar-13 16:51	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Conc-%	Rep 1	Rep 2	Rep 3	Rep 4
34/48/68 CON	1	1	1	1
34/48/68 6.25%	1	1	1	1
34/48/68 12.5%	1	1	1	1
34/48/68 25%	1	1	1	1
34/48/68 50%	0.3	0.2	0.6	0.4

Graphics





CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — **U.S. EPA Region I Lab**

Start Date: 22 Oct-12 **Species:** Oncorhynchus mykiss **Sample Code:** 1012OMARTT
End Date: 26 Oct-12 **Protocol:** EPA/821/R-02-012 (2002) **Sample Source:** Reference Toxicant
Sample Date: 22 Oct-12 **Material:** Zinc sulfate **Sample Station:**

Batch Note: Region 8: Acute RBT Ref Tox Test (concurrent to Oct 2012 Upper Animas SW Tox Test)

Sample Note: Region 8: Acute RBT Ref Tox Test (concurrent to Oct 2012 Upper Animas SW Tox Test)

Conc-µg/L	Code	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
0	L	1	19	10	10	10	10	10	
0	L	2	18	10	10	10	10	10	
0	L	3	12	10	10	10	10	10	
0	L	4	17	10	10	10	10	10	
68.85		1	16	10	10	10	10	10	
68.85		2	23	10	10	10	10	10	
68.85		3	11	10	10	10	10	10	
68.85		4	6	10	10	10	10	10	
131.5		1	21	10	10	8	8	8	
131.5		2	10	10	10	6	6	6	
131.5		3	5	10	10	8	8	8	
131.5		4	20	10	10	8	8	8	
263.5		1	4	10	6	0	0	0	
263.5		2	24	10	10	0	0	0	
263.5		3	14	10	9	2	2	2	
263.5		4	9	10	7	0	0	0	
518.5		1	22	10	7	0	0	0	
518.5		2	2	10	7	0	0	0	
518.5		3	7	10	9	0	0	0	
518.5		4	13	10	6	0	0	0	
1029.5		1	15	10	4	0	0	0	
1029.5		2	3	10	3	0	0	0	
1029.5		3	8	10	5	0	0	0	
1029.5		4	1	10	7	1	0	0	

CETIS Analytical Report

Fish 96-h Acute Survival Test — **U.S. EPA Region I Lab**

Analysis ID: 09-5896-4300 **Endpoint:** 96h Survival Rate **CETIS Version:** CETISv1.8.0
Analyzed: 14 Mar-13 10:27 **Analysis:** Untrimmed Spearman-Kärber **Official Results:** Yes

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	0.00%	2.212	0.02244	162.9	146.9	180.6

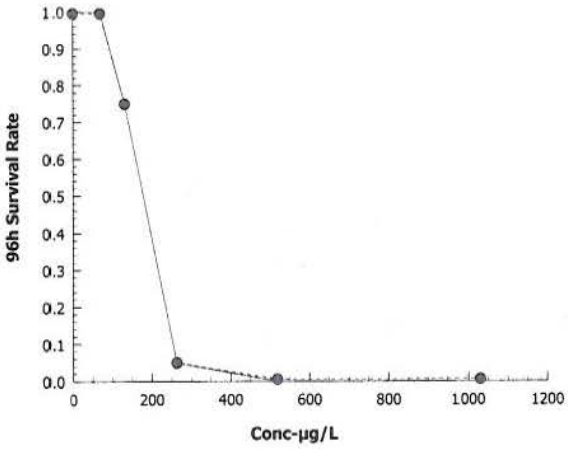
96h Survival Rate Summary — Calculated Variate(A/B)

Conc-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Lab Water	4	1	1	1	0	0	0.0%	0.0%	40	40
68.85		4	1	1	1	0	0	0.0%	0.0%	40	40
131.5		4	0.75	0.6	0.8	0.05	0.1	13.33%	25.0%	30	40
263.5		4	0.05	0	0.2	0.05	0.1	200.0%	95.0%	2	40
518.5		4	0	0	0	0	0		100.0%	0	40
1029.5		4	0	0	0	0	0		100.0%	0	40

96h Survival Rate Detail

Conc-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Lab Water	1	1	1	1
68.85		1	1	1	1
131.5		0.8	0.6	0.8	0.8
263.5		0	0	0.2	0
518.5		0	0	0	0
1029.5		0	0	0	0

Graphics



Attachment 2
November 2012 Upper Animas River Surface Water Toxicity Report
CETIS Analytical Reports

CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Start Date:	02 Nov-12	**Species:**	Oncorhynchus mykiss	**Sample Code:**	M34
End Date:	06 Nov-12	**Protocol:**	EPA/821/R-02-012 (2002)	**Sample Source:**	Upper Animas River
Sample Date:	02 Nov-12	**Material:**	Mining Discharge/Runoff	**Sample Station:**	M34

Batch Note: R8: November 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED)

Conc-NA	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
A68	1	7	10	10	10	9	9	
A68	2	2	10	10	9	8	8	
A68	3	3	10	10	10	10	10	
A68	4	5	10	10	10	10	10	
M34	1	4	10	9	0	0	0	
M34	2	8	10	8	1	0	0	
M34	3	1	10	10	1	1	0	
M34	4	6	10	8	1	0	0	

CETIS Analytical Report

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	14-8077-4318	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	14 Mar-13 11:25	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Sample Code	Sample Comments
A68	R8: November 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).
M34	R8: November 2012 Upper Animas RBT Acute SW Tox Test (UNDILUTED).

Data Transform	Zeta	Alt Hyp	MC Trials	Test Result	PMSD
Angular (Corrected)	0	C > T	Not Run	Sample passes 96h survival rate endpoint	9.75%

Equal Variance t Two-Sample Test

Sample Code	vs	Sample Code	Test Stat	Critical	DF	MSD	P-Value	Decision(α:5%)
A68		M34	15.46	1.943	6	0.1428	<0.0001	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	2.582248	2.582248	1	239.2	<0.0001	Significant Effect
Error	0.06478542	0.01079757	6			
Total	2.647034	2.593046	7			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	10.87	13.75	0.0165	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.8598	0.6451	0.1195	Normal Distribution

96h Survival Rate Summary

Conc-NA	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A68	4	0.925	0.8886	0.9614	0.8	1	0.04787	0.09574	10.35%	0.0%
M34	4	0	0	0	0	0	0	0		100.0%

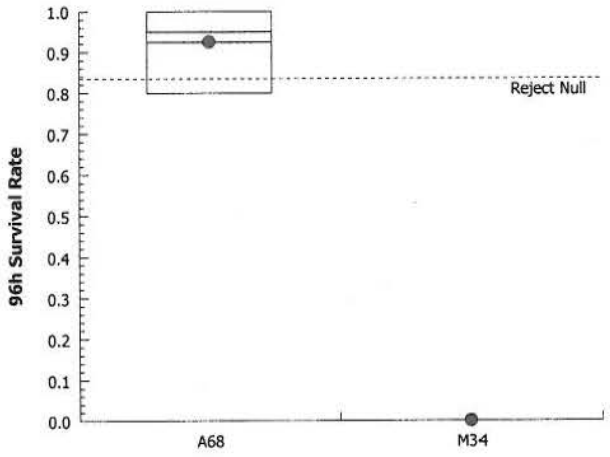
Angular (Corrected) Transformed Summary

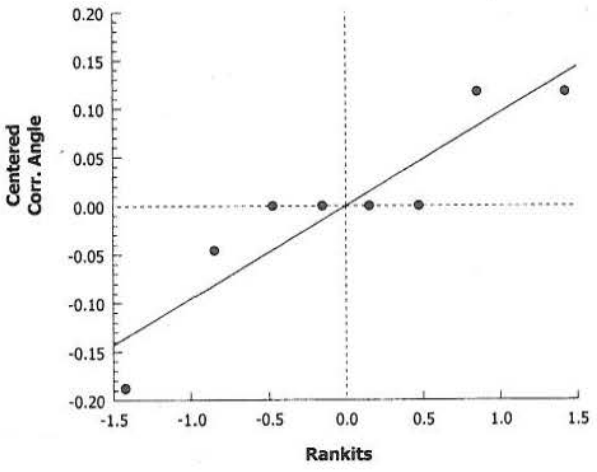
Conc-NA	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A68	4	1.295	1.239	1.351	1.107	1.412	0.07348	0.147	11.35%	0.0%
M34	4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	87.74%

96h Survival Rate Detail

Conc-NA	Rep 1	Rep 2	Rep 3	Rep 4
A68	0.9	0.8	1	1
M34	0	0	0	0

Graphics





CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Start Date:	02 Nov-12	**Species:**	Oncorhynchus mykiss	**Sample Code:**	A68/A72 100%
End Date:	06 Nov-12	**Protocol:**	EPA/821/R-02-012 (2002)	**Sample Source:**	Upper Animas River
Sample Date:	02 Nov-12	**Material:**	Mining Discharge/Runoff	**Sample Station:**	A68/A72 100%

Batch Note: R8: November 2012 Upper Animas RBT Acute SW Tox Test (A72 DILUTED w/A68)

Conc-NA	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
A68/A72 Control	1	8	10	10	10	10	10	
A68/A72 Control	2	5	10	10	10	10	10	
A68/A72 Control	3	3	10	10	10	10	10	
A68/A72 Control	4	10	10	10	10	10	10	
A68/A72 5%	1	4	10	10	10	10	10	
A68/A72 5%	2	1	10	10	10	8	8	
A68/A72 5%	3	26	10	10	10	10	10	
A68/A72 5%	4	12	10	10	10	9	9	
A68/A72 10%	1	20	9	9	8	8	8	
A68/A72 10%	2	17	8	8	8	8	8	
A68/A72 10%	3	2	10	10	10	9	9	
A68/A72 10%	4	22	10	10	10	10	10	
A68/A72 25%	1	28	10	10	10	8	8	
A68/A72 25%	2	16	10	10	10	10	10	
A68/A72 25%	3	15	9	9	9	8	8	
A68/A72 25%	4	11	10	10	10	10	10	
A68/A72 50%	1	27	10	10	10	10	10	
A68/A72 50%	2	24	10	10	10	10	10	
A68/A72 50%	3	14	9	9	9	9	9	
A68/A72 50%	4	25	10	10	10	10	10	
A68/A72 75%	1	23	9	9	9	9	9	
A68/A72 75%	2	6	9	9	9	9	9	
A68/A72 75%	3	13	10	10	10	10	10	
A68/A72 75%	4	9	10	10	10	10	10	
A68/A72 100%	1	7	10	10	3	2	0	
A68/A72 100%	2	21	10	10	5	4	1	
A68/A72 100%	3	18	10	10	5	4	0	
A68/A72 100%	4	19	10	10	5	3	0	

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	12-0049-8676	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	14 Mar-13 14:38	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Sample Code	Sample Comments
A68/A72 Control	R8: November 2012 Upper Animas RBT Acute SW Tox Test (A72 DILUTED w/A68).
A68/A72 5%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (A72 DILUTED w/A68).
A68/A72 10%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (A72 DILUTED w/A68).
A68/A72 25%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (A72 DILUTED w/A68).
A68/A72 50%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (A72 DILUTED w/A68).
A68/A72 75%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (A72 DILUTED w/A68).
A68/A72 100%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (A72 DILUTED w/A68).

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run					9.79%

Steel Many-One Rank Test

Sample Code	vs	Sample Code	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
A68/A72 Control		A68/A72 5%	14	10	6	1	0.3760	Non-Significant Effect
		A68/A72 10%	14	10	6	1	0.3760	Non-Significant Effect
		A68/A72 25%	14	10	6	1	0.3760	Non-Significant Effect
		A68/A72 50%	18	10	6	1	0.8571	Non-Significant Effect
		A68/A72 75%	18	10	6	1	0.8571	Non-Significant Effect
		A68/A72 100%	10	10	6	0	0.0480	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	4.657713	0.7762855	6	91.43	<0.0001	Significant Effect
Error	0.1782962	0.008490295	21			
Total	4.836009	0.7847758	27			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	5.219	3.812	0.0020	Unequal Variances
Distribution	Shapiro-Wilk W Normality	0.9013	0.8975	0.0123	Normal Distribution

96h Survival Rate Summary

Conc-NA	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A68/A72 Control	4	1	1	1	1	1	0	0	0.0%	0.0%
A68/A72 5%	4	0.925	0.8886	0.9614	0.8	1	0.04787	0.09574	10.35%	7.5%
A68/A72 10%	4	0.9472	0.924	0.9705	0.8889	1	0.03056	0.06111	6.45%	5.28%
A68/A72 25%	4	0.9222	0.8854	0.9591	0.8	1	0.04843	0.09686	10.5%	7.78%
A68/A72 50%	4	1	1	1	1	1	0	0	0.0%	0.0%
A68/A72 75%	4	1	1	1	1	1	0	0	0.0%	0.0%
A68/A72 100%	4	0.025	0.005981	0.04402	0	0.1	0.025	0.05	200.0%	97.5%

Angular (Corrected) Transformed Summary

Conc-NA	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A68/A72 Control	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
A68/A72 5%	4	1.295	1.239	1.351	1.107	1.412	0.07348	0.147	11.35%	8.28%
A68/A72 10%	4	1.321	1.285	1.357	1.231	1.412	0.04723	0.09445	7.15%	6.43%
A68/A72 25%	4	1.291	1.234	1.347	1.107	1.412	0.07455	0.1491	11.55%	8.6%
A68/A72 50%	4	1.41	1.408	1.412	1.403	1.412	0.002171	0.004341	0.31%	0.15%
A68/A72 75%	4	1.408	1.406	1.41	1.403	1.412	0.002505	0.00501	0.36%	0.31%
A68/A72 100%	4	0.1995	0.1685	0.2305	0.1588	0.3218	0.04074	0.08149	40.84%	85.87%

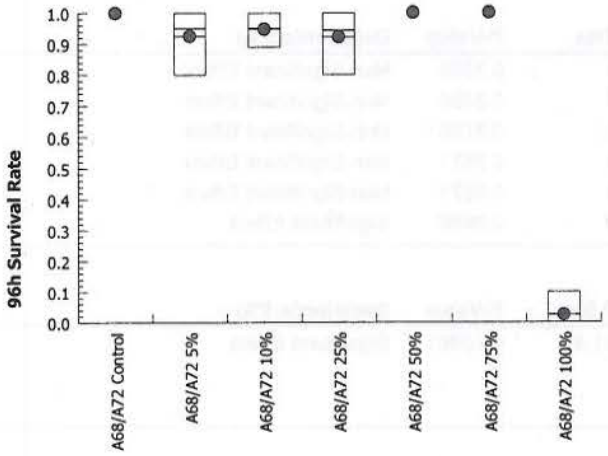
Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

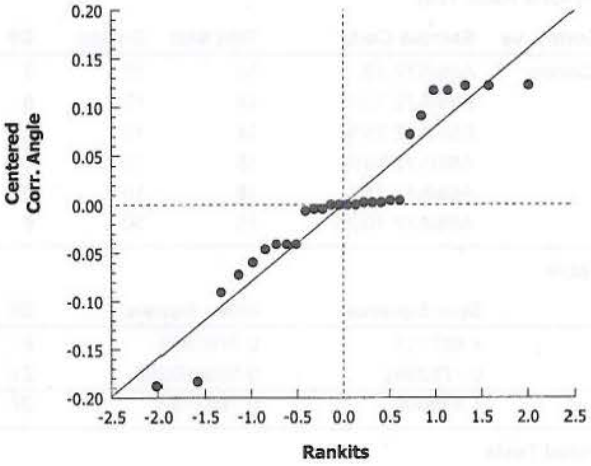
Analysis ID:	12-0049-8676	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	14 Mar-13 14:38	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Conc-NA	Rep 1	Rep 2	Rep 3	Rep 4
A68/A72 Control	1	1	1	1
A68/A72 5%	1	0.8	1	0.9
A68/A72 10%	0.8889	1	0.9	1
A68/A72 25%	0.8	1	0.8889	1
A68/A72 50%	1	1	1	1
A68/A72 75%	1	1	1	1
A68/A72 100%	0	0.1	0	0

Graphics





CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Start Date: 02 Nov-12 **Species:** Oncorhynchus mykiss **Sample Code:** A68/CC48 Con
End Date: 06 Nov-12 **Protocol:** EPA/821/R-02-012 (2002) **Sample Source:** Upper Animas River
Sample Date: 02 Nov-12 **Material:** Mining Discharge/Runoff **Sample Station:** A68/CC48 Control

Batch Note: R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48 DILUTED w/A68)

Conc-NA	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
A68/CC48 Con	1	25	9	9	9	9	9	
A68/CC48 Con	2	23	10	10	10	10	10	
A68/CC48 Con	3	28	10	10	10	10	10	
A68/CC48 Con	4	22	10	10	10	10	10	
A68/CC48 1%	1	18	10	10	9	9	9	
A68/CC48 1%	2	16	10	10	9	9	9	
A68/CC48 1%	3	15	10	10	10	10	10	
A68/CC48 1%	4	14	10	10	8	6	6	
A68/CC48 3%	1	9	10	10	10	10	10	
A68/CC48 3%	2	3	9	9	9	9	9	
A68/CC48 3%	3	2	10	10	9	9	9	
A68/CC48 3%	4	27	10	10	10	10	10	
A68/CC48 6%	1	6	10	10	9	9	9	
A68/CC48 6%	2	4	10	10	10	10	10	
A68/CC48 6%	3	5	10	10	10	10	10	
A68/CC48 6%	4	13	10	10	10	10	10	
A68/CC48 12%	1	24	10	10	10	9	9	
A68/CC48 12%	2	17	10	10	10	10	10	
A68/CC48 12%	3	20	10	10	10	10	10	
A68/CC48 12%	4	21	10	10	8	7	7	
A68/CC48 25%	1	7	10	10	10	6	6	
A68/CC48 25%	2	1	10	10	10	10	10	
A68/CC48 25%	3	10	10	10	10	10	10	
A68/CC48 25%	4	8	10	10	10	10	10	
A68/CC48 50%	1	26	10	0	0	0	0	
A68/CC48 50%	2	12	10	0	0	0	0	
A68/CC48 50%	3	19	10	0	0	0	0	
A68/CC48 50%	4	11	10	0	0	0	0	

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	15-7164-8232	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	14 Mar-13 11:42	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Sample Code	Sample Comments
A68/CC48 Con	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48 DILUTED w/A68).
A68/CC48 1%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48 DILUTED w/A68).
A68/CC48 3%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48 DILUTED w/A68).
A68/CC48 6%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48 DILUTED w/A68).
A68/CC48 12%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48 DILUTED w/A68).
A68/CC48 25%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48 DILUTED w/A68).
A68/CC48 50%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48 DILUTED w/A68).

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run					17.5%

Steel Many-One Rank Test

Sample Code	vs	Sample Code	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
A68/CC48 Con		A68/CC48 1%	12	10	6	1	0.1598	Non-Significant Effect
		A68/CC48 3%	16	10	6	1	0.6450	Non-Significant Effect
		A68/CC48 6%	16	10	6	1	0.6450	Non-Significant Effect
		A68/CC48 12%	14	10	6	1	0.3760	Non-Significant Effect
		A68/CC48 25%	16	10	6	1	0.6450	Non-Significant Effect
		A68/CC48 50%	10	10	6	0	0.0480	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	4.719674	0.7866123	6	32.17	<0.0001	Significant Effect
Error	0.5134777	0.02445132	21			
Total	5.233151	0.8110636	27			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	0.8895	3.812	0.5201	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.8407	0.8975	0.0006	Non-normal Distribution

96h Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A68/CC48 Con	4	1	1	1	1	1	0	0	0.0%	0.0%
A68/CC48 1%	4	0.85	0.7841	0.9159	0.6	1	0.0866	0.1732	20.38%	15.0%
A68/CC48 3%	4	0.975	0.956	0.994	0.9	1	0.025	0.05	5.13%	2.5%
A68/CC48 6%	4	0.975	0.956	0.994	0.9	1	0.025	0.05	5.13%	2.5%
A68/CC48 12%	4	0.9	0.8462	0.9538	0.7	1	0.07071	0.1414	15.71%	10.0%
A68/CC48 25%	4	0.9	0.8239	0.9761	0.6	1	0.1	0.2	22.22%	10.0%
A68/CC48 50%	4	0	0	0	0	0	0	0		100.0%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A68/CC48 Con	4	1.41	1.408	1.412	1.403	1.412	0.002171	0.004341	0.31%	0.0%
A68/CC48 1%	4	1.199	1.114	1.284	0.8861	1.412	0.1112	0.2223	18.54%	14.95%
A68/CC48 3%	4	1.369	1.339	1.4	1.249	1.412	0.04007	0.08015	5.85%	2.89%
A68/CC48 6%	4	1.371	1.34	1.402	1.249	1.412	0.04074	0.08149	5.94%	2.74%
A68/CC48 12%	4	1.266	1.19	1.342	0.9912	1.412	0.09936	0.1987	15.7%	10.2%
A68/CC48 25%	4	1.281	1.181	1.381	0.8861	1.412	0.1315	0.263	20.54%	9.17%
A68/CC48 50%	4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.74%

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	15-7164-8232	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	14 Mar-13 11:42	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4
A68/CC48 Con	1	1	1	1
A68/CC48 1%	0.9	0.9	1	0.6
A68/CC48 3%	1	1	0.9	1
A68/CC48 6%	0.9	1	1	1
A68/CC48 12%	0.9	1	1	0.7
A68/CC48 25%	0.6	1	1	1
A68/CC48 50%	0	0	0	0

CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Start Date:	02 Nov-12	**Species:**	Oncorhynchus mykiss	**Sample Code:**	A68/CC48/M34CON
End Date:	06 Nov-12	**Protocol:**	EPA/821/R-02-012 (2002)	**Sample Source:**	Upper Animas River
Sample Date:	02 Nov-12	**Material:**	Mining Discharge/Runoff	**Sample Station:**	A68/CC48/M34 Control

Batch Note: R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48/M34 DILUTED with A68)

Sample Code	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
A68/CC48/M34CON	1	2	10	10	10	10	10	
A68/CC48/M34CON	2	16	10	10	10	10	10	
A68/CC48/M34CON	3	27	10	10	10	10	10	
A68/CC48/M34CON	4	21	10	10	10	10	10	
68/48/34 4%	1	5	10	10	10	10	10	
68/48/34 4%	2	26	9	9	9	9	9	
68/48/34 4%	3	19	10	10	10	10	10	
68/48/34 4%	4	17	10	10	10	9	9	
68/48/34 9%	1	12	10	10	10	10	10	
68/48/34 9%	2	6	10	10	9	9	9	
68/48/34 9%	3	8	10	10	10	10	10	
68/48/34 9%	4	10	10	10	10	9	9	
68/48/34 20%	1	22	10	10	10	10	10	
68/48/34 20%	2	15	10	10	10	10	10	
68/48/34 20%	3	4	10	10	10	10	10	
68/48/34 20%	4	11	10	10	10	10	10	
68/48/34 40%	1	9	10	10	10	10	9	
68/48/34 40%	2	13	10	10	10	10	10	
68/48/34 40%	3	18	10	10	10	10	8	
68/48/34 40%	4	24	10	10	10	10	10	
68/48/34 65%	1	7	10	7	3	1	0	
68/48/34 65%	2	14	10	9	3	1	0	
68/48/34 65%	3	25	10	9	2	2	0	
68/48/34 65%	4	23	10	10	4	4	0	
68/48/34 85%	1	1	10	0	0	0	0	
68/48/34 85%	2	20	10	0	0	0	0	
68/48/34 85%	3	3	10	0	0	0	0	
68/48/34 85%	4	28	10	0	0	0	0	

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	19-2177-9212	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	14 Mar-13 15:03	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Sample Code	Sample Comments
A68/CC48/M34CON	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48/M34 DILUTED with A68).
68/48/34 4%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48/M34 DILUTED with A68).
68/48/34 9%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48/M34 DILUTED with A68).
68/48/34 20%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48/M34 DILUTED with A68).
68/48/34 40%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48/M34 DILUTED with A68).
68/48/34 65%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48/M34 DILUTED with A68).
68/48/34 85%	R8: November 2012 Upper Animas RBT Acute SW Tox Test (CC48/M34 DILUTED with A68).

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run					7.87%

Steel Many-One Rank Test

Sample Code vs	Sample Code	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
A68/CC48/M34CO	68/48/34 4%	16	10	6	1	0.6450	Non-Significant Effect
	68/48/34 9%	14	10	6	1	0.3760	Non-Significant Effect
	68/48/34 20%	18	10	6	1	0.8571	Non-Significant Effect
	68/48/34 40%	14	10	6	1	0.3760	Non-Significant Effect
	68/48/34 65%	10	10	6	0	0.0480	Significant Effect
	68/48/34 85%	10	10	6	0	0.0480	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	8.338845	1.389808	6	263.9	<0.0001	Significant Effect
Error	0.1106143	0.005267348	21			
Total	8.449459	1.395075	27			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	5.879	3.812	0.0010	Unequal Variances
Distribution	Shapiro-Wilk W Normality	0.8503	0.8975	0.0009	Non-normal Distribution

96h Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A68/CC48/M34CON	4	1	1	1	1	1	0	0	0.0%	0.0%
68/48/34 4%	4	0.975	0.956	0.994	0.9	1	0.025	0.05	5.13%	2.5%
68/48/34 9%	4	0.95	0.928	0.972	0.9	1	0.02887	0.05773	6.08%	5.0%
68/48/34 20%	4	1	1	1	1	1	0	0	0.0%	0.0%
68/48/34 40%	4	0.925	0.8886	0.9614	0.8	1	0.04787	0.09574	10.35%	7.5%
68/48/34 65%	4	0	0	0	0	0	0	0		100.0%
68/48/34 85%	4	0	0	0	0	0	0	0		100.0%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
A68/CC48/M34CON	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
68/48/34 4%	4	1.369	1.339	1.4	1.249	1.412	0.04007	0.08015	5.85%	3.04%
68/48/34 9%	4	1.331	1.295	1.366	1.249	1.412	0.04705	0.09409	7.07%	5.77%
68/48/34 20%	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
68/48/34 40%	4	1.295	1.239	1.351	1.107	1.412	0.07348	0.147	11.35%	8.28%
68/48/34 65%	4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.76%
68/48/34 85%	4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.76%

Fish 96-h Acute Survival Test

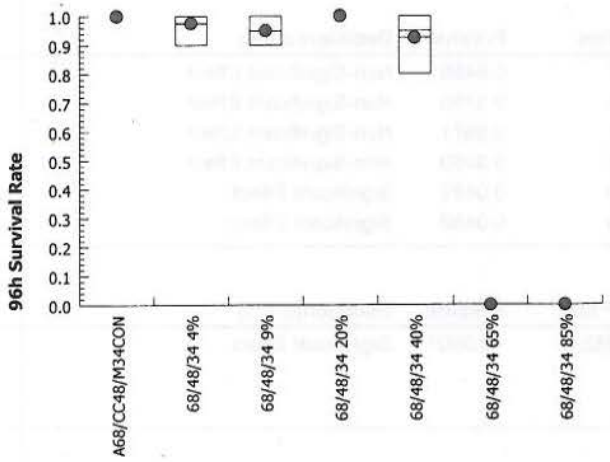
U.S. EPA Region 8 Lab

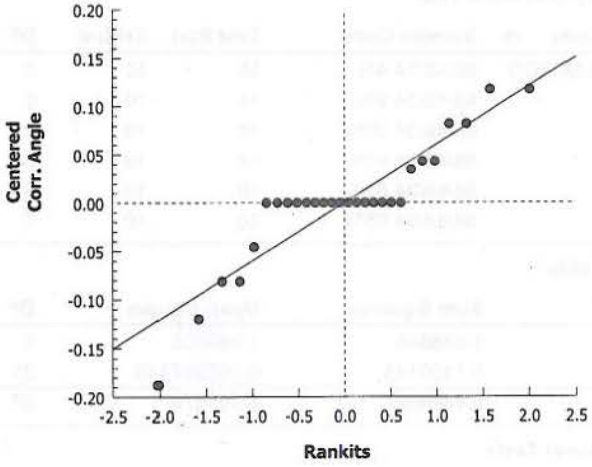
Analysis ID:	19-2177-9212	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	14 Mar-13 15:03	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4
A68/CC48/M34CON	1	1	1	1
68/48/34 4%	1	1	1	0.9
68/48/34 9%	1	0.9	1	0.9
68/48/34 20%	1	1	1	1
68/48/34 40%	0.9	1	0.8	1
68/48/34 65%	0	0	0	0
68/48/34 85%	0	0	0	0

Graphics





CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — **U.S. EPA Region I Lab**

Start Date:	02 Nov-12	**Species:**	Oncorhynchus mykiss	**Sample Code:**	1112OMARTT
End Date:	06 Nov-12	**Protocol:**	EPA/821/R-02-012 (2002)	**Sample Source:**	Reference Toxicant
Sample Date:	02 Nov-12	**Material:**	Zinc sulfate	**Sample Station:**	

Batch Note: Region 8: Acute RBT Ref Tox Test (concurrent to Nov 2012 Upper Animas SW Tox Test)

Sample Note: Region 8: Acute RBT Ref Tox Test (concurrent to Nov 2012 Upper Animas SW Tox Test)

Conc-µg/L	Code	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
0	L	1	1	10	10	10	10	10	
0	L	2	6	10	10	10	10	10	
0	L	3	22	10	10	10	10	10	
0	L	4	3	10	10	10	10	10	
55.3		1	14	10	10	10	10	10	
55.3		2	17	10	10	10	10	10	
55.3		3	16	10	10	10	10	10	
55.3		4	10	10	10	10	10	10	
107		1	4	10	10	5	5	5	
107		2	15	10	10	9	8	8	
107		3	5	10	10	9	9	9	
107		4	8	10	9	9	8	8	
220		1	9	10	10	0	0	0	
220		2	13	10	9	1	0	0	
220		3	20	10	8	1	0	0	
220		4	7	10	10	2	0	0	
435		1	11	10	6	0	0	0	
435		2	21	10	10	0	0	0	
435		3	12	10	9	0	0	0	
435		4	18	9	6	0	0	0	
874		1	24	8	5	0	0	0	
874		2	2	10	5	0	0	0	
874		3	19	10	4	0	0	0	
874		4	23	9	5	0	0	0	

CETIS Analytical Report

Test Code: 1112OMARTT | 08-3088-5134

Fish 96-h Acute Survival Test

U.S. EPA Region I Lab

Analysis ID:	12-5759-7385	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	14 Mar-13 12:01	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	0.00%	2.111	0.02053	129.1	117.5	141.9

96h Survival Rate Summary

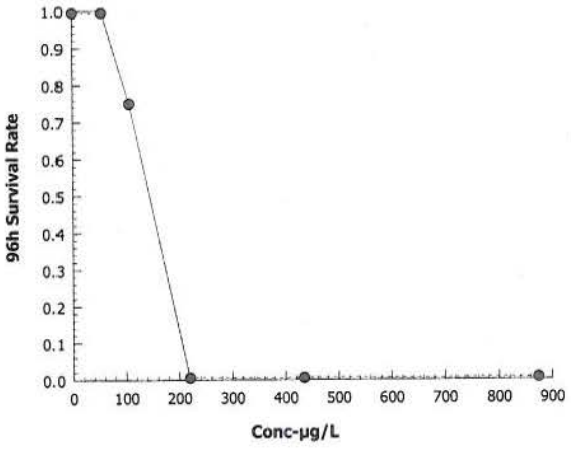
Calculated Variate(A/B)

Conc-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Lab Water	4	1	1	1	0	0	0.0%	0.0%	40	40
55.3		4	1	1	1	0	0	0.0%	0.0%	40	40
107		4	0.75	0.5	0.9	0.0866	0.1732	23.09%	25.0%	30	40
220		4	0	0	0	0	0		100.0%	0	40
435		4	0	0	0	0	0		100.0%	0	39
874		4	0	0	0	0	0		100.0%	0	37

96h Survival Rate Detail

Conc-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Lab Water	1	1	1	1
55.3		1	1	1	1
107		0.5	0.8	0.9	0.8
220		0	0	0	0
435		0	0	0	0
874		0	0	0	0

Graphics



Appendix 9b

Surface water toxicity testing report for the Upper Animas River (April 2013)

Upper Animas River
Surface Water Toxicity Testing Report
April 2013 Surface Water Collection
Final

Prepared for:

United States Environmental Protection Agency, Region 8
Ecosystem Protection and Remediation-Program Support
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September 2013

Contract No. EP-W-06-033
DCN: EP8-7-7604

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List of Acronyms

BERA	Baseline Ecological Risk Assessment
^{o}C	Degrees Celsius
CDPHE	Colorado Department of Public Health and Environment
CETIS	Comprehensive Environmental Toxicity Information System
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
LC50	50% Lethal Concentration
LCL	Lower Confidence Limit
mg/L	Milligrams per liter
MHRW	Moderately Hard Reconstituted Water
mL	Milliliter
ms/cm	Millisiemens/centimeter
QA	Quality assurance
QAPP	Quality Assurance Project Plan
SI	Site Inspection
UCL	Upper Confidence Limit
ug/L	Micrograms per liter

1.0 INTRODUCTION

Acute (96-hour), static-renewal toxicity tests were performed in April of 2013 at the United States Environmental Protection Agency (EPA) Region 8 Laboratory using juvenile rainbow trout (*Oncorhynchus mykiss*) exposed to undiluted and serially-diluted surface water samples from the Animas River, Cement Creek, and Mineral Creek collected at and downstream of the town of Silverton, CO. Three tests were performed during 2012 and 2013 to better understand the chemistry and potential acute aquatic toxicity of metal contamination in these streams associated with historical mining activities and to provide data in support of a future Baseline Ecological Risk Assessment (BERA) as part of an on-going Remedial Investigation (RI).

As a Quality Assurance (QA) measure, a simultaneous reference toxicity test with a separate batch of juvenile rainbow trout was performed using Hard Reconstituted Water (HRW) spiked with different concentrations of zinc sulfate heptahydrate (include formula). Survival was the endpoint evaluated in all tests. This report includes a brief background of the Upper Animas River area in the vicinity of Silverton, materials and methods, test results, a discussion of those results, and supporting references.

1.1 Background

The following background information was obtained from the *Baseline Sampling and Analysis Plan for Upper Cement Creek Water Quality Characterization* (EPA, 2009). The discovery of gold and silver brought miners to the Silverton area and Animas Mining District in the early 1870's. The discovery of silver in the base-metal ores was the major factor in establishing Silverton as a permanent settlement. Between 1870 and 1890, the richer ore deposits were discovered and mined to the extent possible. Not until 1890 was any serious attempt made to mine and concentrate the larger low-grade ore bodies in the area. Twelve concentration mills in the valley were sending their products to the Kendrick and Gelder Smelter near the mouth of Cement Creek by 1900. Mining and milling operations slowed down around 1905. At that point in time, the remaining mines were consolidated into fewer and larger operations with the facilities for milling large volumes of ore. Mining and milling activities continued throughout the basin after 1907, but only when prices were relatively favorable.

Gladstone, located about eight miles upstream of Silverton on Cement Creek, is the site of an historic mining town which developed in the 1880s with the onset of mining in the surrounding area. The town was the central location and railroad terminus for milling and shipping mine ores from the surrounding valley. The town declined in the 1920's and no remnants of it remain today. Only one, year-round, producing mine (Sunnyside Mine) remained in the county by the 1970's. This mine ceased production in 1991, and has since undergone extensive reclamation efforts. The Gold King Mine's permit with the Division of Reclamation, Mining and Safety (DRMS) is currently in inactive status; however, landowners hope to rehabilitate the mine.

Both the Sunnyside and Gold King properties were partially accessed through the American Tunnel which has its portal in Gladstone. Previously, this feature drained as much as 1,600 gallons per minute (gpm) of water from the mines. A lime feed and settling pond-type treatment facility was constructed in Gladstone in 1979 by Standard Metals Corporation. Water discharging from the American Tunnel was treated as required by the water discharge permit. The facility operations and mine ownership was later transferred to the Sunnyside Gold Corporation (SGC). SGC installed several bulkheads within the Sunnyside Mine under jurisdiction of a court consent decree to terminate their discharge permit. This action greatly reduced the volume of discharge from the American Tunnel. However, the tunnel currently continues to discharge 70 to 100 gpm, presumably from near-surface groundwater. SGC met all terms of the consent decree in 2002.

Numerous historic and now abandoned mines exist within a two-mile radius of Gladstone. They include: the Upper Gold King 7 Level, American Tunnel, Grand Mogul, Mogul, and Red and Bonita, Evelyne, Henrietta, Joe and John, and Lark mines. Some of these mines have acid mine drainage that flows between 30 and 300 gpm directly or indirectly into Cement Creek and eventually into the Animas River.

1.2 Objective

The objectives of the toxicity tests were to: (a) characterize the effects of mine waste-impacted surface water samples on juvenile rainbow trout under acute exposure conditions, (b) refine the understanding of the extent of toxicity in Mineral Creek, Cement Creek, and the Animas River with and without dilution, and (c) generate data to support the future BERA and RI.

2.0 MATERIALS AND METHODS

This section outlines the materials and methods used in the test, including surface water collection procedures, water preparation and delivery, test organisms, food preparation, and test conditions. The general test methods and testing criteria followed EPA protocol (EPA, 2002) and are summarized in **Table 2.5-1**.

2.1 Surface water collection

Surface water samples were collected on April 16, 2013 from the Animas River, Cement Creek, and Mineral Creek. These samples were intended to represent low-flow conditions (i.e., before the May-June snowmelt period). The weather before and during the sampling event was sunny, windy, and cool with ambient temperature in the morning around 35°C and afternoon temperature of approximately 50°C.

The surface water samples used in the toxicity tests were obtained from the following locations (see **Figure 2.1-1)**:

- *A68*: sample collected from the Animas River about 0.5 mile upstream of the confluence with Cement Creek in Silverton; this sample represents the regional conditions in the Animas River above Silverton.

- *M34*: sample collected from Mineral Creek about 0.29 miles above the confluence with the Animas River in Silverton.
- *A72*: sample collected from the Animas River about 0.71 miles downstream of the confluence with Mineral Creek below Silverton.
- *A73*: sample collected from the Animas River just above the confluence with Elk Creek, located about 5 miles downstream from A72.
- *A73B*: Sample collected from the Animas River below the confluence with Elk Creek, located about 5.1 miles downstream from A72.
- *A75B*: sample collected from the Animas River below the confluence with Cascade Creek, located about 12.80 miles downstream from A73B.
- *CC48/M34:* a mixed sample collected from Cement Creek at location CC48 and Mineral Creek at location M34 (note: CC48 is located about 0.80 miles above the confluence with the Animas River in Silverton).

Surface water samples A68, M34, A72, A73, A73B, and A75B represent composite samples collected in the mid-water column across the width of the Animas River and Mineral Creek.

Mixed surface water sample CC48/M34 was collected using a discharge-weighted approach based on the total discharge of the two creeks. As a result, this sample represented roughly two parts Mineral Creek for every one part Cement Creek.

All the surface water samples were immediately stored on ice in coolers in the field and transported to the Region 8 laboratory until use for testing. Once at the laboratory, they were placed in a cooler at 4ºC until the test started, which took place within 36 hours after the last sample was collected.

2.2 Water preparation and renewal

The water samples collected from A68, M34, A72, A73, A73B, and A75B were tested undiluted (full strength) for acute toxicity. The water sample obtained from location A72 in the Animas River was also serially diluted with HRW (laboratory control water) before these dilutions were tested for acute toxicity. Mixed water sample CC48/M34 was serially diluted twice, using the water sample obtained from location A68 and using HRW, before these two dilution series were tested separately for acute toxicity.

The HRW was prepared according to Smith *et al*. (1997) by adding 95 grams of calcium sulfate, 246 grams of magnesium sulfate heptahydrate, 192 grams of sodium bicarbonate, and 8 grams of potassium chloride to the laboratory stainless steel batch tank containing 1,000 liters of deionized water. Once the HRW was prepared, the batch tank was continuously aerated during the toxicity test. The water quality of the HRW was measured to verify that key parameters had been met, as follows: hardness between 160-180 milligrams per liter (mg/L), alkalinity between 110-120 mg/L, and pH between 7.6 and 8.0 (EPA, 2002). Actual results for HRW batch water are as follows: hardness of 176 mg/L, alkalinity of 120 mg/L, conductivity of 634 ms/cm and pH of 7.4

The exposure water in each of the test chambers was replaced daily. The renewal was achieved when >90% of the water in each vessel was replaced (measured volumetrically). Site water used for renewal was first warmed to 12 degrees Celsius (ºC) prior to use. The water temperature was held constant during the 96-hour exposure period by placing all the test chambers in a temperature-controlled water bath.

2.3 Test organisms

Juvenile (15-30 days post yolk-sac absorption) rainbow trout (*O. mykiss*) were obtained from Trout Lodge, Inc. (Sumner, Washington) for use in the toxicity tests. An importation license was obtained from the Colorado Division of Wildlife before the *O. mykiss* were shipped by the supplier. The trout were of uniform size and had an average wet weight of 0.38 grams.

The fish in the shipping bag were placed in a 20-gallon holding tank at 12°C to equilibrate the temperature after they arrived at the Region 8 laboratory. Afterwards, the shipping bag was carefully opened to allow a small amount of HRW water to enter the bag. This procedure was repeated several times throughout the day until laboratory HRW and shipping water were well mixed. The fish were then released from the shipping bag into the holding tank where they were held for five days until used for testing.

2.4 Feeding procedure

The fish were fed starter trout chow obtained from Nelson's Silver Cup, Inc. in accordance with EPA methods (EPA, 2002). The fish were fed twice each day before the test started and once daily thereafter. They were not fed for 24 hours before the start of the test to reduce waste accumulation.

2.5 Toxicity test procedures

The following subsections summarize the procedures used for the acute toxicity tests and the reference toxicity test.

All test chambers consisted of 1-L glass beakers placed in a water bath to maintain a temperature of 12º C during the 96-hour exposure period. Four replicates were tested for each water sample, including the laboratory control. The test followed the criteria specified in EPA (2002) (see also **Table 2.5-1**).

A laboratory control consisting of HRW was also tested to verify the health of the test organisms and to serve as a reference sample. Note that sample A68 was not used as a reference because it was impacted by mining-related activities or natural discharges in the watershed upstream of Silverton.

Ten fish were added to each test chamber at the start of the test using a small dip net and an 8-ounce cup, in which the count was quickly verified. Four replicate test chambers were used for each of the site and reference water samples.

Dissolved Oxygen (DO), pH, conductivity, and temperature were measured directly from each replicate. Water samples were also collected on Day 0 and Day 4 from each test chamber for the following analyses: total and dissolved metals (EPA Method 200.7/200.80), anions (EPA Method 300.0), ammonia (EPA Method 350.1), and alkalinity (EPA Method 310.1). Fish mortality was observed daily and recorded. All dead organisms were removed and discarded.

2.5.1 Profile testing of the Animas River and Mineral Creek surface water samples

The composite surface water samples collected from the Animas River (A68, A72, A73, A73B, and A75B) and Mineral Creek (M34) were tested undiluted (i.e., 100% strength).

Appendix A provides the survival and daily water chemistry data for this test. **Table 2.5-2** provides the initial and final results for total recoverable metals, whereas **Table 2.5-3** provides the initial and final results for dissolved metals. **Table 2.5-4** summarizes the initial and final wet chemistry results, whereas **Table 2.5-5** shows initial and final ammonia levels, as well as the calculated pH-adjusted acute ammonia surface water criteria for comparison.

2.5.2 Serial Dilution Toxicity Testing

2.5.2.1 Animas River water (A72) diluted by HRW

The surface water sample collected from location A72 in the Animas River was serially diluted with HRW to determine what dilutions of site water would cause acute toxicity to juvenile rainbow trout. The serial dilutions resulted in Animas River A72 surface water samples of 88%, 75%, 50%, 35%, 25%, and 12% strength.

Appendix B provides the survival and daily water chemistry data for this dilution series. **Table 2.5-2** provides the initial and final results for total recoverable metals, whereas **Table 2.5-3** provides the initial and final results for dissolved metals. **Table 2.5-4** summarizes the initial and final wet chemistry results, whereas **Table 2.5-5** shows initial and final ammonia levels, as well as the calculated pH-adjusted acute ammonia surface water criteria for comparison.

2.5.2.2 Combined Mineral Creek and Cement Creek water (M34/CC48) diluted by A68 and HRW

The stream discharge-weighted mixed surface water sample M34/CC48 was serially diluted either with HRW or with Animas River water collected upstream of Silverton (i.e., A68) to determine what dilutions would cause acute toxicity to juvenile rainbow trout. The serial dilutions resulted in M34/CC48 surface water samples of 100%, 95%, 90%, 80%, 75%, 50%, and 25% strength.

Appendices C and D provide the survival and daily water chemistry data for the A68 diluent series and HRW diluent series, respectively. **Table 2.5-2** provides the initial and final results for total recoverable metals, whereas **Table 2.5-3** provides the initial and

final results for dissolved metals. **Table 2.5-4** summarizes the initial and final wet chemistry results, whereas **Table 2.5-5** shows initial and final ammonia levels, as well as the calculated pH-adjusted acute ammonia surface water criteria for comparison.

2.5.3 Reference Toxicity Testing

For QA purposes, a reference toxicity test using juvenile rainbow trout was performed simultaneously with the site water toxicity tests. HRW was spiked with different concentrations of a zinc sulfate heptahydrate. Zinc concentrations were reduced by 50% starting with the highest target concentration until the lowest dilution of 6.25% was reached.

The following values present the dilutions and average dissolved zinc levels (obtained by averaging the initial and final dissolved zinc results) used for this reference test: 100% concentration (1075 µg/L Zn), 50% concentration (525 µg/L Zn), 25% concentration (305 µg/L), 12.5% concentration (155 µg/L Zn), and 6.25% concentration (87.7 µg/L). The zinc levels were verified in the analytical laboratory using EPA Method 200.7/200.8.

Appendix E provides the survival and daily water chemistry data for the reference toxicity test. **Table 2.5-2** provides the initial and final results for total recoverable metals, whereas **Table 2.5-3** provides the initial and final results for dissolved metals. **Table 2.5-4** summarizes the initial and final wet chemistry results, whereas **Table 2.5-5** shows initial and final ammonia levels, as well as the calculated pH-adjusted acute ammonia surface water criteria for comparison.

3.0 RESULTS

This section presents the results of the various toxicity tests performed on the surface water samples collected from the Animas River, Cement Creek, and Mineral Creek, plus the reference toxicity test.

The juvenile rainbow trout exposed to the laboratory control water (HRW) showed 100% survival after 96 hours of exposure, which exceeded the minimum performance criterion of 90% survival. As a result, all the tests discussed below are considered valid.

The Comprehensive Environmental Toxicity Information System (CETIS) statistical software package (version 1.8.0.13) was used to analyze the significance of the results discussed below.

CETIS was used to perform Analyses of Variance (ANOVAs) to identify the presence of statistically significant differences in survival measured in the profile test and serial dilution tests when compared to those measured in the laboratory control sample.

In addition, CETIS was used to calculate EC_{50} values based on the survival data from all the serial dilution tests and the reference toxicity test.

3.1 The Animas River and Mineral Creek profile test

The water quality parameters were consistent throughout this toxicity test (see **Appendix A** and **Table 2.5-5**). All DO readings remained above 6.0 mg/L, and the average test chamber temperatures fell within +/- 2ºC of the target (12ºC), which met the performance criteria for these two parameters. The ammonia measured on day 0 and day 4 remained well below the pH-adjusted and sample-specific acute ammonia criteria, indicating that ammonia levels were not a concern in this test.

The results showed 67.5% survival at A68, 15% at M34, 0% survival at A72, 97.5% survival at A73, 97.5% survival at 73B, and 100% survival at A75B (see **Appendix A** and **Figure 3.1**). The ANOVA and Steel Many-One Rank Test found no statistically significant differences when survival in A73, 73B, and A75B was compared to that measured in the control. Survival was significantly lower in A68, M34, and A72 when compared to that measured in the control (see **Attachment 1**).

3.2 A72 diluted by HRW

The water quality parameters were consistent throughout the toxicity test (see **Appendix B** and **Table 2.5-5**). All DO readings remained above 6.0 mg/L, and the average test chamber temperatures fell within +/- 2ºC of the target (12ºC), which met the performance criteria for these two parameters. The ammonia measured on day 0 and day 4 remained well below the pH-adjusted and sample-specific acute ammonia criteria, indicating that ammonia levels were not a concern in this test.

The results showed that 100% of the juvenile rainbow trout survived at all the dilutions except the 88% dilution which had a survival of 97.5% (see **Appendix B** and **Figure 3.1**).

These data were statistically analyzed using CETIS, which provided the following results:

- The ANOVA and Steel Many-One Rank Test found that survival in all the dilutions did not differ significantly from that measured in the HRW sample (see **Attachment 2**).

- CETIS selected a Linear Interpolation to calculate an EC_{50} of >88% based on the dose-response data (see **Attachment 2**).

3.3 M34/CC48 diluted by A68 and HRW

3.3.1 A68 as a diluent

The water quality parameters were consistent throughout the toxicity test (see **Appendix C** and **Table 2.5-5**). All DO readings remained above 6.0 mg/L, and the average test chamber temperatures fell within +/- 2ºC of the target (12ºC), which met the performance

criteria for these two parameters. The ammonia measured on day 0 and day 4 remained well below the pH-adjusted and sample-specific acute ammonia criteria, indicating that ammonia levels were not a concern in this test or a source of toxicity.

Survival in juvenile rainbow trout exposed for 96 hours to the CC48/M34 sample diluted with A68 surface water was as follows: 100% CC48/M34 = 0% survival; 95% CC48/M34 = 0% survival; 90% CC48/M34 = 0% survival; 80% CC48/M34 = 0% survival; 75% CC48/M34 = 0% survival; 50% CC48/M34 = 90% survival; and 25% CC48/M34 = 100% survival (see **Appendix C** and **Figure 3.2**).

These data were statistically analyzed using CETIS, which provided the following results:

- The ANOVA and Steel Many-One Rank Sum Test found that survival in the 100%, 95%, 90%, 80%, and 75% CC48/M34 samples was significantly lower than that measured in the HRW sample. Survival in the 50% and 25% CC48/M34 samples did not differ significantly from that measured in the HRW sample (see **Attachment 3**).

- CETIS selected the Spearman-Karber method to calculate an EC_{50} of 58% based on the dose-response data. This value indicated that half of the juvenile rainbow trout can be expected to die after 96 hours of exposure to a mixture consisting of 58% of CC48/M34 surface water and 42% of A68 surface water. The EC_{50} had a 95% Lower Confidence Limit (95% LCL) of 55.0% and a 95% Upper Confidence Limit (95% UCL) of 61.1% (see **Attachment 3**).

3.3.2 HRW as a diluent

The water quality parameters were consistent throughout the toxicity test (see **Appendix D** and **Table 2.5-5**). All DO readings remained above 6.0 mg/L, and the average test chamber temperatures fell within +/- 2ºC of the target (12ºC), which met the performance criteria for these two parameters. The ammonia measured on day 0 and day 4 remained well below the pH-adjusted and sample-specific acute ammonia criteria, indicating that ammonia levels were not a concern in this test.

Survival in juvenile rainbow trout exposed for 96 hours to the CC48/M34 sample diluted with HRW was as follows: 95% CC48/M34 = 0% survival; 90% CC48/M34 = 0% survival; 75% CC48/M34 = 100% survival; 50% CC48/M34 = 100% survival; and 25% CC48/M34 = 100% survival (see **Appendix D** and **Figure 3.2**).

These data were statistically analyzed using CETIS, which provided the following results:

- The ANOVA and Steel Many-One Rank Test found that survival in the 95% and 90% CC48/M34 samples were significantly lower than that measured in the HRW

sample. Survival in the 75%, 50% and 25% CC48/M34 samples did not differ significantly from that measured in the HRW sample (see **Attachment 4**).

- CETIS selected the Binomial/Graphical Estimates method to calculate an EC_{50} of 82.2% based on the dose-response data (see **Attachment 4**). This value indicated that half of juvenile rainbow trout can be expected to die after 96 hours of exposure to a mixture consisting of 82.2% of CC48/M34 surface water and 17.8% of HRW. The EC_{50} had a 95% LCL of 79.8% and a 95% UCL of 84.6% **(Attachment 4)**.

3.4 Reference Toxicity Test

A reference toxicity test was conducted simultaneously with the other toxicity tests to check for the quality of the juvenile rainbow trout. The water quality parameters were consistent throughout this test (see **Appendix E** and **Table 2.5-5**). All DO readings remained above 6.0 mg/L, and the average test chamber temperatures fell within +/- 2ºC of the target (12ºC), which met the performance criteria for these two parameters. The ammonia measured on day 0 and day 4 remained well below the pH-adjusted and sample-specific acute ammonia criteria, indicating that ammonia levels were not a concern in this test.

The zinc concentrations used in the reference toxicity test increased sequentially as follows (the % survival at the end of the 96-hour exposure period is included in parentheses): 6.25% strength = 88 µg/L (97.5% survival); 12.5% strength = 155 µg/L (85% survival); 25% strength = 305 µg/L (15% survival); 50% strength = 525 µg/L (0% survival); and 100% strength (i.e., no dilution) = 1075 µg/L (0% survival) (see **Appendix E** and **Figure 3.3**).

CETIS selected the Trimmed Spearman-Karber method to calculate an EC_{50} of 215.8 µg/L based on the dose-response data (see **Attachment 5**). This value indicated that half of juvenile rainbow trout can be expected to die after 96 hours of exposure to surface water that contains 215.8 µg/L of zinc. The EC_{50} had a LCL of 194.5 µg/L and an UCL of 239.4 µg/L(see **Attachment 5**). This value is comparable to previous reference toxicity tests performed from 2005 through 2011. **Figure 3.4** provides the zinc LC_{50} control chart which shows historical LC_{50} data obtained at the Region 8 Laboratory.

4.0 DISCUSSION

The results of the profile test showed that surface water collected from the Animas River above the confluence of Cement Creek (A68) indicated toxic effects in juvenile rainbow trout (67.5 % survival). This suggests that natural or mining-related sources of contamination further upstream in the watershed.

100% mortality was observed just below the confluence with Mineral and Cement Creeks at location A72. One contributing factor is the input of highly-toxic water from Mineral

Creek (M34 = 15% survival). In addition, and although not included in the April 2013 investigation, previous analyses of surface water samples collected from Cement Creek showed that the contaminant levels in this stream would be lethal to aquatic organisms.

The high toxicity observed at A72 was not observed in the water sample collected from A73 (95% survival), which is located about 5 miles further downstream. The most likely reason is the continuous input of water from the numerous creeks and streams that discharge to this stretch of the mainstem, thereby diluting the high metal levels observed at A72. This trend continued further downstream approximately 17 miles to A75B where100% survival was observed. It was therefore concluded that the stretch of the Animas River which is acutely toxic to juvenile rainbow trout extends for less than 5 miles below Silverton.

Results of the A72 serial dilution test support this conclusion. Even though the undiluted water sample collected at A72 was acutely toxic to juvenile rainbow trout, no mortality was observed when this sample was diluted with only 12% HRW.

The acute toxicity to juvenile rainbow trout associated with the undiluted mixed CC48/M34 sample was severe (0% survival). Note that the effect of dilution with A68 water was contradictory, as follows: undiluted (full-strength) A68 water resulted in 67.5% survival, whereas diluting the highly toxic CC48/M34 sample by half using A68 water resulted in 90% survival. It is not known what may have caused this discrepancy.

The reference toxicity test generated a 96-hour EC_{50} for the juvenile rainbow trout equal to 215.8 µg/L zinc.

5.0 REFERENCES

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U.S Environmental Protection Agency (EPA). 2002. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. 5th ed., October 2002. EPA-821-R-02-012.

U.S. Environmental Protection Agency (EPA). 2009. "Baseline Sampling and Analysis Plan for Upper Cement Creek Watershed, Gladstone, San Juan County, Colorado Revision 1". April 8, 2009.

Tables

Table 2.5-1: April 2013 Upper Animas River Surface Water Toxicity Test Summary of the Test Conditions

Test Parameter	Criterion
Test type	static renewal
Test duration	96 hour
Temperature range	12ºC +/- 2ºC
Light quality	ambient laboratory illumination
Light intensity	50-100 ft-c
Photo period	16 hours light, 8 hours dark
Test chamber size	1 liter
Test solution volume	900 mL
Renewal of test solutions	daily
Age of test organisms	RBT (15-30 days post yolk-sac absorption)
No. of replicate chambers per sample	4
No. of fish per chamber	10
No. of fish per sample	40
Feeding regime	once daily
Test chamber cleaning	cleaning not required
Test solution aeration	not to exceed 100 bubbles per minute
Dissolved oxygen concentration	≥6.0 mg/L
Dilution water used	hard reconstituted water
End point evaluated	mortality
Sample holding time	36 hours after collecting the last surface water sample in the field
Test acceptability	90% or greater survival in controls

Table 2.5-2 April 2013 Upper Animas River Surface Water Toxicity Testing

Total Recoverable Metals Initial Analytical Results (ug/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of the Animas River and Mineral Creek surface water samples																							
A68	317	<2.50U	<2.50U	<25.0U	<2.00U	2.98D	65700	7.09JD	1.42D	14.4D	213J	3.46BD	3940	3920	2.76JD	767J	<2.50U	<2.50U	2750	702	<2.50U	<10.0U	962
M34	3290	<2.50U	<2.50U	27.2JD	<2.00U	1.20D	76400	<5.00U	6.44D	7.60D	4720	11.7D	5890	433	<2.50U	809J	<2.50U	<2.50U	5680	796	<2.50U	<10.0U	317
A72	2690	<2.50U	<2.50U	<25.0U	<2.00U	2.54D	86900	<5.00U	6.51D	17.7D	4680	8.79BD	5790	2340	2.82JD	1020	<2.50U	<2.50U	4250	972	<2.50U	<10.0U	935
A73	2220	<2.50U	<2.50U	<25.0U	<2.00U	2.28D	79400	6.10JD	6.00D	15.4D	3620	7.70BD	5590	1950	2.56JD	975J	<2.50U	<2.50U	4090	874	<2.50U	<10.0U	835
A73B	1930	<2.50U	<2.50U	25.6JD	<2.00U	2.05D	75200	<5.00U	4.94D	13.0D	3220	6.81BD	5430	1860	2.86JD	960J	<2.50U	<2.50U	3950	827	<2.50U	<10.0U	798
A75B	1230	<2.50U	<2.50U	25.0JD	<2.00U	1.39D	60100	7.09JD	3.45D	7.56D	1290	4.09BD	4780	1260	<2.50U	976J	<2.50U	<2.50U	3330	640	<2.50U	<10.0U	563
Animas River surface water sample A72 serially diluted by hard reconstituted water (HRW)																							
HRW Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	23800	5.50JD	<0.500U	<2.50U	<100U	<0.500U	27100	<2.00U	<2.50U	4940	<2.50U	<2.50U	58700	158	<2.50U	<10.0U	<10.0U
HRW(A72)-88%	2440	<2.50U	<2.50U	<25.0U	<2.00U	2.21D	80500	<5.00U	6.68D	17.1D	4160	7.33D	8420	2080	3.02JD	1480	<2.50U	<2.50U	10900	877	<2.50U	<10.0U	840
HRW(A72)-75%	2120	<2.50U	<2.50U	<25.0U	<2.00U	1.82D	72200	<5.00U	5.29D	14.7D	3670	6.46D	11300	1770	2.92JD	2020	<2.50U	<2.50U	18200	773	<2.50U	<10.0U	699
HRW(A72)-50%	1190	<2.50U	<2.50U	<25.0U	<2.00U	1.30D	55600	6.38JD	3.49D	8.97D	2100	3.70D	16700	1180	<2.50U	3010	<2.50U	<2.50U	32000	570	<2.50U	<10.0U	451
HRW(A72)-35%	914	<2.50U	<2.50U	<25.0U	<2.00U	0.770JD	46100	7.08JD	2.33D	6.05D	1560	2.69BD	19700	864	<2.50U	3550	<2.50U	<2.50U	39900	502	<2.50U	<10.0U	345
HRW(A72)-25%	684	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	39300	6.94JD	1.56D	4.93JD	1170	2.24JBD	21800	582	<2.50U	3950	<2.50U	<2.50U	45300	361	<2.50U	<10.0U	225
HRW(A72)-12%	320	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	31300	5.62JD	0.550JD	<2.50U	547	1.01JBD	24600	273	<2.50U	4450	<2.50U	<2.50U	52100	255	<2.50U	<10.0U	110
Combined sample CC48/M34 serially diluted by Animas River surface water sample A68																							
A68(CC48/M34) Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	24100	7.44JD	<0.500U	<2.50U	<100U	<0.500U	27300	<2.00U	<2.50U	4910	<2.50U	<2.50U	58400	159	<2.50U	<10.0U	<10.0U
A68(CC48/M34)-100%	4330	<2.50U	<2.50U	<25.0U	<2.00U	2.46D	99800	<5.00U	12.5D	24.1D	7160	12.1BD	6870	1700	5.72D	1130	<2.50U	<2.50U	5020	1110	<2.50U	<10.0U	921
A68(CC48/M34)-95%	4210	<2.50U	<2.50U	<25.0U	<2.00U	2.50D	98100	5.23JD	10.6D	23.3D	6910	12.0BD	6770	1840	4.79JD	1120	<2.50U	<2.50U	4960	1120	<2.50U	<10.0U	940
A68(CC48/M34)-90%	3860	<2.50U	<2.50U	<25.0U	<2.00U	2.67D	96900	<5.00U	9.88D	21.7D	6430	11.2BD	6630	1900	4.57JD	1100	<2.50U	<2.50U	4840	1080	<2.50U	<10.0U	923
A68(CC48/M34)-80%	3570	<2.50U	<2.50U	<25.0U	<2.00U	2.37D	92200	5.63JD	9.44D	23.1D	5810	10.7BD	6270	2110	4.84JD	1050	<2.50U	<2.50U	4570	1040	<2.50U	<10.0U	931
A68(CC48/M34)-75%	3510	<2.50U	<2.50U	<25.0U	<2.00U	2.53D	92500	5.24JD	9.23D	22.8D	5650	11.1BD	6210	2340	4.11JD	1060	<2.50U	<2.50U	4410	1030	<2.50U	<10.0U	966
A68(CC48/M34)-50%	2300	<2.50U	<2.50U	<25.0U	<2.00U	2.57D	81400	5.23JD	6.17D	16.4D	3740	7.65BD	5320	2740	4.08JD	922J	<2.50U	<2.50U	3820	902	<2.50U	<10.0U	914
A68(CC48/M34)-25%	1350	<2.50U	<2.50U	<25.0U	<2.00U	2.83D	74000	7.10JD	4.03D	15.6D	1960	5.81BD	4710	3340	2.70JD	851J	<2.50U	<2.50U	3360	801	<2.50U	<10.0U	956
Combined sample CC48/M34 serially diluted by hard reconstituted water (HRW)																							
HRW(CC48/M34)-95%	4190	<2.50U	<2.50U	<25.0U	<2.00U	2.17D	96600	<5.00U	9.90D	20.3D	6870	11.6D	7990	1610	4.78JD	1320	<2.50U	<2.50U	7880	1070	<2.50U	<10.0U	870
HRW(CC48/M34)-90%	4050	<2.50U	<2.50U	<25.0U	<2.00U	2.07D	95400	<5.00U	9.79D	21.0D	6680	11.7D	9080	1560	4.63JD	1520	<2.50U	<2.50U	10500	1060	<2.50U	<10.0U	849
HRW(CC48/M34)-75%	3260	<2.50U	<2.50U	<25.0U	<2.00U	1.59D	80800	5.55JD	7.89D	17.1D	5190	9.18D	12000	1280	3.32JD	2090	<2.50U	<2.50U	18700	879	<2.50U	<10.0U	688
HRW(CC48/M34)-50%	2190	<2.50U	<2.50U	<25.0U	<2.00U	1.08D	62300	7.42JD	5.54D	11.6D	3560	6.16D	17200	849	2.75JD	3050	<2.50U	<2.50U	32400	644	<2.50U	<10.0U	441
HRW(CC48/M34)-25%	1190	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	42900	6.12JD	2.75D	5.83D	1850	3.41D	22500	421	<2.50U	4040	<2.50U	<2.50U	46400	399	<2.50U	<10.0U	224
Reference toxicity test																							
Ref. Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11600	8.46JD	<0.500U	<2.50U	<100U	<0.500U	13100	<2.00U	<2.50U	1990	<2.50U	<2.50U	24100	71.6	<2.50U	<10.0U	<10.0U
Ref. 100%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11700	5.64JD	<0.500U	<2.50U	<100U	<0.500U	13300	<2.00U	<2.50U	2010	<2.50U	<2.50U	24300	72.8	<2.50U	<10.0U	974
Ref. 50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11900	7.20JD	<0.500U	<2.50U	<100U	<0.500U	13600	<2.00U	<2.50U	2070	<2.50U	<2.50U	24900	72.2	<2.50U	<10.0U	480
Ref. 25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11700	5.92JD	<0.500U	<2.50U	<100U	<0.500U	13200	<2.00U	<2.50U	2000	<2.50U	<2.50U	24100	72.7	<2.50U	<10.0U	219
Ref. 12.5%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12000	<5.00U	<0.500U	<2.50U	<100U	<0.500U	13500	<2.00U	<2.50U	2050	<2.50U	<2.50U	24700	74.9	<2.50U	<10.0U	115
Ref. 6.25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11600	9.88JD	<0.500U	<2.50U	<100U	<0.500U	13100	<2.00U	<2.50U	2000	<2.50U	<2.50U	24100	72.6	<2.50U	<10.0U	80.3

Table 2.5-2 (cont'd) April 2013 Upper Animas River Surface Water Toxicity Testing

Total Recoverable Metals Final Analytical Results (ug/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of the Animas River and Mineral Creek surface water samples																							
A68	150	<2.50U	<2.50U	<25.0U	<2.00U	2.85D	70800	<5.00U	1.49D	7.41D	<100U	1.47D	4200	4090	<2.50U	1070	<2.50U	<2.50U	2840	696	<2.50U	<10.0U	982
M34	2250	<2.50U	<2.50U	26.8JD	<2.00U	1.45D	81400	<5.00U	6.16D	7.36D	4010	8.70D	6180	457	5.89D	1380	<2.50U	<2.50U	6220	824	<2.50U	<10.0U	349
A72	710	<2.50U	<2.50U	<25.0U	<2.00U	2.94D	95200	5.69JD	7.28D	11.8D	2040	1.12D	6270	2450	4.15JD	2090	<2.50U	<2.50U	5010	985	<2.50U	<10.0U	985
A73	1030	<2.50U	<2.50U	<25.0U	<2.00U	2.42D	87200	6.11JD	6.23D	8.44D	1720	3.30D	6070	2070	3.75JD	1370	<2.50U	<2.50U	4280	888	<2.50U	<10.0U	875
A73B	1050	<2.50U	<2.50U	25.1JD	<2.00U	2.13D	81400	<5.00U	5.53D	8.44D	1750	3.61D	5780	1950	3.16JD	1330	<2.50U	<2.50U	4030	831	<2.50U	<10.0U	836
A75B	1230	<2.50U	<2.50U	25.1JD	<2.00U	1.50D	65300	5.01JD	3.69D	8.17D	1450	4.31D	5120	1310	2.89JD	1370	<2.50U	<2.50U	3490	642	<2.50U	<10.0U	591
Animas River surface water sample A72 serially diluted by hard reconstituted water (HRW)																							
HRW Control	20.3J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	23400	5.08JD	<0.500U	<2.50U	<100U	<0.500U	29600	<2.00U	<2.50U	5620	<2.50U	<2.50U	62900	173	<2.50U	<10.0U	<10.0U
HRW(A72)-88%	1550	<2.50U	<2.50U	<25.0U	<2.00U	2.20D	87200	<5.00U	5.82D	9.89D	2770	4.61D	9070	2210	3.75JD	1880	<2.50U	<2.50U	11600	915	<2.50U	<10.0U	817
HRW(A72)-75%	1300	<2.50U	<2.50U	<25.0U	<2.00U	2.08D	77200	<5.00U	5.61D	9.48D	2310	4.01D	12000	1870	4.05JD	2400	<2.50U	<2.50U	19000	812	<2.50U	<10.0U	626
HRW(A72)-50%	871	<2.50U	<2.50U	<25.0U	<2.00U	1.21D	58200	<5.00U	3.49D	6.44D	1580	2.74D	17700	1220	<2.50U	3400	<2.50U	<2.50U	33100	583	<2.50U	<10.0U	377
HRW(A72)-35%	752	<2.50U	<2.50U	<25.0U	<2.00U	0.908JD	47400	<5.00U	2.52D	6.23D	1300	2.37D	21000	848	<2.50U	3990	<2.50U	<2.50U	41400	456	<2.50U	<10.0U	274
HRW(A72)-25%	366	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	39900	7.19JD	1.58D	<2.50U	504	0.928JD	23100	593	<2.50U	4410	<2.50U	<2.50U	47100	370	<2.50U	<10.0U	141
HRW(A72)-12%	206	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	31300	7.74JD	0.638JD	<2.50U	146J	<0.500U	26500	289	<2.50U	5000	<2.50U	<2.50U	55300	267	<2.50U	<10.0U	60.7
Combined sample CC48/M34 serially diluted by Animas River surface water sample A68																							
A68(CC48/M34)-Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	23000	5.59JD	<0.500U	<2.50U	<100U	<0.500U	28700	<2.00U	<2.50U	5340	<2.50U	<2.50U	60300	167	<2.50U	<10.0U	<10.0U
A68(CC48/M34)-100%	4010	<2.50U	<2.50U	<25.0U	<2.00U	2.55D	110000	<5.00U	13.0D	22.7D	1770	6.77D	7480	1820	6.19D	2260	<2.50U	<2.50U	7820	1160	<2.50U	<10.0U	1020
A68(CC48/M34)-95%	3750	<2.50U	<2.50U	<25.0U	<2.00U	2.52D	110000	5.18JD	11.8D	21.4D	1700	6.66D	7480	1970	6.04D	2190	<2.50U	<2.50U	7770	1150	<2.50U	<10.0U	1040
A68(CC48/M34)-90%	3190	<2.50U	<2.50U	<25.0U	<2.00U	2.67D	108000	5.05JD	11.0D	17.9D	1710	5.77D	7240	2040	5.53D	2320	<2.50U	<2.50U	7680	1100	<2.50U	<10.0U	1010
A68(CC48/M34)-80%	2140	<2.50U	<2.50U	<25.0U	<2.00U	2.39D	99400	5.06JD	9.64D	17.2D	1660	4.26D	6650	2200	4.46JD	1930	<2.50U	<2.50U	7000	1040	<2.50U	<10.0U	1010
A68(CC48/M34)-75%	1710	<2.50U	<2.50U	<25.0U	<2.00U	2.55D	99400	5.03JD	9.16D	16.3D	1860	3.96D	6640	2350	4.90JD	2090	<2.50U	<2.50U	7030	1030	<2.50U	<10.0U	1010
A68(CC48/M34)-50%	1080	<2.50U	<2.50U	<25.0U	<2.00U	2.47D	87800	5.89JD	6.34D	10.1D	1840	3.69D	5710	2900	3.00JD	1360	<2.50U	<2.50U	4210	913	<2.50U	<10.0U	960
A68(CC48/M34)-25%	384	<2.50U	<2.50U	<25.0U	<2.00U	2.70D	78700	5.89JD	4.07D	6.39D	498	1.73D	4980	3480	2.71JD	1200	<2.50U	<2.50U	3560	803	<2.50U	<10.0U	815
Combined sample CC48/M34 serially diluted by hard reconstituted water (HRW)																							
HRW(CC48/M34)-95%	2680	<2.50U	<2.50U	<25.0U	<2.00U	2.25D	106000	<5.00U	11.0D	17.7D	2680	5.33D	8570	1760	5.15D	2550	<2.50U	<2.50U	10800	1150	<2.50U	<10.0U	988
HRW(CC48/M34)-90%	1490	<2.50U	<2.50U	<25.0U	<2.00U	1.98D	102000	<5.00U	9.37D	14.2D	2780	3.92D	9610	1630	5.02D	2850	<2.50U	<2.50U	13400	1080	<2.50U	<10.0U	908
HRW(CC48/M34)-75%	2260	<2.50U	<2.50U	<25.0U	<2.00U	1.70D	87200	<5.00U	7.97D	12.0D	3980	6.52D	12900	1360	4.70JD	2470	<2.50U	<2.50U	19700	931	<2.50U	<10.0U	670
HRW(CC48/M34)-50%	2220	<2.50U	<2.50U	<25.0U	<2.00U	1.04D	66200	<5.00U	5.12D	10.1D	3830	6.37D	18700	900	2.91JD	3530	<2.50U	<2.50U	34400	669	<2.50U	<10.0U	456
HRW(CC48/M34)-25%	865	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	43600	<5.00U	2.61D	5.66D	1480	2.46D	24100	440	<2.50U	4590	<2.50U	<2.50U	48900	423	<2.50U	<10.0U	195
Reference toxicity test																							
Ref. 100%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11200	5.46JD	<0.500U	<2.50U	<100U	<0.500U	12500	<2.00U	<2.50U	1930	<2.50U	<2.50U	22400	67.3	<2.50U	<10.0U	1120
Ref. 50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11200	5.82JD	<0.500U	<2.50U	<100U	<0.500U	12600	<2.00U	<2.50U	1920	<2.50U	<2.50U	22700	68.1	<2.50U	<10.0U	623
Ref. 25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	11100	<5.00U	<0.500U	<2.50U	<100U	<0.500U	12500	<2.00U	<2.50U	1930	<2.50U	<2.50U	22500	68.0	<2.50U	<10.0U	299
Ref. 12.5%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	10900	<5.00U	<0.500U	<2.50U	<100U	<0.500U	12600	<2.00U	<2.50U	2210	<2.50U	<2.50U	22700	67.6	<2.50U	<10.0U	182
Ref. 6.25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	10800	6.66JD	<0.500U	<2.50U	<100U	<0.500U	12600	<2.00U	<2.50U	2180	<2.50U	<2.50U	22700	67.0	<2.50U	<10.0U	89.8
Ref. Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	10900	7.11JD	<0.500U	<2.50U	<100U	<0.500U	12700	<2.00U	<2.50U	2240	<2.50U	<2.50U	22900	69.0	<2.50U	<10.0U	<10.0U

Table 2.5-3 April 2013 Upper Animas River Surface Water Toxicity Testing
Dissolved Metals Initial Analytical Results (ug/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Hardness (mg/L)	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of the Animas River and Mineral Creek surface water samples																								
A68	38.5J	<0.500U	<0.500U	23.7	<2.00U	3.11	70600	1.68J	1.44	3.70	194	<100U	0.134J	4260	3960	1.49	765J	<0.500U	<0.500U	2910	695	<0.500U	<2.00U	994
M34	887	<0.500U	<0.500U	25.7	<2.00U	1.20	80700	<1.00U	6.10	7.35	227	3170	5.16	6210	444	2.04	829J	<0.500U	<0.500U	5830	809	<0.500U	<2.00U	335
A72	694	<0.500U	<0.500U	22.4	<2.00U	2.74	91900	<1.00U	7.39	13.4	255	2720	1.27	6160	2380	3.63	1010	0.705J	<0.500U	4440	974	<0.500U	<2.00U	979
A73	187	<0.500U	<0.500U	23.6	<2.00U	2.32	85000	<1.00U	5.82	6.06	237	1310	<0.100U	5980	2000	3.54	998J	<0.500U	<0.500U	4300	876	<0.500U	<2.00U	892
A73B	145	<0.500U	<0.500U	24.6	<2.00U	2.25	80800	<1.00U	5.73	5.60	226	1150	0.704	5860	1870	3.86	999J	0.609J	<0.500U	4180	827	<0.500U	<2.00U	825
A75B	24.3J	<0.500U	<0.500U	25.3	<2.00U	1.58	65100	<1.00U	3.64	1.16	184	<100U	1.02	5190	1270	2.84	998J	0.654J	<0.500U	3540	641	<0.500U	<2.00U	566
Animas River surface water sample A72 serially diluted by hard reconstituted water (HRW)																								
HRW Control	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	24200	6.30	<0.100U	<0.500U	176	<100U	<0.100U	28100	<2.00U	<0.500U	4860	<0.500U	<0.500U	59900	154	<0.500U	<2.00U	<10.0U
HRW(A72)-88%	67.1	<0.500U	<0.500U	19.2	<2.00U	2.38	85700	<1.00U	5.61	6.36	251	2010	0.212	8900	2120	3.02	1520	<0.500U	<0.500U	11200	878	<0.500U	<2.00U	859
HRW (A72)-75%	69.1	<0.500U	<0.500U	16.1	<2.00U	1.92	77800	1.24J	5.06	4.31	244	1800	0.106J	12100	1820	3.12	2080	<0.500U	<0.500U	19000	781	<0.500U	<2.00U	725
HRW(A72)-50%	68.2	<0.500U	<0.500U	10.7	<2.00U	1.13	59700	2.50	3.38	0.933J	223	653	<0.100U	17800	1210	1.70	3110	<0.500U	<0.500U	33000	569	<0.500U	<2.00U	399
HRW(A72)-35%	84.2	<0.500U	<0.500U	7.65J	<2.00U	0.667	49700	4.27	2.29	<0.500U	211	141J	<0.100U	21100	846	1.29	3690	<0.500U	<0.500U	41200	446	<0.500U	<2.00U	216
HRW(A72)-25%	123	<0.500U	0.596J	5.81J	<2.00U	0.359	41900	4.82	1.67	1.06	200	<100U	<0.100U	23200	590	1.39	4060	<0.500U	<0.500U	47100	361	<0.500U	<2.00U	111
HRW(A72)-12%	80.6	<0.500U	<0.500U	<5.00U	<2.00U	0.178J	32800	6.33	0.733	1.70	190	218J	<0.100U	26300	270	0.832J	4590	<0.500U	<0.500U	54900	249	<0.500U	<2.00U	93.6
Combined sample CC48/M34 serially diluted by Animas River surface water sample A68																								
A68(CC48/M34) Contro	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	25300	6.77	<0.100U	<0.500U	183	<100U	0.230	29000	<2.00U	<0.500U	5000	<0.500U	<0.500U	60600	159	<0.500U	<2.00U	<10.0U
A68(CC48/M34)-100%	2910	<0.500U	<0.500U	21.2	<2.00U	2.51	106000	<1.00U	10.1	20.1	294	3900	8.64	7280	1760	4.46	1130	0.813J	<0.500U	5210	1140	<0.500U	<2.00U	1020
A68(CC48/M34)-95%	2800	<0.500U	<0.500U	21.6	<2.00U	2.48	105000	<1.00U	11.2	21.2	293	3780	8.26	7250	1880	4.76	1120	<0.500U	<0.500U	5180	1120	<0.500U	<2.00U	1010
A68(CC48/M34)-90%	2680	<0.500U	<0.500U	21.2	<2.00U	2.57	104000	<1.00U	9.85	19.7	291	3460	7.67	7200	1960	4.27	1130	<0.500U	<0.500U	5160	1090	<0.500U	<2.00U	994
A68(CC48/M34)-80%	2290	<0.500U	<0.500U	21.8	<2.00U	2.68	99000	<1.00U	9.22	18.7	275	2480	5.93	6740	2150	3.80	1060	<0.500U	<0.500U	4840	1030	<0.500U	<2.00U	977
A68(CC48/M34)-75%	2110	<0.500U	<0.500U	21.8	<2.00U	2.82	98600	<1.00U	8.15	16.5	274	2230	5.08	6680	2400	3.67	1070	<0.500U	<0.500U	4690	1050	<0.500U	<2.00U	1030
A68(CC48/M34)-50%	553	<0.500U	<0.500U	22.6	<2.00U	2.76	88300	<1.00U	6.30	9.84	244	1610	1.67	5800	2860	3.26	939J	<0.500U	<0.500U	4100	919	<0.500U	<2.00U	1010
A68(CC48/M34)-25%	102	<0.500U	<0.500U	23.0	<2.00U	2.93	77500	<1.00U	3.70	3.97	214	787	0.365	4940	3390	2.39	851J	<0.500U	<0.500U	3470	806	<0.500U	<2.00U	972
Combined sample CC48/M34 serially diluted by hard reconstituted water (HRW)																								
HRW(CC48/M34)-95%	2770	<0.500U	<0.500U	20.2	<2.00U	2.30	103000	<1.00U	10.2	19.4	293	3320	6.67	8510	1670	4.61	1390	<0.500U	<0.500U	8210	1100	<0.500U	<2.00U	944
HRW(CC48/M34)-90%	1980	<0.500U	<0.500U	18.7	<2.00U	2.09	97700	<1.00U	9.36	18.0	283	3110	4.91	9400	1580	4.41	1540	<0.500U	<0.500U	10800	1050	<0.500U	<2.00U	902
HRW(CC48/M34)-75%	248	<0.500U	<0.500U	15.7	<2.00U	1.73	86100	1.22J	8.30	7.68	267	2380	0.465	12700	1300	4.79	2160	<0.500U	<0.500U	19300	887	<0.500U	<2.00U	710
HRW(CC48/M34)-50%	39.2J	<0.500U	<0.500U	10.9	<2.00U	1.16	66600	2.68	5.29	1.81	242	1520	0.113J	18300	864	3.00	3170	<0.500U	<0.500U	33700	647	<0.500U	<2.00U	427
HRW(CC48/M34)-25%	126	<0.500U	<0.500U	5.61J	<2.00U	0.351	44900	3.74	2.32	0.987J	210	305	0.120J	23800	433	1.39	4090	<0.500U	<0.500U	47900	402	<0.500U	<2.00U	154
Reference toxicity test																								
Ref. 100%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	12700	2.67	<0.100U	<0.500U	90	<100U	<0.100U	14200	<2.00U	<0.500U	2110	<0.500U	<0.500U	25100	73.1	<0.500U	<2.00U	1050
Ref. 50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	12600	3.19	<0.100U	<0.500U	89	<100U	<0.100U	14100	<2.00U	<0.500U	2090	<0.500U	<0.500U	25100	73.6	<0.500U	<2.00U	478
Ref. 25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	12600	2.47	<0.100U	<0.500U	90	<100U	<0.100U	14100	<2.00U	<0.500U	2100	<0.500U	<0.500U	25100	73.0	<0.500U	<2.00U	314
Ref. 12.5%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	12400	2.85	<0.100U	<0.500U	88	<100U	<0.100U	13800	<2.00U	<0.500U	2050	<0.500U	<0.500U	24400	74.2	<0.500U	<2.00U	128
Ref. 6.25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	12700	2.88	<0.100U	<0.500U	90	<100U	<0.100U	14200	<2.00U	<0.500U	2120	<0.500U	<0.500U	25300	73.2	<0.500U	<2.00U	85.6
Ref. Control	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	12500	3.02	<0.100U	<0.500U	89	<100U	0.360	14000	<2.00U	<0.500U	2090	<0.500U	<0.500U	25000	73.6	<0.500U	<2.00U	<10.0U

Table 2.5-3 (cont'd) April 2013 Upper Animas River Surface Water Toxicity Testing
Dissolved Metals Final Analytical Results (ug/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Hardness (mg/l)	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Profile test of the Animas River and Mineral Creek surface water samples																								
A68	41.3J	<0.500U	<0.500U	22.8	<2.00U	2.79	69400	1.52J	1.25	3.48	191	<100U	<0.100U	4180	3920	1.34	1050	0.538J	<0.500U	2840	689	<0.500U	<2.00U	905
M34	761	<0.500U	<0.500U	25.2	<2.00U	1.19	79500	<1.00U	7.13	7.09	224	2530	3.75	6140	438	2.72	1400	<0.500U	<0.500U	6210	791	<0.500U	<2.00U	337
A72	562	<0.500U	<0.500U	22.7	<2.00U	2.60	95900	<1.00U	7.24	13.2	265	1850	0.907	6280	2460	3.16	1950	0.875J	<0.500U	4940	1010	<0.500U	<2.00U	1010
A73	35.1J	<0.500U	<0.500U	23.8	<2.00U	2.17	85600	<1.00U	5.93	3.26	238	<100U	<0.100U	5940	2000	3.27	1360	0.581J	<0.500U	4190	855	<0.500U	<2.00U	857
A73B	26.2J	<0.500U	<0.500U	24.5	<2.00U	1.95	80900	<1.00U	5.43	2.71	226	<100U	<0.100U	5740	1880	3.54	1290	0.792J	<0.500U	3990	816	<0.500U	<2.00U	796
A75B	20.0J	<0.500U	<0.500U	25.1	<2.00U	1.40	67000	<1.00U	3.60	2.37	189	<100U	<0.100U	5300	1290	3.15	1380	0.932J	<0.500U	3620	647	<0.500U	<2.00U	525
Animas River surface water sample A72 serially diluted by hard reconstituted water (HRW)																								
HRW Control	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	23500	6.03	<0.100U	0.712J	181	<100U	<0.100U	29700	<2.00U	<0.500U	5630	<0.500U	<0.500U	62300	169	<0.500U	<2.00U	<10.0U
HRW(A72)-88%	24.2J	<0.500U	<0.500U	18.4	<2.00U	1.97	82300	<1.00U	5.78	1.29	241	<100U	<0.100U	8680	2040	3.19	1830	0.557J	<0.500U	11100	865	<0.500U	<2.00U	679
HRW(A72)-75%	31.6J	<0.500U	<0.500U	15.7	<2.00U	1.49	75300	<1.00U	5.13	1.11	237	<100U	<0.100U	11900	1780	2.19	2380	<0.500U	<0.500U	18800	768	<0.500U	<2.00U	453
HRW(A72)-50%	48.1J	<0.500U	<0.500U	10.6	<2.00U	0.854	57900	2.10	3.35	1.44	218	<100U	<0.100U	17800	1060	2.03	3500	<0.500U	<0.500U	33300	522	<0.500U	<2.00U	200
HRW(A72)-35%	79.1	<0.500U	<0.500U	7.55J	<2.00U	0.465	46400	2.94	2.16	1.26	201	<100U	0.113J	20800	808	0.930J	3980	<0.500U	<0.500U	41600	446	<0.500U	<2.00U	108
HRW(A72)-25%	91.3	<0.500U	<0.500U	5.31J	<2.00U	0.259	37000	4.99	1.44	1.35	182	<100U	<0.100U	21700	538	1.44	4140	0.717J	<0.500U	44900	340	<0.500U	<2.00U	68.9
HRW(A72)-12%	136	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	30400	5.66	0.611	1.59	182	<100U	<0.100U	25800	271	1.01	4820	0.727J	<0.500U	53500	256	<0.500U	<2.00U	37.2
Combined sample CC48/M34 serially diluted by Animas River surface water sample A68																								
A68(CC48/M34)-Control	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	23400	6.52	<0.100U	<0.500U	179	<100U	<0.100U	29300	<2.00U	<0.500U	5430	0.736J	<0.500U	61400	169	<0.500U	<2.00U	<10.0U
A68(CC48/M34)-100%	4040	<0.500U	<0.500U	21.2	<2.00U	2.42	109000	<1.00U	10.5	19.8	304	1650	6.43	7480	1760	4.79	2260	0.765J	<0.500U	7780	1130	<0.500U	<2.00U	998
A68(CC48/M34)-95%	3540	<0.500U	<0.500U	21.1	<2.00U	2.41	104000	<1.00U	9.79	19.4	289	1520	5.75	7050	1830	5.14	2020	0.773J	<0.500U	7320	1100	<0.500U	<2.00U	948
A68(CC48/M34)-90%	3040	<0.500U	<0.500U	22.3	<2.00U	2.46	102000	<1.00U	9.47	17.3	285	1510	5.18	6960	1930	4.16	2240	0.781J	<0.500U	7460	1070	<0.500U	<2.00U	965
A68(CC48/M34)-80%	1970	<0.500U	<0.500U	21.7	<2.00U	2.48	97700	<1.00U	8.48	16.2	271	1170	3.52	6590	2110	4.19	1920	1.02J	<0.500U	6980	1010	<0.500U	<2.00U	959
A68(CC48/M34)-75%	1470	<0.500U	<0.500U	22.5	<2.00U	2.53	100000	<1.00U	7.79	13.9	278	1340	2.99	6760	2290	3.94	2100	1.13J	<0.500U	7150	1030	<0.500U	<2.00U	982
A68(CC48/M34)-50%	32.9J	<0.500U	<0.500U	21.9	<2.00U	2.48	87700	<1.00U	5.56	1.92	242	220J	<0.100U	5690	2820	2.70	1320	<0.500U	<0.500U	4170	894	<0.500U	<2.00U	915
A68(CC48/M34)-25%	37.2J	<0.500U	<0.500U	22.9	<2.00U	2.59	80000	<1.00U	3.64	1.95	221	<100U	<0.100U	5070	3640	2.52	1220	1.08J	<0.500U	3610	853	<0.500U	<2.00U	798
Combined sample CC48/M34 serially diluted by hard reconstituted water (HRW)																								
HRW(CC48/M34)-95%	2560	<0.500U	<0.500U	20.2	<2.00U	2.32	103000	<1.00U	10.1	16.0	292	2140	4.52	8480	1650	3.95	2580	<0.500U	<0.500U	10800	1090	<0.500U	<2.00U	909
HRW(CC48/M34)-90%	1110	<0.500U	<0.500U	18.8	<2.00U	2.10	96600	<1.00U	9.89	13.1	280	1970	2.71	9360	1540	4.48	2890	<0.500U	<0.500U	13200	1030	<0.500U	<2.00U	854
HRW(CC48/M34)-75%	30.1J	<0.500U	<0.500U	15.5	<2.00U	1.51	84800	<1.00U	8.03	1.50	265	<100U	<0.100U	12800	1290	3.45	2500	<0.500U	<0.500U	19700	895	<0.500U	<2.00U	523
HRW(CC48/M34)-50%	63.2	<0.500U	<0.500U	10.4	<2.00U	0.655	64200	1.51J	4.89	1.42	235	<100U	<0.100U	18200	842	2.14	3470	<0.500U	<0.500U	33600	643	<0.500U	<2.00U	120
HRW(CC48/M34)-25%	123	<0.500U	<0.500U	5.33J	<2.00U	0.196J	42700	3.24	2.26	1.43	204	<100U	<0.100U	23600	402	1.20	4510	<0.500U	<0.500U	48300	398	<0.500U	<2.00U	43.6
Reference toxicity test																								
Ref. 100%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	10800	1.80J	<0.100U	0.668J	77	<100U	<0.100U	12100	<2.00U	<0.500U	1880	0.537J	<0.500U	21700	64.3	<0.500U	<2.00U	1100
Ref. 50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	10700	2.07	<0.100U	0.562J	76	<100U	<0.100U	12000	<2.00U	<0.500U	1860	<0.500U	<0.500U	21600	63.4	<0.500U	<2.00U	571
Ref. 25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	11100	1.93J	<0.100U	<0.500U	79	<100U	<0.100U	12500	<2.00U	<0.500U	1930	<0.500U	<0.500U	22300	64.9	<0.500U	<2.00U	295
Ref. 12.5%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	10800	2.32	<0.100U	0.527J	78	<100U	<0.100U	12400	<2.00U	<0.500U	2180	<0.500U	<0.500U	22300	65.4	<0.500U	<2.00U	182
Ref. 6.25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	10900	2.48	<0.100U	0.502J	79	<100U	<0.100U	12500	<2.00U	<0.500U	2190	<0.500U	<0.500U	22400	65.5	<0.500U	<2.00U	89.8
Ref. Control	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	11000	2.99	<0.100U	0.566J	79	<100U	<0.100U	12600	<2.00U	<0.500U	2240	<0.500U	<0.500U	22500	65.5	<0.500U	<2.00U	<10.0U

Table 2.5-4 April 2013 Upper Animas River Surface Water Toxicity Testing
Initial Wet Chemistry Results (mg/L)

STATION_ID	Chloride	Dissolved Organic Carbon	Fluoride	Nitrate/Nitrite as N	Sulfate as SO4	Total Alkalinity (mg CaCO3 / L)
Profile test of the Animas River and Mineral Creek surface water samples						
A68	2.8	1.1	0.8	0.2J	178	34.1
M34	11.4JD	1.3	<1.0U	<2.0U	237D	<5.00U
A72	<10.0U	1.2	<1.0U	<2.0U	264D	<5.00U
A73	<10.0U	1.2	<1.0U	<2.0U	237D	<5.00U
A73B	3.6	1.1	0.5	<0.2U	244	<5.00U
A75B	3.0	1.2	0.5	0.2J	193	11.6
Animas River surface water sample A72 serially diluted by hard reconstituted water (HRW)						
HRW Control	4.8	1.0	<0.1U	<0.2U	206	123
HRW(A72)-88%	10.2JD	1.2	<1.0U	<2.0U	253D	9.14
HRW(A72)-75%	10.7JD	1.1	<1.0U	249D	249D	26.6
HRW(A72)-50%	4.1	1.1	0.5	<0.2U	247	55.4
HRW(A72)-35%	4.3	1.2	0.4	<0.2U	235	76.1
HRW(A72)-25%	4.5	1.0	0.2	<0.2U	227	87.5
HRW(A72)-12%	4.6	1.0	0.2	<0.2U	217	106
Combined sample CC48/M34 serially diluted by Animas River surface water sample A68						
A68(CC48/M34) Control	4.7	1.1	<0.1U	<0.2U	204	120
A68(CC48/M34)-100%	<10.0U	1.3	<1.0U	<2.0U	319D	<5.00U
A68(CC48/M34)-95%	<10.0U	1.2	1.0JD	<2.0U	314D	<5.00U
A68(CC48/M34)-90%	<10.0U	1.2	<1.0U	<2.0U	303D	<5.00U
A68(CC48/M34)-80%	<10.0U	1.2	1.0JD	<2.0U	287D	<5.00U
A68(CC48/M34)-75%	<10.0U	1.2	<1.0U	<2.0U	284D	<5.00U
A68(CC48/M34)-50%	13.6JD	1.1	1.1JD	9.0D	249D	5.36
A68(CC48/M34)-25%	3.0	1.1	0.7	0.3J	221	16.6
Combined sample CC48/M34 serially diluted by hard reconstituted water (HRW)						
HRW(CC48/M34)-95%	10.2JD	1.3	1.0JD	<2.0U	319D	<5.00U
HRW(CC48/M34)-90%	10.2JD	1.3	1.0JD	<2.0U	310D	<5.00U
HRW(CC48/M34)-75%	10.4JD	1.2	<1.0U	<2.0U	293D	12.6
HRW(CC48/M34)-50%	11.0JD	1.1	<1.0U	<2.0U	260D	47.9
HRW(CC48/M34)-25%	11.0JD	1.1	<1.0U	<2.0U	224D	83.5
Reference toxicity test						
Ref. Control	2.4	<1.0U	<0.1U	<0.2U	93.8	56.2
Ref. 100%	2.3	<1.0U	<0.1U	<0.2U	94.6	56.8
Ref. 50%	2.3	<1.0U	<0.1U	<0.2U	94.0	56.9
Ref. 25%	2.3	1.0	<0.1U	<0.2U	93.4	60.4
Ref. 12.5%	2.3	<1.0U	<0.1U	<0.2U	93.4	53.7
Ref. 6.25%	2.4	<1.0U	<0.1U	<0.2U	93.6	55.4

Table 2.5-4 (cont'd) April 2013 Upper Animas River Surface Water Toxicity Testing
Final Wet Chemistry Results (mg/L)

STATION_ID	Chloride	Dissolved Organic Carbon	Fluoride	Nitrate as N	Nitrate/Nitrite as N	Nitrite as N	Sulfate as SO4	Total Alkalinity (mg CaCO3 / L)
Profile test of the Animas River and Mineral Creek surface water samples								
A68	2.7	1.5	0.7	0.2J	0.2J	<0.2U	172	38.0
M34	12.5JD	2.5	<1.0U	<2.0U	<2.0U	<2.0U	237D	<5.00U
A72	11.1JD	3.6	<1.0U	<2.0U	<2.0U	<2.0U	265D	<5.00U
A73	10.1JD	1.6	<1.0U	<2.0U	<2.0U	<2.0U	242D	9.98
A73B	3.6	1.6	0.5	0.3J	0.3J	<0.2U	244	8.16
A75B	3.1	1.5	0.5	0.2J	0.2J	<0.2U	195	17.9
Animas River surface water sample A72 serially diluted by hard reconstituted water (HRW)								
HRW Control	4.9	1.2	<0.1U	<0.2U	<0.2U	<0.2U	210	125
HRW(A72)-88%	10.4JD	1.2	<1.0U	<2.0U	<2.0U	<2.0U	262D	12.0
HRW(A72)-75%	10.4JD	1.3	<1.0U	<2.0U	<2.0U	<2.0U	250D	28.8
HRW(A72)-50%	4.3	1.5	0.4	<0.2U	0.2J	<0.2U	248	57.0
HRW(A72)-35%	4.4	1.3	0.3	<0.2U	<0.2U	<0.2U	236	77.9
HRW(A72)-25%	4.6	1.2	0.2	<0.2U	<0.2U	<0.2U	229	90.4
HRW(A72)-12%	4.7	1.4	0.1J	<0.2U	<0.2U	<0.2U	218	104
Combined sample CC48/M34 serially diluted by Animas River surface water sample A68								
A68(CC48/M34)-Control	4.8	1.3	<0.1U	<0.2U	<0.2U	<0.2U	202	122
A68(CC48/M34)-100%	12.5JD	2.4	<1.0U	<2.0U	<2.0U	<2.0U	315D	<5.00U
A68(CC48/M34)-95%	12.8JD	2.3	<1.0U	<2.0U	<2.0U	<2.0U	309D	<5.00U
A68(CC48/M34)-90%	13.4JD	2.6	1.0JD	<2.0U	<2.0U	<2.0U	305D	<5.00U
A68(CC48/M34)-80%	12.9JD	2.1	<1.0U	<2.0U	<2.0U	<2.0U	286D	<5.00U
A68(CC48/M34)-75%	12.9JD	2.3	<1.0U	<2.0U	<2.0U	<2.0U	279D	<5.00U
A68(CC48/M34)-50%	10.9JD	1.6	<1.0U	<2.0U	<2.0U	<2.0U	242D	7.01
A68(CC48/M34)-25%	3.1	1.4	0.8	0.2J	0.2J	<0.2U	220	22.8
Combined sample CC48/M34 serially diluted by hard reconstituted water (HRW)								
HRW(CC48/M34)-95%	13.1JD	2.7	<1.0U	<2.0U	<2.0U	<2.0U	318D	<5.00U
HRW(CC48/M34)-90%	13.6JD	3.1	<1.0U	<2.0U	<2.0U	<2.0U	312D	<5.00U
HRW(CC48/M34)-75%	10.3JD	1.4	<1.0U	<2.0U	<2.0U	<2.0U	298D	13.5
HRW(CC48/M34)-50%	10.6JD	1.2	<1.0U	<2.0U	<2.0U	<2.0U	266D	50.1
HRW(CC48/M34)-25%	11.0JD	1.3	<1.0U	<2.0U	<2.0U	<2.0U	226D	85.0
Reference toxicity test								
Ref. 100%	2.2	1.1	<0.1U	<0.2U	<0.2U	<0.2U	83.6	52.6
Ref. 50%	2.2	1.0	<0.1U	<0.2U	<0.2U	<0.2U	83.3	50.4
Ref. 25%	2.1	1.0	<0.1U	<0.2U	<0.2U	<0.2U	84.2	55.1
Ref. 12.5%	2.2	1.0	<0.1U	<0.2U	<0.2U	<0.2U	84.3	53.1
Ref. 6.25%	2.3	1.3	<0.1U	<0.2U	<0.2U	<0.2U	84.4	55.4
Ref. Control	2.2	1.2	<0.1U	<0.2U	<0.2U	<0.2U	84.6	55.6

Table 2.5-5 April 2013 Upper Animas River Surface Water Toxicity Testing Initial and Final Ammonia Concentrations

Site ID	Day 0 Measured Ammonia Conc. (mg N/L)	Day 0 Measured pH	Day 0 Average Measured Ammonia Conc. (mg N/L)	Day 0 Average Measured pH	Day 0 Ammonia Criterion (mg N/L)	Day 4 Measured Ammonia Conc. (mg N/L)[a]	Day 4 Measured pH[a]	Day 4 Average Measured Ammonia Conc. (mg N/L)	Day 4 Average Measured pH	Day 4 Ammonia Criterion (mg N/L)
PROFILE TEST										
A68	0.04941	7.69	0.0511	7.73	9.20	1.279	6.72	1.1385	6.83	27.54
	0.05017	7.80				0.7289	6.82			
	0.05237	7.71				1.456	6.85			
	0.0524	7.71				1.09	6.92			
M34	0.0354	4.82	0.0357	4.98	38.77	0.479	5.30	0.4880	5.22	38.60
	0.03068	4.92				0.5033	5.19			
	0.03706	5.11				0.4492	5.21			
	0.03953	5.05				0.5204	5.19			
A72	0.08822	5.73	0.0880	5.73	37.74	0.5133	5.85	0.6968	5.67	37.89
	0.08951	5.75				0.396	5.59			
	0.0889	5.73				0.5868	5.62			
	0.08529	5.72				1.291	5.63			
A73	0.08014	7.19	0.0804	7.11	21.72	1.668	6.52	1.6413	6.47	32.97
	0.08095	7.15				1.696	6.47			
	0.0802	7.17				1.636	6.45			
	0.08044	6.93				1.565	6.44			
A73B	0.08696	7.50	0.0893	7.52	12.94	1.767	6.56	1.5815	6.52	32.42
	0.0889	7.86				1.615	6.54			
	0.08929	7.40				1.255	6.45			
	0.09208	7.31				1.689	6.51			
A75B	0.07997	7.76	0.0804	7.76	8.66	1.261	6.50	1.4880	6.55	31.97
	0.07763	7.74				1.491	6.54			
	0.08376	7.75				1.754	6.56			
	0.08015	7.80				1.446	6.60			
SERIAL DILUTION OF SAMPLE A72 WITH HRW AS THE DILUENT										
HRW Control	0.03003	7.74	0.0280	7.96	6.03	1.997	7.68	1.7413	7.83	7.72
	0.03007	7.87				1.783	7.77			
	0.02451	8.08				1.545	7.89			
	0.02743	8.16				1.64	7.97			
HRW(A72)-88%	0.0807	6.96	0.0807	6.86	26.93	1.286	7.28	1.4338	7.28	18.00
	0.08067	6.90				1.479	7.26			
	0.0812	6.81				1.46	7.28			
	0.08004	6.77				1.51	7.29			
HRW(A72)-75%	0.07393	7.27	0.0730	7.15	20.78	1.4	7.42	1.4233	7.36	16.20
	0.07544	7.20				1.368	7.32			
	0.07246	7.12				1.424	7.34			
	0.07019	7.02				1.501	7.36			
HRW(A72)-50%	0.06039	7.68	0.0609	7.52	12.84	1.487	7.70	1.4498	7.58	11.70
	0.06181	7.53				1.454	7.56			
	0.0592	7.44				1.458	7.53			
	0.06233	7.44				1.4	7.54			
HRW(A72)-35%	0.0543	7.38	0.0408	7.73	9.12	1.338	7.76	1.4703	7.70	9.69
	0.03561	7.78				1.477	7.72			
	0.03527	8.02				1.539	7.63			
	0.03813	7.75				1.527	7.68			
HRW(A72)-25%	0.1166	7.18	0.1123	7.27	18.28	1.38	7.78	1.5178	7.80	8.14
	0.1113	7.25				1.609	7.88			
	0.1167	7.24				1.653	7.84			
	0.1046	7.39				1.429	7.69			
HRW(A72)-12%	0.08114	7.49	0.0843	7.47	13.94	1.274	7.56	1.4080	7.63	10.84
	0.08043	7.48				1.19	7.60			
	0.08642	7.47				1.609	7.63			
	0.08918	7.43				1.559	7.73			

[a]values shown are either the measurements made at the end of the test (day 4) or earlier if all test organisms died before the 4-day exposure period was completed

Table 2.5-5 (cont'd) April 2013 Upper Animas River Surface Water Toxicity Testing Initial and Final Ammonia Concentrations

Site ID	Day 0 Measured Ammonia Conc. (mg N/L)	Day 0 Measured pH	Day 0 Average Measured Ammonia Conc. (mg N/L)	Day 0 Average Measured pH	Day 0 Ammonia Criterion (mg N/L)	Day 4 Measured Ammonia Conc. (mg N/L)[a]	Day 4 Measured pH[a]	Day 4 Average Measured Ammonia Conc. (mg N/L)	Day 4 Average Measured pH	Day 4 Ammonia Criterion (mg N/L)
SERIAL DILUTION OF SAMPLE CC48/M34 WITH A68 AS THE DILUENT										
A68(CC48/M34)-100%	0.0367	4.36	0.0335	4.32	38.95	1.026	4.65	0.9995	4.62	38.90
	0.03023	4.29				1.019	4.65			
	0.03478	4.32				0.9901	4.61			
	0.03231	4.30				0.9628	4.57			
A68(CC48/M34)-95%	0.03432	4.58	0.0325	4.54	38.92	0.8675	4.73	0.8658	4.69	38.88
	0.03149	4.53				0.884	4.67			
	0.03123	4.53				0.819	4.69			
	0.03305	4.52				0.8928	4.66			
A68(CC48/M34)-90%	0.03248	4.65	0.0316	4.64	38.89	0.8809	4.75	0.8549	4.78	38.86
	0.03164	4.63				0.7872	4.85			
	0.03085	4.66				0.8561	4.76			
	0.03152	4.63				0.8954	4.74			
A68(CC48/M34)-80%	0.03313	4.69	0.0330	4.70	38.88	0.944	4.90	0.8448	4.83	38.84
	0.03339	4.74				0.7689	4.84			
	0.03163	4.69				0.849	4.81			
	0.03392	4.67				0.8174	4.78			
A68(CC48/M34)-75%	0.03329	4.95	0.0336	4.89	38.81	0.8131	5.22	0.6163	5.20	38.62
	0.03333	4.93				0.9102	5.43			
	0.03367	4.85				0	5.10			
	0.03429	4.84				0.7418	5.06			
A68(CC48/M34)-50%	0.05944	6.34	0.0612	6.15	35.89	1.366	7.01	1.2235	6.94	25.45
	0.06078	6.22				1.201	6.98			
	0.06331	6.04				1.124	6.92			
	0.06128	5.98				1.203	6.83			
A68(CC48/M34)-25%	0.07063	6.97	0.0756	6.88	26.54	1.45	7.25	1.4978	7.24	18.84
	0.07417	6.89				1.431	7.23			
	0.07907	6.84				1.65	7.24			
	0.07862	6.82				1.46	7.24			
SERIAL DILUTION OF SAMPLE CC48/M34 WITH HRW AS THE DILUENT										
HRW(CC48/M34)-Control	0.06793	7.16	0.0691	7.37	16.04	1.251	7.55	1.3228	7.82	7.79
	0.07062	7.22				1.382	7.84			
	0.06924	7.39				1.298	8.01			
	0.06872	7.70				1.36	7.89			
HRW(CC48/M34)-95%	0.03252	5.15	0.0338	4.69	38.88	0.8979	5.00	0.9327	4.99	38.77
	0.03306	4.58				0.9816	4.95			
	0.03355	4.53				0.8745	5.02			
	0.03617	4.48				0.9767	4.98			
HRW(CC48/M34)-90%	0.03385	5.32	0.0361	5.23	38.60	0.9163	6.36	0.9288	5.79	37.55
	0.03668	5.26				0.9138	5.61			
	0.03605	5.15				0.8061	5.40			
	0.03775	5.17				1.079	5.80			
HRW(CC48/M34)-75%	0.03048	6.69	0.0299	6.53	32.23	1.416	7.50	1.3988	7.40	15.29
	0.03321	6.61				1.468	7.34			
	0.03204	6.38				1.372	7.36			
	0.0237	6.44				1.339	7.41			
HRW(CC48/M34)-50%	0.02571	7.23	0.0277	7.14	21.12	1.539	7.71	1.4723	7.67	10.19
	0.02689	7.16				1.524	7.62			
	0.02764	7.10				1.496	7.61			
	0.03052	7.06				1.33	7.73			
HRW(CC48/M34)-25%	0.03247	7.74	0.0312	7.66	10.27	1.481	7.84	1.6005	7.84	7.58
	0.03215	7.76				1.702	7.76			
	0.02816	7.60				1.554	7.88			
	0.03218	7.55				1.665	7.87			

[a]values shown are either the measurements made at the end of the test (day 4) or earlier if all test organisms died before the 4-day exposure period was completed

Table 2.5-5 (cont'd) April 2013 Upper Animas River Surface Water Toxicity Testing Initial and Final Ammonia Concentrations

Site ID	Day 0 Measured Ammonia Conc. (mg N/L)	Day 0 Measured pH	Day 0 Average Measured Ammonia Conc. (mg N/L)	Day 0 Average Measured pH	Day 0 Ammonia Criterion (mg N/L)	Day 4 Measured Ammonia Conc. (mg N/L)[a]	Day 4 Measured pH[a]	Day 4 Average Measured Ammonia Conc. (mg N/L)	Day 4 Average Measured pH	Day 4 Ammonia Criterion (mg N/L)
REFERENCE TOXICITY TEST										
Laboratory Control	0.09254	7.84	0.0814	7.89	6.92	1.653	7.45	1.5710	7.47	13.84
	0.07788	7.88				1.593	7.37			
	0.07861	7.89				1.583	7.50			
	0.0764	7.94				1.455	7.57			
100%	0.05802	7.84	0.0561	7.80	8.11	0.08906	7.28	0.5487	7.42	14.87
	0.05522	7.79				1.006	7.55			
	0.05446	7.79				0.9963	7.54			
	0.05655	7.78				0.1034	7.32			
50%	0.06034	7.92	0.0619	7.91	6.67	1.31	7.63	0.7637	7.52	12.84
	0.06287	7.88				0.6263	7.32			
	0.06745	7.87				1.076	7.54			
	0.05683	7.96				0.04236	7.60			
25%	0.06223	8.07	0.0649	8.02	5.38	0.1619	7.74	0.3588	7.72	9.32
	0.06625	8.06				0.505	7.61			
	0.0678	7.99				0.5246	7.75			
	0.06319	7.97				0.2438	7.78			
12.50%	0.07566	8.00	0.0728	7.99	5.75	1.686	7.60	1.5048	7.64	10.62
	0.06907	7.98				1.031	7.68			
	0.06867	7.99				1.399	7.65			
	0.07793	7.98				1.903	7.64			
6.25%	0.08101	8.05	0.0780	8.02	5.38	1.429	7.58	1.4925	7.62	11.06
	0.07508	8.02				1.481	7.62			
	0.07711	8.03				1.434	7.65			
	0.07886	7.99				1.626	7.62			

[a]values shown are either the measurements made at the end of the test (day 4) or earlier if all test organisms died before the 4-day exposure period was completed

Figures

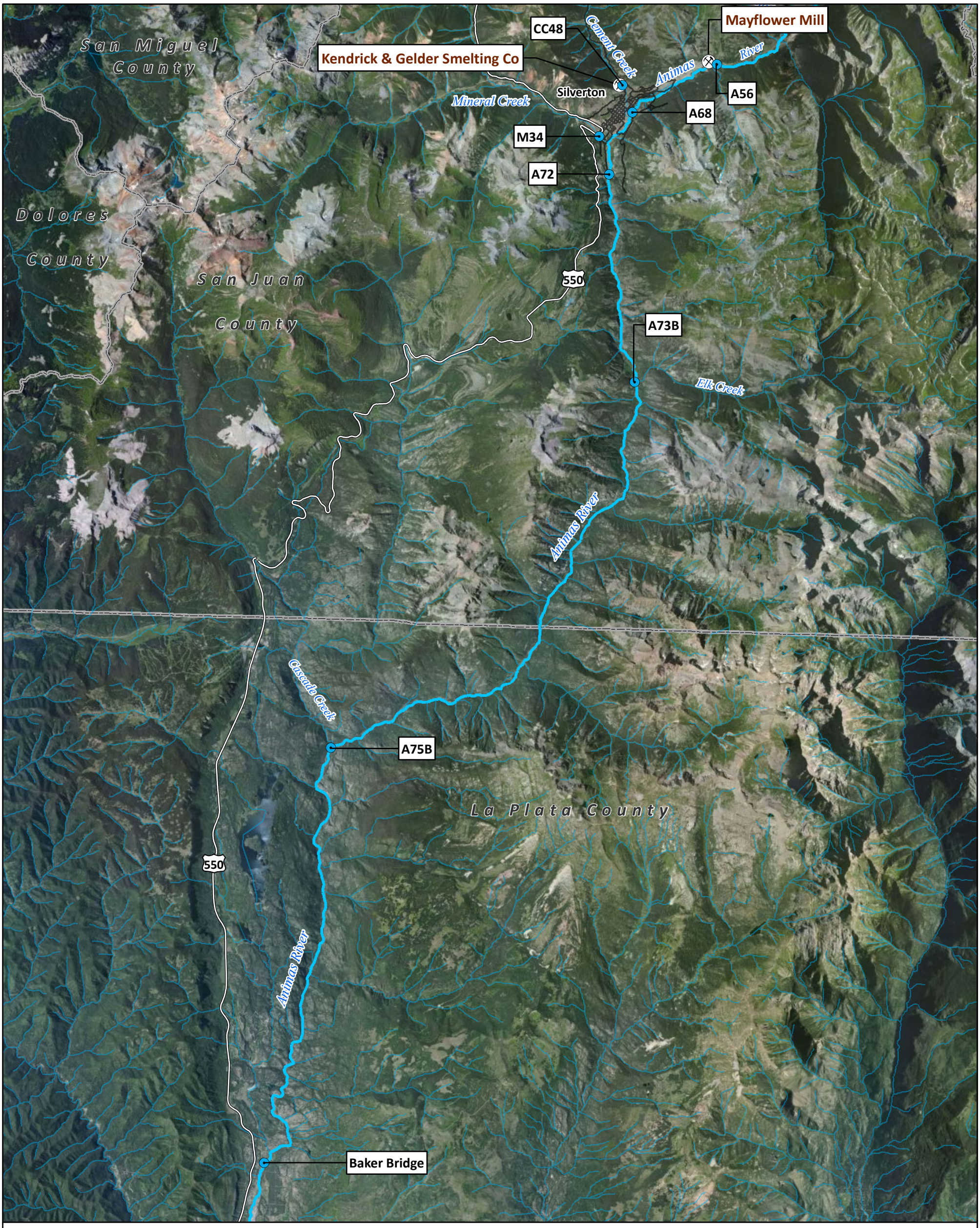


Figure 2.1-1
Upper Animas Mining District
2012 Surface Water Toxicity Test

- Sample Locations
- Mine Locations
- Rivers and Streams
- Roads
- County Boundaries

Date: July 15, 2013

Data Sources:
Sample Locations: U.S. EPA Region 8 and UOS (2013)
Mine Locations: U.S. EPA and ESAT (2012)
Roads: Navteq (2011)
Rivers and Streams: CDOW 1:24k (2004)
County Boundaries: U.S. Census Bureau (2011)
Image: Bing (2013)

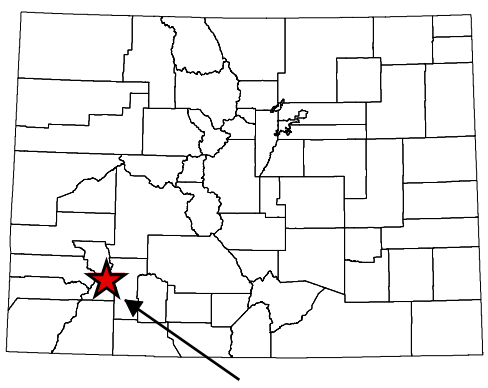
Coordinate System/Projection:
UTM Zone 13 North, NAD 83, Meters

N W E S

0 1 2 Miles

0 1 2 Kilometers

Colorado



Area of Interest

Figure 3.1
Survival in juvenile rainbow trout exposed for 96 hours to undiluted Animas River and Mineral Creek surface water (profile test) and A72 surface water serially diluted with HRW

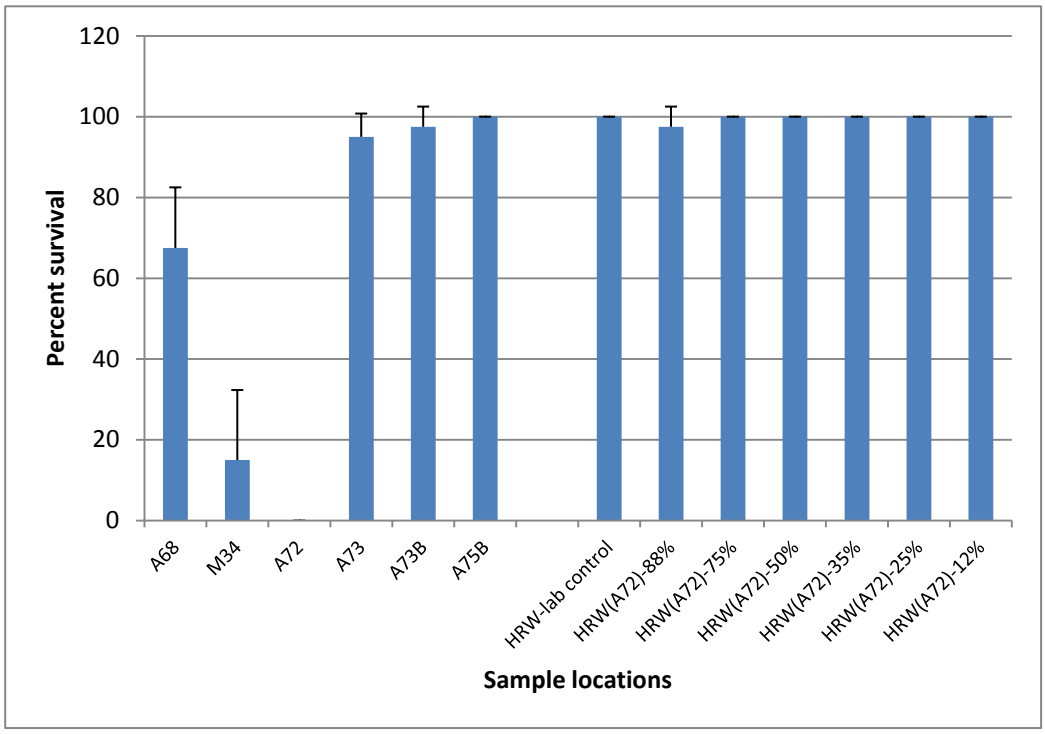


Figure 3.2
Survival in juvenile rainbow trout exposed for 96 hours to mixed CC48/M34 surface water serially diluted with A68 surface water and HRW

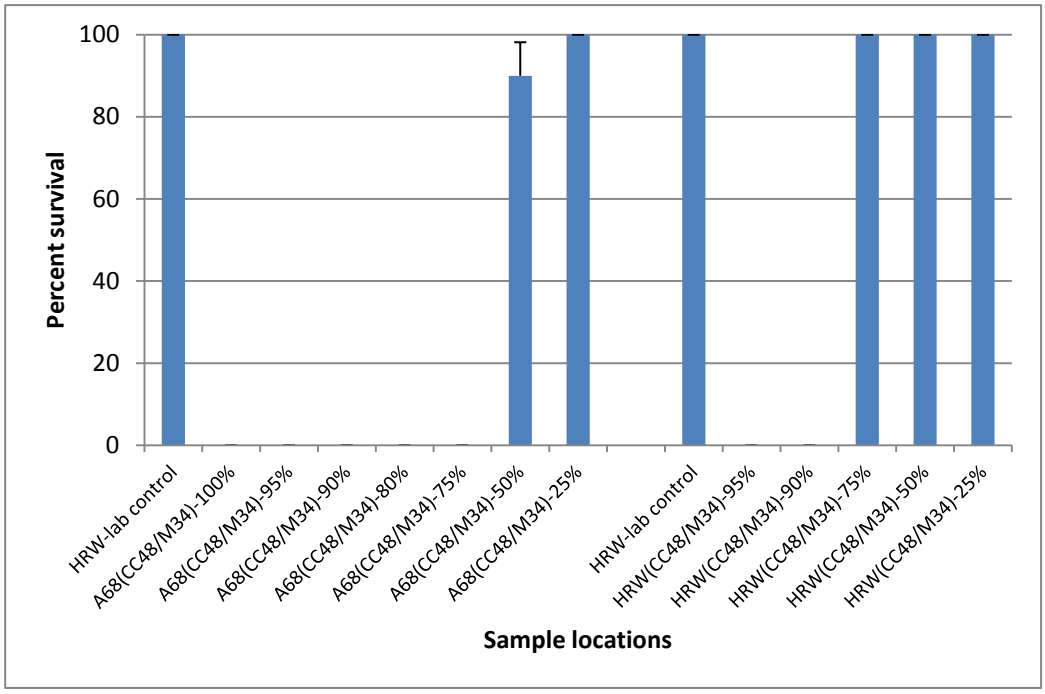


Figure 3.3
Survival in juvenile rainbow trout exposed for 96 hours to a reference toxicant (zinc sulfate heptahydrate)

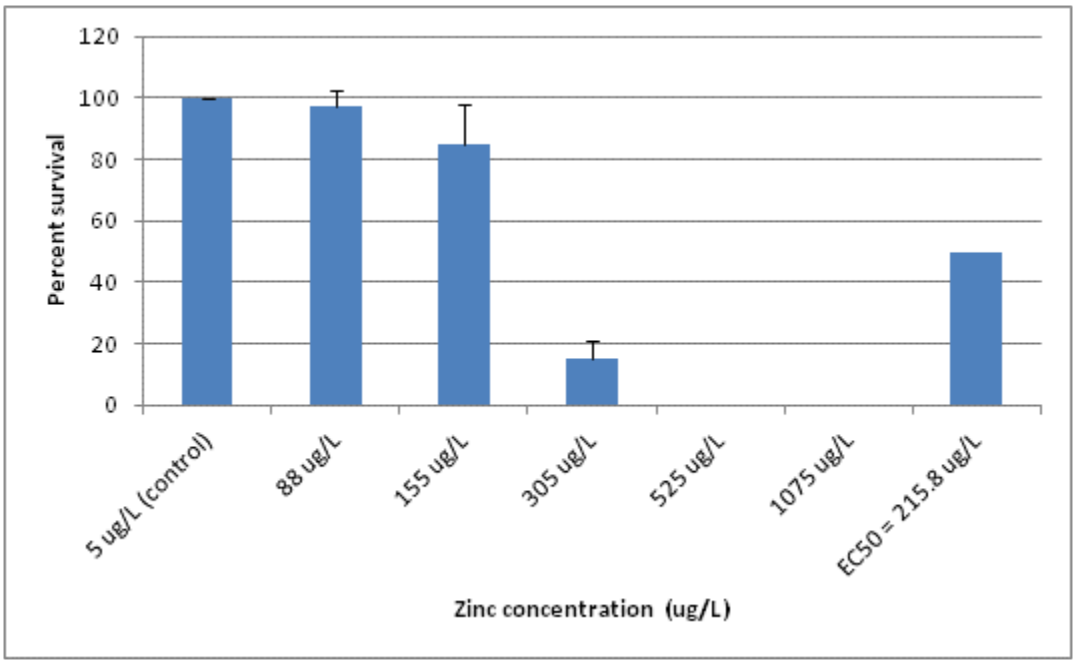
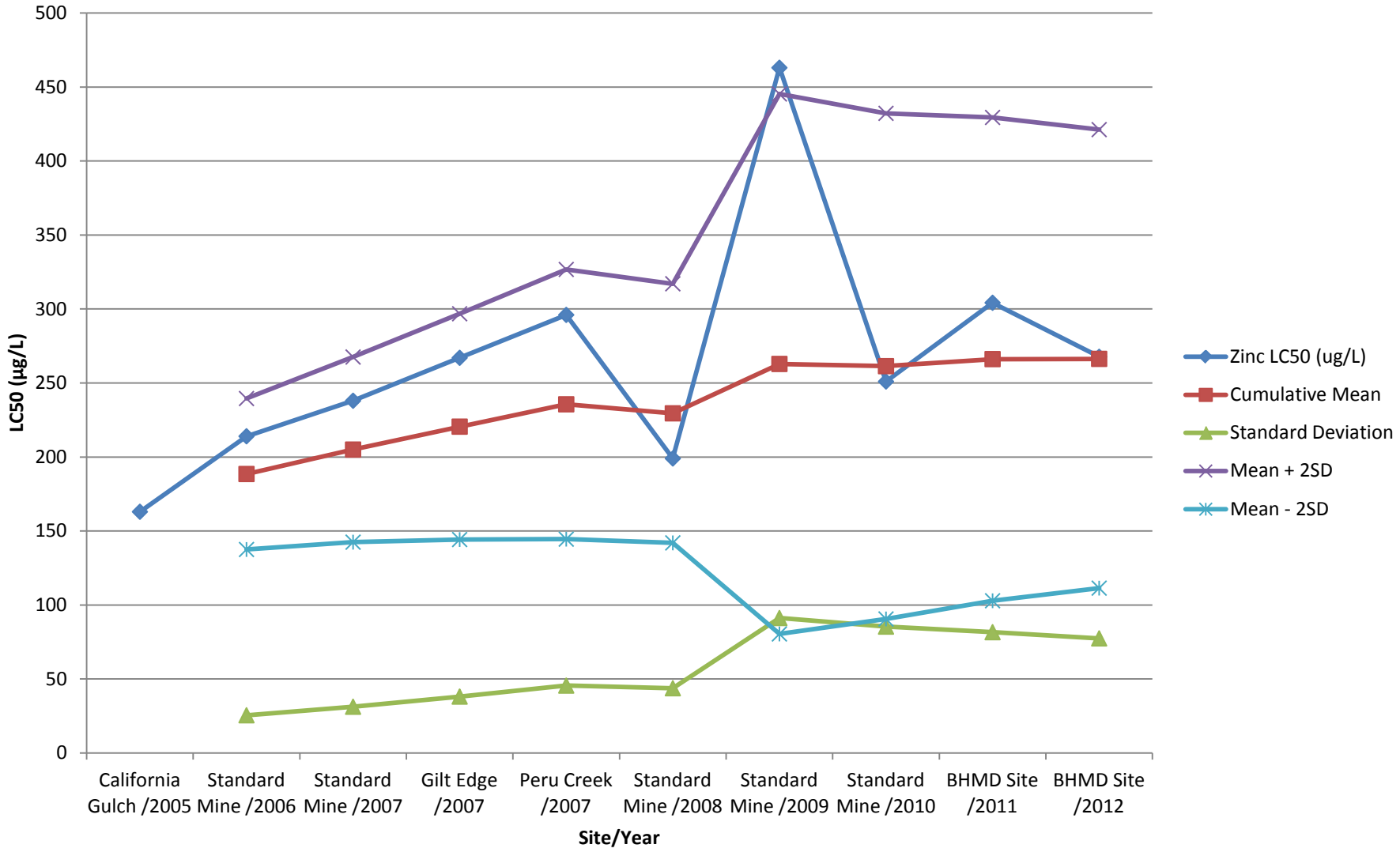


Figure 3.4
Acute reference toxicant control chart for juvenile rainbow trout exposed to zinc at the EPA Region 8 Laboratory



Appendices

APPENDIX A: Test data sheets for the profile test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC, NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-01	No. Alive	10	10	9	8	8
A68-01	pH	7.69	7.37	6.76	6.64	6.72
A68-01	Temp (C)	12.22	11.88	11.8	11.79	12.05
A68-01	D.O. (mg/L)	8.62	8.36	8.38	8.46	8.34
A68-01	Conductivity (us/cm)	426	433	441.6	434.9	435
A68-01	Alkalinity	34.1				38.0
A68-01	Hardness	194				191

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-02	No. Alive	10	10	6	5	5
A68-02	pH	7.8	7.35	6.82	6.79	6.82
A68-02	Temp (C)	12.09	11.83	11.79	11.78	12.06
A68-02	D.O. (mg/L)	8.68	7.72	8.38	8.48	8.37
A68-02	Conductivity (us/cm)	426.4	433.7	438.3	431.6	432.5
A68-02	Alkalinity	34.1				38.0
A68-02	Hardness	194				191

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-03	No. Alive	10	10	8	8	8
A68-03	pH	7.71	7.42	6.87	6.78	6.85
A68-03	Temp (C)	12	11.81	11.79	11.76	12.07
A68-03	D.O. (mg/L)	8.72	8.03	8.35	8.43	8.4
A68-03	Conductivity (us/cm)	427.2	434.7	438.9	436.5	436.9
A68-03	Alkalinity	34.1				38
A68-03	Hardness	194				191

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68-04	No. Alive	10	10	9	6	6
A68-04	pH	7.71	7.42	6.92	6.89	6.92
A68-04	Temp (C)	11.98	11.82	11.79	11.77	12.07
A68-04	D.O. (mg/L)	8.73	8.12	8.3	8.35	8.33
A68-04	Conductivity (us/cm)	427.3	433.1	440.1	436.6	434.8
A68-04	Alkalinity	34.1				38
A68-04	Hardness	194				191

APPENDIX A: Test data sheets for the profile test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC, NM

Site I.D.[a]	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
M34-01	No. Alive	10	10	4	3	0
M34-01	pH	4.82	6.02	6.69	6.44	5.3
M34-01	Temp (C)	12.67	11.85	11.83	12.1	12.26
M34-01	D.O. (mg/L)	8.6	8.2	8.53	8.49	8.73
M34-01	Conductivity (us/cm)	521.7	534.6	554.6	543.2	528.2
M34-01	Alkalinity	<5.00U				<5.00U
M34-01	Hardness	227				224

Site I.D.[a]	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
M34-02	No. Alive	10	10	5	4	3
M34-02	pH	4.92	6.03	6.68	6.37	5.19
M34-02	Temp (C)	12.51	11.79	11.85	12.09	12.14
M34-02	D.O. (mg/L)	8.73	8.25	8.54	8.5	8.69
M34-02	Conductivity (us/cm)	523.4	536.5	556.5	543.2	526.8
M34-02	Alkalinity	<5.00U				<5.00U
M34-02	Hardness	227				224

Site I.D.[a]	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
M34-03	No. Alive	10	10	6	4	3
M34-03	pH	5.11	6.05	6.65	6.36	5.21
M34-03	Temp (C)	12.42	11.74	11.82	12.07	12.06
M34-03	D.O. (mg/L)	8.81	8.31	8.53	8.48	8.61
M34-03	Conductivity (us/cm)	522.2	537.3	555.9	544.7	526.7
M34-03	Alkalinity	<5.00U				<5.00U
M34-03	Hardness	227				224

Site I.D.[a]	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
M34-04	No. Alive	10	10	7	5	0
M34-04	pH	5.05	6.04	6.66	6.37	5.19
M34-04	Temp (C)	12.35	11.73	11.83	12.05	12.04
M34-04	D.O. (mg/L)	8.89	8.35	8.5	8.47	8.64
M34-04	Conductivity (us/cm)	524	534.3	551.5	544.6	529.2
M34-04	Alkalinity	<5.00U				<5.00U
M34-04	Hardness	227				224

APPENDIX A: Test data sheets for the profile test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC, NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A72-01	No. Alive	10	10	3	0	-
A72-01	pH	5.73	6.06	6.3	5.85	-
A72-01	Temp (C)	11.84	11.93	11.89	11.8	-
A72-01	D.O. (mg/L)	8.76	8.29	8.33	8.48	-
A72-01	Conductivity (us/cm)	573.4	581.3	587.7	578.7	-
A72-01	Alkalinity	<5.00U			<5.00U	
A72-01	Hardness	255			265	

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A72-02	No. Alive	10	10	3	0	-
A72-02	pH	5.75	6.21	6.22	5.59	-
A72-02	Temp (C)	11.82	11.87	11.87	11.8	-
A72-02	D.O. (mg/L)	8.76	8.35	8.39	8.53	-
A72-02	Conductivity (us/cm)	575.2	585.7	592.3	576	-
A72-02	Alkalinity	<5.00U			<5.00U	
A72-02	Hardness	255			265	

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A72-03	No. Alive	10	10	4	0	-
A72-03	pH	5.73	6.16	6.25	5.62	-
A72-03	Temp (C)	11.78	11.8	11.85	11.8	-
A72-03	D.O. (mg/L)	8.78	8.4	8.44	8.59	-
A72-03	Conductivity (us/cm)	574.6	583.8	590.1	579.5	-
A72-03	Alkalinity	<5.00U			<5.00U	
A72-03	Hardness	255			265	

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A72-04	No. Alive	10	9	6	0	-
A72-04	pH	5.72	6.2	6.26	5.63	-
A72-04	Temp (C)	11.76	11.82	11.82	11.79	-
A72-04	D.O. (mg/L)	8.77	8.42	8.46	8.63	-
A72-04	Conductivity (us/cm)	574.8	585.2	590.1	583	-
A72-04	Alkalinity	<5.00U			<5.00U	
A72-04	Hardness	255			265	

APPENDIX A: Test data sheets for the profile test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC, NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73-01	No. Alive	10	10	9	9	9
A73-01	pH	7.19	6.56	6.42	6.31	6.52
A73-01	Temp (C)	11.81	12.07	11.89	11.8	12.07
A73-01	D.O. (mg/L)	8.77	8.2	8.27	8.27	8.19
A73-01	Conductivity (us/cm)	531.6	539.6	541.8	537.7	539.2
A73-01	Alkalinity	<5.00U				9.98
A73-01	Hardness	237				238

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73-02	No. Alive	10	10	10	10	10
A73-02	pH	7.15	6.53	6.46	6.31	6.47
A73-02	Temp (C)	11.82	12.02	11.88	11.79	12.07
A73-02	D.O. (mg/L)	8.76	8.3	8.29	8.26	8.15
A73-02	Conductivity (us/cm)	531.8	538.3	540.1	537.8	540.2
A73-02	Alkalinity	<5.00U				9.98
A73-02	Hardness	237				238

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73-03	No. Alive	10	10	10	10	10
A73-03	pH	7.17	6.53	6.5	6.32	6.45
A73-03	Temp (C)	11.8	12	11.89	11.76	12.06
A73-03	D.O. (mg/L)	8.76	8.34	8.25	8.24	8.14
A73-03	Conductivity (us/cm)	531.8	537.5	539.1	538.2	539.2
A73-03	Alkalinity	<5.00U				9.98
A73-03	Hardness	237				238

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73-04	No. Alive	10	10	10	9[b]	9
A73-04	pH	6.93	6.52	6.43	6.3	6.44
A73-04	Temp (C)	11.8	11.99	11.89	11.76	12.07
A73-04	D.O. (mg/L)	8.77	8.28	8.07	8.2	8.15
A73-04	Conductivity (us/cm)	531.8	537.7	539.6	539.1	538.7
A73-04	Alkalinity	<5.00U				9.98
A73-04	Hardness	237				238

APPENDIX A: Test data sheets for the profile test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC, NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73B-01	No. Alive	10	10	10	10	10
A73B-01	pH	7.5	6.74	6.48	6.36	6.56
A73B-01	Temp (C)	11.86	12.14	11.98	11.82	12.05
A73B-01	D.O. (mg/L)	8.77	8.03	8.23	8.29	8
A73B-01	Conductivity (us/cm)	503.6	507.9	510.8	509.7	513.1
A73B-01	Alkalinity	<5.00U				8.16
A73B-01	Hardness	226				226

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73B-02	No. Alive	10	10	10	10	10
A73B-02	pH	7.86	6.67	6.57	6.37	6.54
A73B-02	Temp (C)	11.85	12.04	11.97	11.8	12.05
A73B-02	D.O. (mg/L)	8.75	8.03	8.17	8.25	8.04
A73B-02	Conductivity (us/cm)	503.9	507.8	512.3	511.3	511.6
A73B-02	Alkalinity	<5.00U				8.16
A73B-02	Hardness	226				226

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73B-03	No. Alive	10	10	10	9	9
A73B-03	pH	7.4	6.65	6.51	6.35	6.45
A73B-03	Temp (C)	11.83	12.03	11.94	11.8	12.04
A73B-03	D.O. (mg/L)	8.77	8.15	8.21	8.26	8.07
A73B-03	Conductivity (us/cm)	504.1	507.5	512	510.1	509.2
A73B-03	Alkalinity	<5.00U				8.16
A73B-03	Hardness	226				226

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A73B-04	No. Alive	10	10	10	10	10
A73B-04	pH	7.31	6.61	6.49	6.35	6.51
A73B-04	Temp (C)	11.83	12.06	11.91	11.79	12.05
A73B-04	D.O. (mg/L)	8.76	8.09	8.22	8.25	8.11
A73B-04	Conductivity (us/cm)	503.8	509.1	511.9	510.6	512.2
A73B-04	Alkalinity	<5.00U				8.16
A73B-04	Hardness	226				226

APPENDIX A: Test data sheets for the profile test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC, NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A75B-01	No. Alive	10	10	10	10	10
A75B-01	pH	7.76	7	6.37	6.4	6.5
A75B-01	Temp (C)	11.91	12.21	12.2	12.09	12.36
A75B-01	D.O. (mg/L)	8.73	7.98	8.16	8.14	7.3
A75B-01	Conductivity (us/cm)	416	422.7	427	426.2	428.6
A75B-01	Alkalinity	11.6				17.9
A75B-01	Hardness	184				189

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A75B-02	No. Alive	10	10	10	10	10
A75B-02	pH	7.74	6.91	6.44	6.28	6.54
A75B-02	Temp (C)	11.91	11.93	12.07	12.03	12.15
A75B-02	D.O. (mg/L)	8.75	8.17	8.18	8.17	7.7
A75B-02	Conductivity (us/cm)	416.5	422.9	426.4	425.8	428.1
A75B-02	Alkalinity	11.6				17.9
A75B-02	Hardness	184				189

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A75B-03	No. Alive	10	10	10	10	10
A75B-03	pH	7.75	6.9	6.5	6.32	6.56
A75B-03	Temp (C)	11.87	11.91	12.02	11.83	12.06
A75B-03	D.O. (mg/L)	8.76	7.84	8.3	8.23	7.95
A75B-03	Conductivity (us/cm)	416.8	421.4	428.2	428.8	430.6
A75B-03	Alkalinity	11.6				17.9
A75B-03	Hardness	184				189

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A75B-04	No. Alive	10	10	10	10	10
A75B-04	pH	7.8	6.87	6.56	6.37	6.6
A75B-04	Temp (C)	11.88	11.9	12.01	11.81	12.06
A75B-04	D.O. (mg/L)	8.78	7.57	8.25	8.24	8.05
A75B-04	Conductivity (us/cm)	417.1	421.8	426.9	425.2	427.3
A75B-04	Alkalinity	11.6				17.9
A75B-04	Hardness	184				189

[a] Surface water sample M34 was tested starting 4/19/13

[b] one juvenile rainbow trout jumped out of the test vessel

APPENDIX B: Test data sheet for the serial dilution of A72 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-88%-Rep1	No. Alive	10	10	10	10	10
HRW(A72)-88%-Rep1	pH	6.96	7.23	7.27	7.31	7.28
HRW(A72)-88%-Rep1	Temp (C)	12.65	11.74	12.04	11.75	11.75
HRW(A72)-88%-Rep1	D.O. (mg/L)	8.56	8.13	8.21	8.12	8.29
HRW(A72)-88%-Rep1	Conductivity (us/cm)	578.4	580.9	581.5	583.5	582.3
HRW(A72)-88%-Rep1	Alkalinity	9.14				12.0
HRW(A72)-88%-Rep1	Hardness	251				241

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-88%-Rep2	No. Alive	10	10	10	10	10
HRW(A72)-88%-Rep2	pH	6.9	7.13	7.22	7.28	7.26
HRW(A72)-88%-Rep2	Temp (C)	12.62	11.74	12.04	11.72	11.74
HRW(A72)-88%-Rep2	D.O. (mg/L)	8.63	8.22	8.29	8.18	8.39
HRW(A72)-88%-Rep2	Conductivity (us/cm)	577.1	580.6	581.1	583	583.3
HRW(A72)-88%-Rep2	Alkalinity	9.14				12.0
HRW(A72)-88%-Rep2	Hardness	251				241

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A73)-88%-Rep3	No. Alive	10	10	9	9	9
HRW(A73)-88%-Rep3	pH	6.81	7.17	7.27	7.26	7.28
HRW(A73)-88%-Rep3	Temp (C)	12.59	11.73	12.02	11.7	11.73
HRW(A73)-88%-Rep3	D.O. (mg/L)	8.6	8.26	8.33	8.28	8.43
HRW(A73)-88%-Rep3	Conductivity (us/cm)	578	583.4	583.2	583.2	583.3
HRW(A73)-88%-Rep3	Alkalinity	9.14				12.0
HRW(A73)-88%-Rep3	Hardness	251				241

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-88%-Rep4	No. Alive	10	10	10	10	10
HRW(A72)-88%-Rep4	pH	6.77	7.17	7.24	7.23	7.29
HRW(A72)-88%-Rep4	Temp (C)	12.59	11.72	12.03	11.7	11.72
HRW(A72)-88%-Rep4	D.O. (mg/L)	8.62	8.33	8.33	8.33	8.44
HRW(A72)-88%-Rep4	Conductivity (us/cm)	580.2	581.9	581.5	583.5	583.9
HRW(A72)-88%-Rep4	Alkalinity	9.14				12.0
HRW(A72)-88%-Rep4	Hardness	251				241

APPENDIX B: Test data sheet for the serial dilution of A72 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-75%-Rep1	No. Alive	10	10	10	10	10
HRW(A72)-75%-Rep1	pH	7.27	7.43	7.43	7.53	7.42
HRW(A72)-75%-Rep1	Temp (C)	12.88	11.72	12	11.74	11.73
HRW(A72)-75%-Rep1	D.O. (mg/L)	8.44	7.89	7.91	7.87	8.1
HRW(A72)-75%-Rep1	Conductivity (us/cm)	584.5	590.7	589.4	591.5	591.2
HRW(A72)-75%-Rep1	Alkalinity	26.6				28.8
HRW(A72)-75%-Rep1	Hardness	244				237

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-75%-Rep2	No. Alive	10	10	10	10	10
HRW(A72)-75%-Rep2	pH	7.2	7.39	7.37	7.47	7.32
HRW(A72)-75%-Rep2	Temp (C)	12.94	11.75	12	11.73	11.74
HRW(A72)-75%-Rep2	D.O. (mg/L)	8.45	7.9	7.88	7.87	8.12
HRW(A72)-75%-Rep2	Conductivity (us/cm)	584	588.4	588.7	590.5	590.3
HRW(A72)-75%-Rep2	Alkalinity	26.6				28.8
HRW(A72)-75%-Rep2	Hardness	244				237

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-75%-Rep3	No. Alive	10	10	10	10	10
HRW(A72)-75%-Rep3	pH	7.12	7.34	7.35	7.43	7.34
HRW(A72)-75%-Rep3	Temp (C)	12.74	11.74	11.99	11.72	11.77
HRW(A72)-75%-Rep3	D.O. (mg/L)	8.52	7.97	7.92	7.9	8.21
HRW(A72)-75%-Rep3	Conductivity (us/cm)	585.9	589.1	588.3	590	590.4
HRW(A72)-75%-Rep3	Alkalinity	26.6				28.8
HRW(A72)-75%-Rep3	Hardness	244				237

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-75%-Rep4	No. Alive	10	10	10	10	10
HRW(A72)-75%-Rep4	pH	7.02	7.32	7.34	7.41	7.36
HRW(A72)-75%-Rep4	Temp (C)	12.68	11.75	11.99	11.71	11.74
HRW(A72)-75%-Rep4	D.O. (mg/L)	8.54	7.91	7.97	8.05	8.26
HRW(A72)-75%-Rep4	Conductivity (us/cm)	582.7	589	589.3	591.4	590.8
HRW(A72)-75%-Rep4	Alkalinity	26.6				28.8
HRW(A72)-75%-Rep4	Hardness	244				237

APPENDIX B: Test data sheet for the serial dilution of A72 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-50%-Rep1	No. Alive	10	10	10	10	10
HRW(A72)-50%-Rep1	pH	7.68	7.75	7.56	7.75	7.7
HRW(A72)-50%-Rep1	Temp (C)	13.14	11.76	12.02	11.76	11.76
HRW(A72)-50%-Rep1	D.O. (mg/L)	8.22	8.08	7.91	8.03	8.22
HRW(A72)-50%-Rep1	Conductivity (us/cm)	600.8	608.5	606.6	608.4	607.3
HRW(A72)-50%-Rep1	Alkalinity	55.4				57.0
HRW(A72)-50%-Rep1	Hardness	223				218

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-50%-Rep2	No. Alive	10	10	10	10	10
HRW(A72)-50%-Rep2	pH	7.53	7.67	7.54	7.66	7.56
HRW(A72)-50%-Rep2	Temp (C)	13.22	11.76	12.01	11.74	11.78
HRW(A72)-50%-Rep2	D.O. (mg/L)	8.26	8.05	7.89	8	8.09
HRW(A72)-50%-Rep2	Conductivity (us/cm)	602.6	606	603.4	605.8	606.8
HRW(A72)-50%-Rep2	Alkalinity	55.4				57.0
HRW(A72)-50%-Rep2	Hardness	223				218

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-50%-Rep3	No. Alive	10	10	10	10	10
HRW(A72)-50%-Rep3	pH	7.44	7.58	7.52	7.64	7.53
HRW(A72)-50%-Rep3	Temp (C)	13.12	11.74	11.99	11.72	11.81
HRW(A72)-50%-Rep3	D.O. (mg/L)	8.33	7.92	7.87	7.91	8.01
HRW(A72)-50%-Rep3	Conductivity (us/cm)	601.7	607.5	605.9	606.4	607.6
HRW(A72)-50%-Rep3	Alkalinity	55.4				57.0
HRW(A72)-50%-Rep3	Hardness	223				218

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-50%-Rep4	No. Alive	10	10	10	10	10
HRW(A72)-50%-Rep4	pH	7.44	7.52	7.51	7.61	7.54
HRW(A72)-50%-Rep4	Temp (C)	13.02	11.74	12	11.71	11.76
HRW(A72)-50%-Rep4	D.O. (mg/L)	8.32	7.85	7.82	7.87	7.99
HRW(A72)-50%-Rep4	Conductivity (us/cm)	602.2	607.7	605.3	606.4	606.4
HRW(A72)-50%-Rep4	Alkalinity	55.4				57.0
HRW(A72)-50%-Rep4	Hardness	223				218

APPENDIX B: Test data sheet for the serial dilution of A72 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-35%-Rep1	No. Alive	10	10	10	10	10
HRW(A72)-35%-Rep1	pH	7.38	7.67	7.69	7.82	7.76
HRW(A72)-35%-Rep1	Temp (C)	12.97	11.78	12.01	11.74	11.84
HRW(A72)-35%-Rep1	D.O. (mg/L)	8.34	7.96	8.25	8.21	8.29
HRW(A72)-35%-Rep1	Conductivity (us/cm)	605.2	624.8	616.5	617.6	615.5
HRW(A72)-35%-Rep1	Alkalinity	76.1				77.9
HRW(A72)-35%-Rep1	Hardness	211				201

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-35%-Rep2	No. Alive	10	10	10	10	10
HRW(A72)-35%-Rep2	pH	7.78	7.91	7.7	7.79	7.72
HRW(A72)-35%-Rep2	Temp (C)	13.32	11.77	12.02	11.78	11.81
HRW(A72)-35%-Rep2	D.O. (mg/L)	8.17	8.11	8.24	8.23	8.25
HRW(A72)-35%-Rep2	Conductivity (us/cm)	628.3	628.6	617.1	618.9	617.1
HRW(A72)-35%-Rep2	Alkalinity	76.1				77.9
HRW(A72)-35%-Rep2	Hardness	211				201

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-35%-Rep3	No. Alive	10	10	10	10	10
HRW(A72)-35%-Rep3	pH	8.02	7.92	7.67	7.78	7.63
HRW(A72)-35%-Rep3	Temp (C)	13.59	11.77	12.02	11.78	11.78
HRW(A72)-35%-Rep3	D.O. (mg/L)	8.2	8.15	8.19	8.19	8.27
HRW(A72)-35%-Rep3	Conductivity (us/cm)	627.2	633.9	617.8	618	617.3
HRW(A72)-35%-Rep3	Alkalinity	76.1				77.9
HRW(A72)-35%-Rep3	Hardness	211				201

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-35%-Rep4	No. Alive	10	10	10	10	10
HRW(A72)-35%-Rep4	pH	7.75	7.92	7.67	7.77	7.68
HRW(A72)-35%-Rep4	Temp (C)	13.03	11.76	12.01	11.76	11.7
HRW(A72)-35%-Rep4	D.O. (mg/L)	8.08	8.2	8.07	8.15	8.22
HRW(A72)-35%-Rep4	Conductivity (us/cm)	626.3	636.3	617.5	616.1	618.4
HRW(A72)-35%-Rep4	Alkalinity	76.1				77.9
HRW(A72)-35%-Rep4	Hardness	211				201

APPENDIX B: Test data sheet for the serial dilution of A72 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-25%-Rep1	No. Alive	10	10	10	10	10
HRW(A72)-25%-Rep1	pH	7.18	7.63	7.6	7.86	7.78
HRW(A72)-25%-Rep1	Temp (C)	12.4	11.76	11.98	11.68	11.83
HRW(A72)-25%-Rep1	D.O. (mg/L)	7.56	8.3	8.3	8.29	8.35
HRW(A72)-25%-Rep1	Conductivity (us/cm)	618.9	623.1	622.9	624.9	623.1
HRW(A72)-25%-Rep1	Alkalinity	87.5				90.4
HRW(A72)-25%-Rep1	Hardness	200				182

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-25%-Rep2	No. Alive	10	10	10	10	10
HRW(A72)-25%-Rep2	pH	7.25	7.66	7.62	7.88	7.88
HRW(A72)-25%-Rep2	Temp (C)	12.24	11.73	11.98	11.68	11.79
HRW(A72)-25%-Rep2	D.O. (mg/L)	7.86	8.31	8.35	8.31	8.43
HRW(A72)-25%-Rep2	Conductivity (us/cm)	618.4	624.6	624.2	627.4	624.9
HRW(A72)-25%-Rep2	Alkalinity	87.5				90.4
HRW(A72)-25%-Rep2	Hardness	200				182

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-25%-Rep3	No. Alive	10	10	10	10	10
HRW(A72)-25%-Rep3	pH	7.24	7.69	7.69	7.85	7.84
HRW(A72)-25%-Rep3	Temp (C)	12.21	11.73	11.95	11.67	11.79
HRW(A72)-25%-Rep3	D.O. (mg/L)	7.86	8.31	8.32	8.25	8.28
HRW(A72)-25%-Rep3	Conductivity (us/cm)	616.7	623.8	624.8	624.7	624.8
HRW(A72)-25%-Rep3	Alkalinity	87.5				90.4
HRW(A72)-25%-Rep3	Hardness	200				182

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-25%-Rep4	No. Alive	10	10	10	10	10
HRW(A72)-25%-Rep4	pH	7.39	7.69	7.67	7.8	7.69
HRW(A72)-25%-Rep4	Temp (C)	12.19	11.74	12	11.68	11.77
HRW(A72)-25%-Rep4	D.O. (mg/L)	7.99	8.21	8.07	8.02	8.22
HRW(A72)-25%-Rep4	Conductivity (us/cm)	617.1	620.7	624.7	623	622.6
HRW(A72)-25%-Rep4	Alkalinity	87.5				90.4
HRW(A72)-25%-Rep4	Hardness	200				182

APPENDIX B: Test data sheet for the serial dilution of A72 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-12%-Rep1	No. Alive	10	10	10	10	10
HRW(A72)-12%-Rep1	pH	7.49	7.59	7.28	7.53	7.56
HRW(A72)-12%-Rep1	Temp (C)	12.22	12.44	12.23	12.01	12.01
HRW(A72)-12%-Rep1	D.O. (mg/L)	7.77	7.95	8.11	7.91	8.12
HRW(A72)-12%-Rep1	Conductivity (us/cm)	626.2	627	626.3	628.1	630.3
HRW(A72)-12%-Rep1	Alkalinity	106				104
HRW(A72)-12%-Rep1	Hardness	190				182

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-12%-Rep2	No. Alive	10	10	10	10	10
HRW(A72)-12%-Rep2	pH	7.48	7.65	7.41	7.71	7.6
HRW(A72)-12%-Rep2	Temp (C)	12.23	11.91	12.14	11.88	11.9
HRW(A72)-12%-Rep2	D.O. (mg/L)	7.89	8.09	8.18	7.98	8.26
HRW(A72)-12%-Rep2	Conductivity (us/cm)	630	629.8	628.8	629.7	628.8
HRW(A72)-12%-Rep2	Alkalinity	106				104
HRW(A72)-12%-Rep2	Hardness	190				182

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-12%-Rep3	No. Alive	10	10	10	10	10
HRW(A72)-12%-Rep3	pH	7.47	7.38	7.55	7.87	7.63
HRW(A72)-12%-Rep3	Temp (C)	12.31	11.78	11.99	11.7	11.8
HRW(A72)-12%-Rep3	D.O. (mg/L)	7.9	8.2	8.24	8.2	8.37
HRW(A72)-12%-Rep3	Conductivity (us/cm)	633.6	633.1	630.6	634.6	633.4
HRW(A72)-12%-Rep3	Alkalinity	106				104
HRW(A72)-12%-Rep3	Hardness	190				182

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW(A72)-12%-Rep4	No. Alive	10	10	10	10	10
HRW(A72)-12%-Rep4	pH	7.43	7.5	7.64	7.91	7.73
HRW(A72)-12%-Rep4	Temp (C)	12.32	11.76	11.98	11.67	11.79
HRW(A72)-12%-Rep4	D.O. (mg/L)	8	8.21	8.27	8.29	8.44
HRW(A72)-12%-Rep4	Conductivity (us/cm)	629.9	633	633.7	634.6	632.4
HRW(A72)-12%-Rep4	Alkalinity	106				104
HRW(A72)-12%-Rep4	Hardness	190				182

APPENDIX C: Test data sheet for the serial dilution of CC48/M34 with A68

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-Control-Rep1	No. Alive	10	10	10	10	10
A68/(CC48/M34)-Control-Rep1	pH	7.16	7.15	7.42	7.6	7.55
A68/(CC48/M34)-Control-Rep1	Temp (C)	12.33	12.48	12.01	12.06	12.2
A68/(CC48/M34)-Control-Rep1	D.O. (mg/L)	7.48	7.41	7.76	7.92	7.93
A68/(CC48/M34)-Control-Rep1	Conductivity (us/cm)	631.6	635.6	636.7	638.4	637.7
A68/(CC48/M34)-Control-Rep1	Alkalinity	120				122
A68/(CC48/M34)-Control-Rep1	Hardness	183				179

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-Control-Rep2	No. Alive	10	10	10	10	10
A68/(CC48/M34)-Control-Rep2	pH	7.22	7.35	7.46	7.8	7.84
A68/(CC48/M34)-Control-Rep2	Temp (C)	12.38	12.22	11.94	11.93	12.11
A68/(CC48/M34)-Control-Rep2	D.O. (mg/L)	7.49	7.76	7.85	8.03	8.1
A68/(CC48/M34)-Control-Rep2	Conductivity (us/cm)	632.2	638.6	638.2	637.6	640.2
A68/(CC48/M34)-Control-Rep2	Alkalinity	120				122
A68/(CC48/M34)-Control-Rep2	Hardness	183				179

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-Control-Rep3	No. Alive	10	10	10	10	10
A68/(CC48/M34)-Control-Rep3	pH	7.39	7.61	7.67	7.85	8.01
A68/(CC48/M34)-Control-Rep3	Temp (C)	12.4	12.14	11.86	11.83	12.04
A68/(CC48/M34)-Control-Rep3	D.O. (mg/L)	7.49	7.91	8.06	8.07	8.16
A68/(CC48/M34)-Control-Rep3	Conductivity (us/cm)	630.5	636.4	637.5	636.6	638.3
A68/(CC48/M34)-Control-Rep3	Alkalinity	120				122
A68/(CC48/M34)-Control-Rep3	Hardness	183				179

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-Control-Rep4	No. Alive	10	10	10	10	10
A68/(CC48/M34)-Control-Rep4	pH	7.7	7.75	7.7	7.85	7.89
A68/(CC48/M34)-Control-Rep4	Temp (C)	12.4	12.13	11.83	11.83	12.04
A68/(CC48/M34)-Control-Rep4	D.O. (mg/L)	7.49	7.98	7.97	8.09	8.16
A68/(CC48/M34)-Control-Rep4	Conductivity (us/cm)	630.2	635.2	635.5	637.8	639.3
A68/(CC48/M34)-Control-Rep4	Alkalinity	120				122
A68/(CC48/M34)-Control-Rep4	Hardness	183				179

APPENDIX C: Test data sheet for the serial dilution of CC48/M34 with A68

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-100%-Rep1	No. Alive	10	0	-	-	-
A68/(CC48/M34)-100%-Rep1	pH	4.36	4.65	-	-	-
A68/(CC48/M34)-100%-Rep1	Temp (C)	12.68	11.79	-	-	-
A68/(CC48/M34)-100%-Rep1	D.O. (mg/L)	8.69	8.48	-	-	-
A68/(CC48/M34)-100%-Rep1	Conductivity (us/cm)	687.2	693.7	-	-	-
A68/(CC48/M34)-100%-Rep1	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-100%-Rep1	Hardness	294	304			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-100%-Rep2	No. Alive	10	0	-	-	-
A68/(CC48/M34)-100%-Rep2	pH	4.29	4.65	-	-	-
A68/(CC48/M34)-100%-Rep2	Temp (C)	12.77	11.77	-	-	-
A68/(CC48/M34)-100%-Rep2	D.O. (mg/L)	8.66	8.49	-	-	-
A68/(CC48/M34)-100%-Rep2	Conductivity (us/cm)	689.6	695	-	-	-
A68/(CC48/M34)-100%-Rep2	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-100%-Rep2	Hardness	294	304			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-100%-Rep3	No. Alive	10	0	-	-	-
A68/(CC48/M34)-100%-Rep3	pH	4.32	4.61	-	-	-
A68/(CC48/M34)-100%-Rep3	Temp (C)	12.73	11.78	-	-	-
A68/(CC48/M34)-100%-Rep3	D.O. (mg/L)	8.69	8.52	-	-	-
A68/(CC48/M34)-100%-Rep3	Conductivity (us/cm)	688.3	692.8	-	-	-
A68/(CC48/M34)-100%-Rep3	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-100%-Rep3	Hardness	294	304			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-100%-Rep4	No. Alive	10	0	-	-	-
A68/(CC48/M34)-100%-Rep4	pH	4.3	4.57	-	-	-
A68/(CC48/M34)-100%-Rep4	Temp (C)	12.76	11.79	-	-	-
A68/(CC48/M34)-100%-Rep4	D.O. (mg/L)	8.6	8.53	-	-	-
A68/(CC48/M34)-100%-Rep4	Conductivity (us/cm)	688.9	694.7	-	-	-
A68/(CC48/M34)-100%-Rep4	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-100%-Rep4	Hardness	294	304			

APPENDIX C: Test data sheet for the serial dilution of CC48/M34 with A68

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-95%-Rep1	No. Alive	10	0	-	-	-
A68/(CC48/M34)-95%-Rep1	pH	4.58	4.73	-	-	-
A68/(CC48/M34)-95%-Rep1	Temp (C)	12.69	11.79	-	-	-
A68/(CC48/M34)-95%-Rep1	D.O. (mg/L)	8.72	8.56	-	-	-
A68/(CC48/M34)-95%-Rep1	Conductivity (us/cm)	670	679.7	-	-	-
A68/(CC48/M34)-95%-Rep1	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-95%-Rep1	Hardness	293	289			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-95%-Rep2	No. Alive	10	0	-	-	-
A68/(CC48/M34)-95%-Rep2	pH	4.53	4.67	-	-	-
A68/(CC48/M34)-95%-Rep2	Temp (C)	12.92	11.78	-	-	-
A68/(CC48/M34)-95%-Rep2	D.O. (mg/L)	8.63	8.55	-	-	-
A68/(CC48/M34)-95%-Rep2	Conductivity (us/cm)	668.5	677.9	-	-	-
A68/(CC48/M34)-95%-Rep2	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-95%-Rep2	Hardness	293	289			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-95%-Rep3	No. Alive	10	0	-	-	-
A68/(CC48/M34)-95%-Rep3	pH	4.53	4.69	-	-	-
A68/(CC48/M34)-95%-Rep3	Temp (C)	12.96	11.78	-	-	-
A68/(CC48/M34)-95%-Rep3	D.O. (mg/L)	8.61	8.54	-	-	-
A68/(CC48/M34)-95%-Rep3	Conductivity (us/cm)	668.1	679.4	-	-	-
A68/(CC48/M34)-95%-Rep3	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-95%-Rep3	Hardness	293	289			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-95%-Rep4	No. Alive	10	1	0	-	-
A68/(CC48/M34)-95%-Rep4	pH	4.52	4.66	4.66	-	-
A68/(CC48/M34)-95%-Rep4	Temp (C)	12.85	11.8	12.03	-	-
A68/(CC48/M34)-95%-Rep4	D.O. (mg/L)	8.66	8.52	8.71	-	-
A68/(CC48/M34)-95%-Rep4	Conductivity (us/cm)	668.7	679	672.1	-	-
A68/(CC48/M34)-95%-Rep4	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-95%-Rep4	Hardness	293	289			

APPENDIX C: Test data sheet for the serial dilution of CC48/M34 with A68

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-90%-Rep1	No. Alive	10	0	-	-	-
A68/(CC48/M34)-90%-Rep1	pH	4.65	4.75	-	-	-
A68/(CC48/M34)-90%-Rep1	Temp (C)	12.58	11.79	-	-	-
A68/(CC48/M34)-90%-Rep1	D.O. (mg/L)	8.75	8.57	-	-	-
A68/(CC48/M34)-90%-Rep1	Conductivity (us/cm)	651.8	669.1	-	-	-
A68/(CC48/M34)-90%-Rep1	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-90%-Rep1	Hardness	291	285			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-90%-Rep2	No. Alive	10	0	-	-	-
A68/(CC48/M34)-90%-Rep2	pH	4.63	4.85	-	-	-
A68/(CC48/M34)-90%-Rep2	Temp (C)	12.5	11.76	-	-	-
A68/(CC48/M34)-90%-Rep2	D.O. (mg/L)	8.7	8.59	-	-	-
A68/(CC48/M34)-90%-Rep2	Conductivity (us/cm)	651.5	667.5	-	-	-
A68/(CC48/M34)-90%-Rep2	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-90%-Rep2	Hardness	291	285			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-90%-Rep3	No. Alive	10	0	-	-	-
A68/(CC48/M34)-90%-Rep3	pH	4.66	4.76	-	-	-
A68/(CC48/M34)-90%-Rep3	Temp (C)	12.65	11.78	-	-	-
A68/(CC48/M34)-90%-Rep3	D.O. (mg/L)	8.79	8.59	-	-	-
A68/(CC48/M34)-90%-Rep3	Conductivity (us/cm)	650.6	668	-	-	-
A68/(CC48/M34)-90%-Rep3	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-90%-Rep3	Hardness	291	285			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-90%-Rep4	No. Alive	10	0	-	-	-
A68/(CC48/M34)-90%-Rep4	pH	4.63	4.74	-	-	-
A68/(CC48/M34)-90%-Rep4	Temp (C)	12.64	11.79	-	-	-
A68/(CC48/M34)-90%-Rep4	D.O. (mg/L)	8.78	8.57	-	-	-
A68/(CC48/M34)-90%-Rep4	Conductivity (us/cm)	653.3	666.9	-	-	-
A68/(CC48/M34)-90%-Rep4	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-90%-Rep4	Hardness	291	285			

APPENDIX C: Test data sheet for the serial dilution of CC48/M34 with A68

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-80%-Rep1	No. Alive	10	0	-	-	-
A68/(CC48/M34)-80%-Rep1	pH	4.69	4.9	-	-	-
A68/(CC48/M34)-80%-Rep1	Temp (C)	12.39	11.86	-	-	-
A68/(CC48/M34)-80%-Rep1	D.O. (mg/L)	8.66	8.48	-	-	-
A68/(CC48/M34)-80%-Rep1	Conductivity (us/cm)	622.5	636.5	-	-	-
A68/(CC48/M34)-80%-Rep1	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-80%-Rep1	Hardness	275	271			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-80%-Rep2	No. Alive	10	0	-	-	-
A68/(CC48/M34)-80%-Rep2	pH	4.74	4.84	-	-	-
A68/(CC48/M34)-80%-Rep2	Temp (C)	12.55	11.85	-	-	-
A68/(CC48/M34)-80%-Rep2	D.O. (mg/L)	8.68	8.5	-	-	-
A68/(CC48/M34)-80%-Rep2	Conductivity (us/cm)	625.6	636.7	-	-	-
A68/(CC48/M34)-80%-Rep2	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-80%-Rep2	Hardness	275	271			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-80%-Rep3	No. Alive	10	0	-	-	-
A68/(CC48/M34)-80%-Rep3	pH	4.69	4.81	-	-	-
A68/(CC48/M34)-80%-Rep3	Temp (C)	12.59	11.85	-	-	-
A68/(CC48/M34)-80%-Rep3	D.O. (mg/L)	8.73	8.48	-	-	-
A68/(CC48/M34)-80%-Rep3	Conductivity (us/cm)	623.8	636.6	-	-	-
A68/(CC48/M34)-80%-Rep3	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-80%-Rep3	Hardness	275	271			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-80%-Rep4	No. Alive	10	0	-	-	-
A68/(CC48/M34)-80%-Rep4	pH	4.67	4.78	-	-	-
A68/(CC48/M34)-80%-Rep4	Temp (C)	12.63	11.82	-	-	-
A68/(CC48/M34)-80%-Rep4	D.O. (mg/L)	8.72	8.46	-	-	-
A68/(CC48/M34)-80%-Rep4	Conductivity (us/cm)	625	637	-	-	-
A68/(CC48/M34)-80%-Rep4	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-80%-Rep4	Hardness	275	271			

APPENDIX C: Test data sheet for the serial dilution of CC48/M34 with A68

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-75%-Rep1	No. Alive	10	0	-	-	-
A68/(CC48/M34)-75%-Rep1	pH	4.95	5.22	-	-	-
A68/(CC48/M34)-75%-Rep1	Temp (C)	12.41	11.91	-	-	-
A68/(CC48/M34)-75%-Rep1	D.O. (mg/L)	8.59	8.47	-	-	-
A68/(CC48/M34)-75%-Rep1	Conductivity (us/cm)	608.2	624.7	-	-	-
A68/(CC48/M34)-75%-Rep1	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-75%-Rep1	Hardness	274	278			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-75%-Rep2	No. Alive	10	1	0	-	-
A68/(CC48/M34)-75%-Rep2	pH	4.93	5.09	5.43	-	-
A68/(CC48/M34)-75%-Rep2	Temp (C)	12.45	11.89	11.9	-	-
A68/(CC48/M34)-75%-Rep2	D.O. (mg/L)	8.58	8.45	8.61	-	-
A68/(CC48/M34)-75%-Rep2	Conductivity (us/cm)	604	619.8	623.2	-	-
A68/(CC48/M34)-75%-Rep2	Alkalinity	<5.00U		<5.00U		
A68/(CC48/M34)-75%-Rep2	Hardness	274		278		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-75%-Rep3	No. Alive	10	2	0	-	-
A68/(CC48/M34)-75%-Rep3	pH	4.85	5.15	5.1	-	-
A68/(CC48/M34)-75%-Rep3	Temp (C)	12.42	11.88	11.91	-	-
A68/(CC48/M34)-75%-Rep3	D.O. (mg/L)	8.63	8.44	8.65	-	-
A68/(CC48/M34)-75%-Rep3	Conductivity (us/cm)	612.1	623.7	627.2	-	-
A68/(CC48/M34)-75%-Rep3	Alkalinity	<5.00U		<5.00U		
A68/(CC48/M34)-75%-Rep3	Hardness	274		278		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-75%-Rep4	No. Alive	10	0	-	-	-
A68/(CC48/M34)-75%-Rep4	pH	4.84	5.06	-	-	-
A68/(CC48/M34)-75%-Rep4	Temp (C)	12.57	11.87	-	-	-
A68/(CC48/M34)-75%-Rep4	D.O. (mg/L)	8.71	8.48	-	-	-
A68/(CC48/M34)-75%-Rep4	Conductivity (us/cm)	609.7	626.1	-	-	-
A68/(CC48/M34)-75%-Rep4	Alkalinity	<5.00U	<5.00U			
A68/(CC48/M34)-75%-Rep4	Hardness	274	278			

APPENDIX C: Test data sheet for the serial dilution of CC48/M34 with A68

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-50%-Rep1	No. Alive	10	10	10	10	9
A68/(CC48/M34)-50%-Rep1	pH	6.34	6.95	6.96	7.02	7.01
A68/(CC48/M34)-50%-Rep1	Temp (C)	12.41	12.01	11.81	11.74	12.01
A68/(CC48/M34)-50%-Rep1	D.O. (mg/L)	8.79	8.28	8.29	8.21	8.32
A68/(CC48/M34)-50%-Rep1	Conductivity (us/cm)	542	549.5	550.1	549.2	550.4
A68/(CC48/M34)-50%-Rep1	Alkalinity	5.36				7.01
A68/(CC48/M34)-50%-Rep1	Hardness	244				242

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-50%-Rep2	No. Alive	10	10	10	9	8
A68/(CC48/M34)-50%-Rep2	pH	6.22	6.89	6.98	6.97	6.98
A68/(CC48/M34)-50%-Rep2	Temp (C)	12.32	11.99	11.84	11.72	11.99
A68/(CC48/M34)-50%-Rep2	D.O. (mg/L)	8.76	8.14	8.26	8.22	8.32
A68/(CC48/M34)-50%-Rep2	Conductivity (us/cm)	542.8	548.5	550.8	549.1	548.6
A68/(CC48/M34)-50%-Rep2	Alkalinity	5.36				7.01
A68/(CC48/M34)-50%-Rep2	Hardness	244				242

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-50%-Rep3	No. Alive	10	10	10	10	9
A68/(CC48/M34)-50%-Rep3	pH	6.04	6.84	6.94	6.96	6.92
A68/(CC48/M34)-50%-Rep3	Temp (C)	12.36	12	11.86	11.7	12.02
A68/(CC48/M34)-50%-Rep3	D.O. (mg/L)	8.72	8.13	8.28	8.29	8.28
A68/(CC48/M34)-50%-Rep3	Conductivity (us/cm)	541.7	548.5	548.1	549.5	548.3
A68/(CC48/M34)-50%-Rep3	Alkalinity	5.36				7.01
A68/(CC48/M34)-50%-Rep3	Hardness	244				242

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-50%-Rep4	No. Alive	10	10	10	10	10
A68/(CC48/M34)-50%-Rep4	pH	5.98	6.81	6.92	6.94	6.83
A68/(CC48/M34)-50%-Rep4	Temp (C)	12.43	11.99	11.85	11.72	12.01
A68/(CC48/M34)-50%-Rep4	D.O. (mg/L)	8.7	8.19	8.3	8.36	8.3
A68/(CC48/M34)-50%-Rep4	Conductivity (us/cm)	542.8	548.2	547.6	546.5	547.6
A68/(CC48/M34)-50%-Rep4	Alkalinity	5.36				7.01
A68/(CC48/M34)-50%-Rep4	Hardness	244				242

APPENDIX C: Test data sheet for the serial dilution of CC48/M34 with A68

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-25%-Rep1	No. Alive	10	10	10	10	10
A68/(CC48/M34)-25%-Rep1	pH	6.97	7.14	7.22	7.27	7.25
A68/(CC48/M34)-25%-Rep1	Temp (C)	12.46	12.1	11.82	11.77	12.02
A68/(CC48/M34)-25%-Rep1	D.O. (mg/L)	8.42	8.14	8.43	8.23	8.41
A68/(CC48/M34)-25%-Rep1	Conductivity (us/cm)	483.8	491.4	493.5	495.4	498.1
A68/(CC48/M34)-25%-Rep1	Alkalinity	16.6				22.8
A68/(CC48/M34)-25%-Rep1	Hardness	214				221

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-25%-Rep2	No. Alive	10	10	10	10	10
A68/(CC48/M34)-25%-Rep2	pH	6.89	7.06	7.19	7.26	7.23
A68/(CC48/M34)-25%-Rep2	Temp (C)	12.6	12.05	11.81	11.75	12.01
A68/(CC48/M34)-25%-Rep2	D.O. (mg/L)	8.52	8.21	8.43	8.27	8.4
A68/(CC48/M34)-25%-Rep2	Conductivity (us/cm)	484.2	491.8	495.8	496.3	496.5
A68/(CC48/M34)-25%-Rep2	Alkalinity	16.6				22.8
A68/(CC48/M34)-25%-Rep2	Hardness	214				221

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-25%-Rep3	No. Alive	10	10	10	10	10
A68/(CC48/M34)-25%-Rep3	pH	6.84	7.04	7.16	7.33	7.24
A68/(CC48/M34)-25%-Rep3	Temp (C)	12.58	12.04	11.8	11.75	12.02
A68/(CC48/M34)-25%-Rep3	D.O. (mg/L)	8.65	8.17	8.35	8.23	8.4
A68/(CC48/M34)-25%-Rep3	Conductivity (us/cm)	485.3	490.6	493.4	497.3	495.3
A68/(CC48/M34)-25%-Rep3	Alkalinity	16.6				22.8
A68/(CC48/M34)-25%-Rep3	Hardness	214				221

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
A68/(CC48/M34)-25%-Rep4	No. Alive	10	10	10	10	10
A68/(CC48/M34)-25%-Rep4	pH	6.82	7.02	7.13	7.3	7.24
A68/(CC48/M34)-25%-Rep4	Temp (C)	12.6	12.04	11.81	11.76	12.03
A68/(CC48/M34)-25%-Rep4	D.O. (mg/L)	8.74	8.13	8.28	8.21	8.33
A68/(CC48/M34)-25%-Rep4	Conductivity (us/cm)	481.2	490.9	492..8	493.6	495
A68/(CC48/M34)-25%-Rep4	Alkalinity	16.6				22.8
A68/(CC48/M34)-25%-Rep4	Hardness	214				221

APPENDIX D: Test data sheet for the serial dilution of CC48/M34 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)Control-Rep1	No. Alive	10	10	10	10	10
HRW (CC48/M34)Control-Rep1	pH	7.74	7.65	7.67	7.77	7.68
HRW (CC48/M34)Control-Rep1	Temp (C)	13.25	12.05	12.21	11.93	11.92
HRW (CC48/M34)Control-Rep1	D.O. (mg/L)	8.03	8.02	7.55	7.72	7.89
HRW (CC48/M34)Control-Rep1	Conductivity (us/cm)	627.4	637.8	637.8	642.2	639.4
HRW (CC48/M34)Control-Rep1	Alkalinity	123				125
HRW (CC48/M34)Control-Rep1	Hardness	176				181

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)Control-Rep2	No. Alive	10	10	10	10	10
HRW (CC48/M34)Control-Rep2	pH	7.87	7.76	7.81	7.85	7.77
HRW (CC48/M34)Control-Rep2	Temp (C)	13.18	11.95	12.14	11.88	11.83
HRW (CC48/M34)Control-Rep2	D.O. (mg/L)	8.11	8.1	7.69	7.76	8.13
HRW (CC48/M34)Control-Rep2	Conductivity (us/cm)	634.8	636.5	635.5	638.9	640.1
HRW (CC48/M34)Control-Rep2	Alkalinity	123				125
HRW (CC48/M34)Control-Rep2	Hardness	176				181

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)Control-Rep3	No. Alive	10	10	10	10	10
HRW (CC48/M34)Control-Rep3	pH	8.08	7.85	7.97	7.93	7.89
HRW (CC48/M34)Control-Rep3	Temp (C)	13.12	11.9	12.03	11.79	11.8
HRW (CC48/M34)Control-Rep3	D.O. (mg/L)	8.07	8.24	8	8.03	8.28
HRW (CC48/M34)Control-Rep3	Conductivity (us/cm)	628.6	635.1	638.4	639.7	639
HRW (CC48/M34)Control-Rep3	Alkalinity	123				125
HRW (CC48/M34)Control-Rep3	Hardness	176				181

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)Control-Rep4	No. Alive	10	10	10	10	10
HRW (CC48/M34)Control-Rep4	pH	8.16	7.91	8.03	7.93	7.97
HRW (CC48/M34)Control-Rep4	Temp (C)	13.1	11.89	12.02	11.78	11.79
HRW (CC48/M34)Control-Rep4	D.O. (mg/L)	8.08	8.35	8.16	8.09	8.34
HRW (CC48/M34)Control-Rep4	Conductivity (us/cm)	631.4	644.8	636.9	639.6	642.1
HRW (CC48/M34)Control-Rep4	Alkalinity	123				125
HRW (CC48/M34)Control-Rep4	Hardness	176				181

APPENDIX D: Test data sheet for the serial dilution of CC48/M34 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-95%-Rep1	No. Alive	10	0	-	-	-
HRW (CC48/M34)-95%-Rep1	pH	5.15	5	-	-	-
HRW (CC48/M34)-95%-Rep1	Temp (C)	12.13	11.96	-	-	-
HRW (CC48/M34)-95%-Rep1	D.O. (mg/L)	8.82	8.58	-	-	-
HRW (CC48/M34)-95%-Rep1	Conductivity (us/cm)	672.7	686	-	-	-
HRW (CC48/M34)-95%-Rep1	Alkalinity	<5.00U	<5.00U			
HRW (CC48/M34)-95%-Rep1	Hardness	293	292			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-95%-Rep2	No. Alive	10	0	-	-	-
HRW (CC48/M34)-95%-Rep2	pH	4.58	4.95	-	-	-
HRW (CC48/M34)-95%-Rep2	Temp (C)	12.09	11.96	-	-	-
HRW (CC48/M34)-95%-Rep2	D.O. (mg/L)	8.91	8.5	-	-	-
HRW (CC48/M34)-95%-Rep2	Conductivity (us/cm)	675.1	686.6	-	-	-
HRW (CC48/M34)-95%-Rep2	Alkalinity	<5.00U	<5.00U			
HRW (CC48/M34)-95%-Rep2	Hardness	293	292			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-95%-Rep3	No. Alive	10	0	-	-	-
HRW (CC48/M34)-95%-Rep3	pH	4.53	5.02	-	-	-
HRW (CC48/M34)-95%-Rep3	Temp (C)	12.05	11.96	-	-	-
HRW (CC48/M34)-95%-Rep3	D.O. (mg/L)	8.95	8.51	-	-	-
HRW (CC48/M34)-95%-Rep3	Conductivity (us/cm)	675.6	689.3	-	-	-
HRW (CC48/M34)-95%-Rep3	Alkalinity	<5.00U	<5.00U			
HRW (CC48/M34)-95%-Rep3	Hardness	293	292			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-95%-Rep4	No. Alive	10	0	-	-	-
HRW (CC48/M34)-95%-Rep4	pH	4.48	4.98	-	-	-
HRW (CC48/M34)-95%-Rep4	Temp (C)	12	11.96	-	-	-
HRW (CC48/M34)-95%-Rep4	D.O. (mg/L)	9.01	8.55	-	-	-
HRW (CC48/M34)-95%-Rep4	Conductivity (us/cm)	674.2	688.8	-	-	-
HRW (CC48/M34)-95%-Rep4	Alkalinity	<5.00U	<5.00U			
HRW (CC48/M34)-95%-Rep4	Hardness	293	292			

APPENDIX D: Test data sheet for the serial dilution of CC48/M34 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-90%-Rep1	No. Alive	10	0	-	-	-
HRW (CC48/M34)-90%-Rep1	pH	5.32	6.36	-	-	-
HRW (CC48/M34)-90%-Rep1	Temp (C)	12.23	11.93	-	-	-
HRW (CC48/M34)-90%-Rep1	D.O. (mg/L)	8.8	8.46	-	-	-
HRW (CC48/M34)-90%-Rep1	Conductivity (us/cm)	658.6	677.4	-	-	-
HRW (CC48/M34)-90%-Rep1	Alkalinity	<5.00U	<5.00U			
HRW (CC48/M34)-90%-Rep1	Hardness	283	280			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-90%-Rep2	No. Alive	10	0	-	-	-
HRW (CC48/M34)-90%-Rep2	pH	5.26	5.61	-	-	-
HRW (CC48/M34)-90%-Rep2	Temp (C)	12.2	11.95	-	-	-
HRW (CC48/M34)-90%-Rep2	D.O. (mg/L)	8.91	8.5	-	-	-
HRW (CC48/M34)-90%-Rep2	Conductivity (us/cm)	657.7	672.6	-	-	-
HRW (CC48/M34)-90%-Rep2	Alkalinity	<5.00U	<5.00U			
HRW (CC48/M34)-90%-Rep2	Hardness	283	280			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-90%-Rep3	No. Alive	10	0	-	-	-
HRW (CC48/M34)-90%-Rep3	pH	5.15	5.4	-	-	-
HRW (CC48/M34)-90%-Rep3	Temp (C)	12.15	11.96	-	-	-
HRW (CC48/M34)-90%-Rep3	D.O. (mg/L)	8.89	8.5	-	-	-
HRW (CC48/M34)-90%-Rep3	Conductivity (us/cm)	659.7	673.1	-	-	-
HRW (CC48/M34)-90%-Rep3	Alkalinity	<5.00U	<5.00U			
HRW (CC48/M34)-90%-Rep3	Hardness	283	280			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-90%-Rep4	No. Alive	10	1	0	-	-
HRW (CC48/M34)-90%-Rep4	pH	5.17	5.36	5.8	-	-
HRW (CC48/M34)-90%-Rep4	Temp (C)	12.09	11.96	11.8	-	-
HRW (CC48/M34)-90%-Rep4	D.O. (mg/L)	8.94	8.54	8.58	-	-
HRW (CC48/M34)-90%-Rep4	Conductivity (us/cm)	657.9	675.7	682.1	-	-
HRW (CC48/M34)-90%-Rep4	Alkalinity	<5.00U		<5.00U		
HRW (CC48/M34)-90%-Rep4	Hardness	283		280		

APPENDIX D: Test data sheet for the serial dilution of CC48/M34 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-75%-Rep1	No. Alive	10	10	10	10	10
HRW (CC48/M34)-75%-Rep1	pH	6.69	7.49	7.51	7.36	7.5
HRW (CC48/M34)-75%-Rep1	Temp (C)	12.44	11.94	11.87	11.77	11.78
HRW (CC48/M34)-75%-Rep1	D.O. (mg/L)	8.57	8.41	8.43	8.43	8.42
HRW (CC48/M34)-75%-Rep1	Conductivity (us/cm)	647	650.6	645.5	648.7	651.9
HRW (CC48/M34)-75%-Rep1	Alkalinity	12.6				13.5
HRW (CC48/M34)-75%-Rep1	Hardness	267				265

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-75%-Rep2	No. Alive	10	10	10	10	10
HRW (CC48/M34)-75%-Rep2	pH	6.61	7.41	7.54	7.31	7.34
HRW (CC48/M34)-75%-Rep2	Temp (C)	12.52	11.94	11.87	11.79	11.78
HRW (CC48/M34)-75%-Rep2	D.O. (mg/L)	8.63	8.32	8.4	8.13	8.33
HRW (CC48/M34)-75%-Rep2	Conductivity (us/cm)	648.2	650.9	648.5	648.5	650.9
HRW (CC48/M34)-75%-Rep2	Alkalinity	12.6				13.5
HRW (CC48/M34)-75%-Rep2	Hardness	267				265

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-75%-Rep3	No. Alive	10	10	10	10	10
HRW (CC48/M34)-75%-Rep3	pH	6.38	7.36	7.38	7.23	7.36
HRW (CC48/M34)-75%-Rep3	Temp (C)	12.32	11.93	11.87	11.8	11.75
HRW (CC48/M34)-75%-Rep3	D.O. (mg/L)	8.66	8.19	8.32	8.12	8.33
HRW (CC48/M34)-75%-Rep3	Conductivity (us/cm)	646.3	649.8	648.9	649.8	650.5
HRW (CC48/M34)-75%-Rep3	Alkalinity	12.6				13.5
HRW (CC48/M34)-75%-Rep3	Hardness	267				265

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-75%-Rep4	No. Alive	10	10	10	10	10
HRW (CC48/M34)-75%-Rep4	pH	6.44	7.33	7.4	7.22	7.41
HRW (CC48/M34)-75%-Rep4	Temp (C)	12.37	11.94	11.85	11.78	11.76
HRW (CC48/M34)-75%-Rep4	D.O. (mg/L)	8.67	8.2	8.28	8.2	8.37
HRW (CC48/M34)-75%-Rep4	Conductivity (us/cm)	646.9	651.3	645	643.9	652
HRW (CC48/M34)-75%-Rep4	Alkalinity	12.6				13.5
HRW (CC48/M34)-75%-Rep4	Hardness	267				265

APPENDIX D: Test data sheet for the serial dilution of CC48/M34 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-50%-Rep1	No. Alive	10	10	10	10	10
HRW (CC48/M34)-50%-Rep1	pH	7.23	7.76	7.8	7.76	7.71
HRW (CC48/M34)-50%-Rep1	Temp (C)	12.79	11.92	11.94	11.75	11.82
HRW (CC48/M34)-50%-Rep1	D.O. (mg/L)	8.34	8.43	8.34	8.31	8.39
HRW (CC48/M34)-50%-Rep1	Conductivity (us/cm)	642.3	645.6	644.1	647.8	648.7
HRW (CC48/M34)-50%-Rep1	Alkalinity	47.9				50.1
HRW (CC48/M34)-50%-Rep1	Hardness	242				235

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-50%-Rep2	No. Alive	10	10	10	10	10
HRW (CC48/M34)-50%-Rep2	pH	7.16	7.75	7.8	7.76	7.62
HRW (CC48/M34)-50%-Rep2	Temp (C)	12.78	11.93	11.92	11.77	11.78
HRW (CC48/M34)-50%-Rep2	D.O. (mg/L)	8.35	8.43	8.26	8.3	8.37
HRW (CC48/M34)-50%-Rep2	Conductivity (us/cm)	640.8	644.2	645.2	646	649.2
HRW (CC48/M34)-50%-Rep2	Alkalinity	47.9				50.1
HRW (CC48/M34)-50%-Rep2	Hardness	242				235

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-50%-Rep3	No. Alive	10	10	10	10	10
HRW (CC48/M34)-50%-Rep3	pH	7.1	7.69	7.79	7.71	7.61
HRW (CC48/M34)-50%-Rep3	Temp (C)	12.62	11.93	11.89	11.76	11.76
HRW (CC48/M34)-50%-Rep3	D.O. (mg/L)	8.34	8.41	8.28	8.24	8.39
HRW (CC48/M34)-50%-Rep3	Conductivity (us/cm)	642.8	646.5	647.2	646.8	648.1
HRW (CC48/M34)-50%-Rep3	Alkalinity	47.9				50.1
HRW (CC48/M34)-50%-Rep3	Hardness	242				235

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-50%-Rep4	No. Alive	10	10	10	10	10
HRW (CC48/M34)-50%-Rep4	pH	7.06	7.66	7.74	7.72	7.73
HRW (CC48/M34)-50%-Rep4	Temp (C)	12.53	11.93	11.88	11.75	11.75
HRW (CC48/M34)-50%-Rep4	D.O. (mg/L)	8.43	8.36	8.3	8.28	8.4
HRW (CC48/M34)-50%-Rep4	Conductivity (us/cm)	639.2	642.2	643.6	642.4	647.1
HRW (CC48/M34)-50%-Rep4	Alkalinity	47.9				50.1
HRW (CC48/M34)-50%-Rep4	Hardness	242				235

APPENDIX D: Test data sheet for the serial dilution of CC48/M34 with HRW

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/19/13	No. Organisms	10
End Date	04/23/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA,BW,LC,NM

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-25%-Rep1	No. Alive	10	10	10	10	10
HRW (CC48/M34)-25%-Rep1	pH	7.74	7.8	7.86	7.85	7.84
HRW (CC48/M34)-25%-Rep1	Temp (C)	13.09	11.92	12.1	11.8	11.79
HRW (CC48/M34)-25%-Rep1	D.O. (mg/L)	8.01	8.14	8.27	8.18	8.4
HRW (CC48/M34)-25%-Rep1	Conductivity (us/cm)	637.1	643.4	646.7	641.5	646.3
HRW (CC48/M34)-25%-Rep1	Alkalinity	83.5				85.0
HRW (CC48/M34)-25%-Rep1	Hardness	210				204

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-25%-Rep2	No. Alive	10	10	10	10	10
HRW (CC48/M34)-25%-Rep2	pH	7.76	7.77	7.87	7.86	7.76
HRW (CC48/M34)-25%-Rep2	Temp (C)	13.22	11.92	12.02	11.78	11.78
HRW (CC48/M34)-25%-Rep2	D.O. (mg/L)	8.08	8.14	8.3	8.21	8.4
HRW (CC48/M34)-25%-Rep2	Conductivity (us/cm)	636.1	641.8	641.8	642.7	646.6
HRW (CC48/M34)-25%-Rep2	Alkalinity	83.5				85.0
HRW (CC48/M34)-25%-Rep2	Hardness	210				204

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-25%-Rep3	No. Alive	10	10	10	10	10
HRW (CC48/M34)-25%-Rep3	pH	7.6	7.88	7.86	7.85	7.88
HRW (CC48/M34)-25%-Rep3	Temp (C)	13.42	11.92	11.96	11.76	11.78
HRW (CC48/M34)-25%-Rep3	D.O. (mg/L)	8.16	8.23	8.33	8.22	8.43
HRW (CC48/M34)-25%-Rep3	Conductivity (us/cm)	636.1	640.3	640.5	641.6	645.6
HRW (CC48/M34)-25%-Rep3	Alkalinity	83.5				85.0
HRW (CC48/M34)-25%-Rep3	Hardness	210				204

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
HRW (CC48/M34)-25%-Rep4	No. Alive	10	10	10	10	10
HRW (CC48/M34)-25%-Rep4	pH	7.55	7.83	7.86	7.85	7.87
HRW (CC48/M34)-25%-Rep4	Temp (C)	13.47	11.91	11.98	11.77	11.81
HRW (CC48/M34)-25%-Rep4	D.O. (mg/L)	8.07	8.28	8.32	8.24	8.46
HRW (CC48/M34)-25%-Rep4	Conductivity (us/cm)	636.8	640.3	642.1	640.3	646.1
HRW (CC48/M34)-25%-Rep4	Alkalinity	83.5				85.0
HRW (CC48/M34)-25%-Rep4	Hardness	210				204

APPENDIX E: Test data sheet for the reference toxicity test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA, BW, NM, LC

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-01	No. Alive	10	10	10	10	10
Control-01	pH	7.84	7.11	7.04	7.15	7.45
Control-01	Temp (C)	12.54	12.24	12.1	12.17	12.29
Control-01	D.O. (mg/L)	8.49	7.92	8.03	7.98	7.09
Control-01	Conductivity (us/cm)	307.9	318.3	279.6	286.4	290.5
Control-01	Alkalinity	56.2				55.6
Control-01	Hardness	89				79

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-02	No. Alive	10	10	10	10	10
Control-02	pH	7.88	7.13	7.18	7.28	7.37
Control-02	Temp (C)	12.32	12.19	12.01	12.13	12.08
Control-02	D.O. (mg/L)	8.57	7.94	8.03	7.94	7.28
Control-02	Conductivity (us/cm)	306.3	313.9	279.6	283.5	288.8
Control-02	Alkalinity	56.2				55.6
Control-02	Hardness	89				79

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-03	No. Alive	10	10	10	10	10
Control-03	pH	7.89	7.15	7.09	7.22	7.5
Control-03	Temp (C)	12.18	12.05	11.86	11.98	11.93
Control-03	D.O. (mg/L)	8.64	8.03	8.06	7.97	7.66
Control-03	Conductivity (us/cm)	306.5	314.5	278.4	283.4	288.2
Control-03	Alkalinity	56.2				55.6
Control-03	Hardness	89				79

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-04	No. Alive	10	10	10	10	10
Control-04	pH	7.94	7.19	7.12	7.35	7.57
Control-04	Temp (C)	12.13	12.01	11.82	11.84	11.9
Control-04	D.O. (mg/L)	8.63	8.05	8.1	8.01	7.89
Control-04	Conductivity (us/cm)	306.6	314	278.7	283.7	287.4
Control-04	Alkalinity	56.2				55.6
Control-04	Hardness	89				79

APPENDIX E: Test data sheet for the reference toxicity test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA, BW, NM, LC

APPENDIX E: Test data sheet for the reference toxicity test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA, BW, NM, LC

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-01	No. Alive	10	10	9	9	9
6.25%-01	pH	8.05	7.38	7.18	7.49	7.58
6.25%-01	Temp (C)	12.1	12.01	11.86	11.85	11.94
6.25%-01	D.O. (mg/L)	8.66	8.11	8.23	8.32	8.23
6.25%-01	Conductivity (us/cm)	306.6	317.7	280.5	284.6	288.1
6.25%-01	Alkalinity	55.4				55.4
6.25%-01	Hardness	90				79

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-02	No. Alive	10	10	10	10	10
6.25%-02	pH	8.02	7.47	7.2	7.48	7.62
6.25%-02	Temp (C)	12.11	11.86	11.83	11.82	11.91
6.25%-02	D.O. (mg/L)	8.66	7.3	8.19	8.28	8.28
6.25%-02	Conductivity (us/cm)	306.8	316.2	278.5	284.3	288.5
6.25%-02	Alkalinity	55.4				55.4
6.25%-02	Hardness	90				79

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-03	No. Alive	10	10	10	10	10
6.25%-03	pH	8.03	7.19	7.21	7.5	7.65
6.25%-03	Temp (C)	12.12	12.02	11.82	11.76	11.84
6.25%-03	D.O. (mg/L)	8.67	7.16	8.17	8.25	8.31
6.25%-03	Conductivity (us/cm)	306.5	314.5	277.5	282.6	286.2
6.25%-03	Alkalinity	55.4				55.4
6.25%-03	Hardness	90				79

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%-04	No. Alive	10	10	10	10	10
6.25%-04	pH	7.99	7.35	7.23	7.5	7.62
6.25%-04	Temp (C)	12.11	12.02	11.81	11.74	11.82
6.25%-04	D.O. (mg/L)	8.67	7.52	8.22	8.17	8.23
6.25%-04	Conductivity (us/cm)	306.4	315.6	279.1	284	287.3
6.25%-04	Alkalinity	55.4				55.4
6.25%-04	Hardness	90				79

APPENDIX E: Test data sheet for the reference toxicity test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA, BW, NM, LC

APPENDIX E: Test data sheet for the reference toxicity test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA, BW, NM, LC

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
12.5%-01	No. Alive	10	10	9	9	9
12.5%-01	pH	8	7.19	7.28	7.48	7.66
12.5%-01	Temp (C)	11.94	12.02	11.79	11.77	11.84
12.5%-01	D.O. (mg/L)	8.69	7.5	8.35	8.23	8.23
12.5%-01	Conductivity (us/cm)	307.3	328.3	281.3	286.8	290
12.5%-01	Alkalinity	53.7				53.1
12.5%-01	Hardness	88				78

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
12.5%-02	No. Alive	10	9	8	7	7
12.5%-02	pH	7.98	7.36	7.14	7.49	7.68
12.5%-02	Temp (C)	11.95	12.03	11.8	11.77	11.83
12.5%-02	D.O. (mg/L)	8.71	7.42	8.4	8.25	8.27
12.5%-02	Conductivity (us/cm)	307.2	316.2	278.4	283.1	284
12.5%-02	Alkalinity	53.7				53.1
12.5%-02	Hardness	88				78

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
12.5%-03	No. Alive	10	8	8	8	8
12.5%-03	pH	7.99	7.09	7.29	7.52	7.65
12.5%-03	Temp (C)	12.09	12.05	11.8	11.76	11.82
12.5%-03	D.O. (mg/L)	8.68	7.36	8.44	8.24	8.3
12.5%-03	Conductivity (us/cm)	306.5	316.3	279.2	283.2	286.2
12.5%-03	Alkalinity	53.7				53.1
12.5%-03	Hardness	88				78

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
12.5%-04	No. Alive	10	10	10	10	10
12.5%-04	pH	7.98	7.12	7.53	7.51	7.64
12.5%-04	Temp (C)	12.09	12.03	11.8	11.74	11.81
12.5%-04	D.O. (mg/L)	8.69	7.28	8.45	8.32	8.34
12.5%-04	Conductivity (us/cm)	306.5	320.8	283.2	288.9	288.8
12.5%-04	Alkalinity	53.7				53.1
12.5%-04	Hardness	88				78

APPENDIX E: Test data sheet for the reference toxicity test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA, BW, NM, LC

APPENDIX E: Test data sheet for the reference toxicity test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA, BW, NM, LC

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
25%-01	No. Alive	10	3	1	1	1
25%-01	pH	8.07	7.46	7.4	7.53	7.74
25%-01	Temp (C)	12.13	12.04	11.82	11.71	11.82
25%-01	D.O. (mg/L)	8.67	8.04	8.5	8.53	8.47
25%-01	Conductivity (us/cm)	306.3	317.4	275.8	276	282.4
25%-01	Alkalinity	60.4				55.1
25%-01	Hardness	90				79

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
25%-02	No. Alive	10	5	3	2	2
25%-02	pH	8.06	7.52	7.35	7.63	7.61
25%-02	Temp (C)	12.12	12.04	11.83	11.73	11.84
25%-02	D.O. (mg/L)	8.68	8.14	8.47	8.57	8.55
25%-02	Conductivity (us/cm)	305.8	320	277.6	278.9	281.3
25%-02	Alkalinity	60.4				55.1
25%-02	Hardness	90				79

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
25%-03	No. Alive	10	5	2	2	2
25%-03	pH	7.99	7.5	7.37	7.62	7.75
25%-03	Temp (C)	12.05	12.04	11.82	11.75	11.82
25%-03	D.O. (mg/L)	8.7	8.1	8.47	8.57	8.55
25%-03	Conductivity (us/cm)	305.9	320.1	277.8	277.7	280.1
25%-03	Alkalinity	60.4				55.1
25%-03	Hardness	90				79

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
25%-04	No. Alive	10	5	2	1	1
25%-04	pH	7.97	7.55	7.35	7.61	7.78
25%-04	Temp (C)	12.03	12.05	11.82	11.74	11.84
25%-04	D.O. (mg/L)	8.7	8.13	8.49	8.58	8.56
25%-04	Conductivity (us/cm)	306.6	318.5	278	277.2	276.7
25%-04	Alkalinity	60.4				55.1
25%-04	Hardness	90				79

APPENDIX E: Test data sheet for the reference toxicity test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA, BW, NM, LC

APPENDIX E: Test data sheet for the reference toxicity test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA, BW, NM, LC

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
50%-01	No. Alive	10	0	-	-	-
50%-01	pH	7.92	7.63	-	-	-
50%-01	Temp (C)	12.05	12.03	-	-	-
50%-01	D.O. (mg/L)	8.7	8.35	-	-	-
50%-01	Conductivity (us/cm)	306.6	322.1	-	-	-
50%-01	Alkalinity	56.9	50.4			
50%-01	Hardness	89	76			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
50%-02	No. Alive	10	2	0	-	-
50%-02	pH	7.88	7.76	7.32	-	-
50%-02	Temp (C)	12.01	12.04	11.84	-	-
50%-02	D.O. (mg/L)	8.74	8.43	8.6	-	-
50%-02	Conductivity (us/cm)	306.6	321	275.4	-	-
50%-02	Alkalinity	56.9		50.4		
50%-02	Hardness	89		76		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
50%-03	No. Alive	10	0	-	-	-
50%-03	pH	7.87	7.54	-	-	-
50%-03	Temp (C)	11.98	12.03	-	-	-
50%-03	D.O. (mg/L)	8.73	8.47	-	-	-
50%-03	Conductivity (us/cm)	306.6	318.8	-	-	-
50%-03	Alkalinity	56.9	50.4			
50%-03	Hardness	89	76			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
50%-04	No. Alive	10	2	1	0	-
50%-04	pH	7.96	7.53	7.33	7.6	-
50%-04	Temp (C)	11.99	12.02	11.85	11.75	-
50%-04	D.O. (mg/L)	8.74	8.46	8.61	8.66	-
50%-04	Conductivity (us/cm)	306.6	319.1	276.7	275.2	-
50%-04	Alkalinity	56.9			50.4	
50%-04	Hardness	89			76	

APPENDIX E: Test data sheet for the reference toxicity test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA, BW, NM, LC

APPENDIX E: Test data sheet for the reference toxicity test

Upper Animas 2013
Aquatic Toxicity Test

Start Date	04/18/13	No. Organisms	10
End Date	04/22/13	No. of Replicates	4
Organism	RBT (0.38 gram)	Analysts	SA, BW, NM, LC

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
100%-01	No. Alive	10	1	0	-	-
100%-01	pH	7.84	7.61	7.28	-	-
100%-01	Temp (C)	12.06	11.99	11.87	-	-
100%-01	D.O. (mg/L)	8.72	7.98	8.62	-	-
100%-01	Conductivity (us/cm)	306.8	322.6	274.9	-	-
100%-01	Alkalinity	56.8		52.6		
100%-01	Hardness	90		77		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
100%-02	No. Alive	10	0	-	-	-
100%-02	pH	7.79	7.55	-	-	-
100%-02	Temp (C)	12.02	12.01	-	-	-
100%-02	D.O. (mg/L)	8.71	8.16	-	-	-
100%-02	Conductivity (us/cm)	306.6	319	-	-	-
100%-02	Alkalinity	56.8	52.6			
100%-02	Hardness	90	77			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
100%-03	No. Alive	10	0	-	-	-
100%-03	pH	7.79	7.54	-	-	-
100%-03	Temp (C)	12	12.02	-	-	-
100%-03	D.O. (mg/L)	8.73	8.26	-	-	-
100%-03	Conductivity (us/cm)	306.8	321	-	-	-
100%-03	Alkalinity	56.8	52.6			
100%-03	Hardness	90	77			

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
100%-04	No. Alive	10	1	0	-	-
100%-04	pH	7.78	7.5	7.32	-	-
100%-04	Temp (C)	11.99	12.02	11.87	-	-
100%-04	D.O. (mg/L)	8.72	8.29	8.63	-	-
100%-04	Conductivity (us/cm)	306.8	321.8	275	-	-
100%-04	Alkalinity	56.8		52.6		
100%-04	Hardness	90		77		

Attachments

Attachment 1:

CETIS analyses of the acute toxicity data for the profile test

CETIS Test Data Worksheet

Report Date: 05 Jun-13 10:31 (p 1 of 1)
Test Code: 20-4898-5532/7A2109BC

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Start Date: 18 Apr-13
End Date: 22 Apr-13
Sample Date: 18 Apr-13
Species: Oncorhynchus mykiss
Protocol: EPA/821/R-02-012 (2002)
Material: Lab Control
Sample Code: HRW-Lab Control
Sample Source: Upper Animas River
Sample Station: Control

Batch Note: Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test#1, no dilutions)

Sample Code	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
HRW-Lab Control	1	10	10	10	10	10	10	
HRW-Lab Control	2	11	10	10	10	10	10	
HRW-Lab Control	3	6	10	10	10	10	10	
HRW-Lab Control	4	20	10	10	10	10	10	
A75B	1	27	10	10	10	10	10	
A75B	2	1	10	10	10	10	10	
A75B	3	22	10	10	10	10	10	
A75B	4	5	10	10	10	10	10	
A73B	1	7	10	10	10	10	10	
A73B	2	2	10	10	10	10	10	
A73B	3	25	10	10	10	9	9	
A73B	4	8	10	10	10	10	10	
A73	1	16	10	10	9	9	9	
A73	2	28	10	10	10	10	10	
A73	3	17	10	10	10	10	10	
A73	4	18	9	9	9	9	9	
A72	1	15	10	10	3	0	0	
A72	2	9	10	10	3	0	0	
A72	3	13	10	10	4	0	0	
A72	4	24	10	9	6	0	0	
A68	1	12	10	10	9	8	8	
A68	2	21	10	10	6	5	5	
A68	3	4	10	10	8	8	8	
A68	4	19	10	10	9	6	6	
M34	1	26	10	10	4	3	0	
M34	2	3	10	10	5	4	3	
M34	3	14	10	10	6	4	3	
M34	4	23	10	10	7	5	0	

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID: 09-0066-7618 **Endpoint:** 96h Survival Rate **CETIS Version:** CETISv1.8.0
Analyzed: 19 Jun-13 15:41 **Analysis:** Nonparametric-Control vs Treatments **Official Results:** Yes

Sample Code	Sample Comments
HRW-Lab Control	Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test#1, no dilutions).
A75B	Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test#1, no dilutions).
A73B	Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test#1, no dilutions).
A73	Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test#1, no dilutions).
A72	Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test#1, no dilutions).
A68	Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test#1, no dilutions).
M34	Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test #1, no dilutions).

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run					12.7%

Steel Many-One Rank Test

Sample Code vs	Sample Code	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
HRW-Lab Control	A75B	18	10	6	1	0.8571	Non-Significant Effect
	A73B	16	10	6	1	0.6450	Non-Significant Effect
	A73	16	10	6	1	0.6450	Non-Significant Effect
	A72	10	10	6	0	0.0480	Significant Effect
	A68	10	10	6	0	0.0480	Significant Effect
	M34	10	10	6	0	0.0480	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	6.877513	1.146252	6	81.59	<0.0001	Significant Effect
Error	0.2950439	0.01404971	21			
Total	7.172557	1.160302	27			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	12.28	3.812	<0.0001	Unequal Variances
Distribution	Shapiro-Wilk W Normality	0.8904	0.8975	0.0069	Non-normal Distribution

96h Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
HRW-Lab Control	4	1	1	1	1	1	0	0	0.0%	0.0%
A75B	4	1	1	1	1	1	0	0	0.0%	0.0%
A73B	4	0.975	0.956	0.994	0.9	1	0.025	0.05	5.13%	2.5%
A73	4	0.975	0.956	0.994	0.9	1	0.025	0.05	5.13%	2.5%
A72	4	0	0	0	0	0	0	0		100.0%
A68	4	0.675	0.6179	0.7321	0.5	0.8	0.075	0.15	22.22%	32.5%
M34	4	0.15	0.08412	0.2159	0	0.3	0.0866	0.1732	115.5%	85.0%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
HRW-Lab Control	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
A75B	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
A73B	4	1.371	1.34	1.402	1.249	1.412	0.04074	0.08149	5.94%	2.89%
A73	4	1.369	1.339	1.4	1.249	1.412	0.04007	0.08015	5.85%	3.04%
A72	4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.76%
A68	4	0.9714	0.9098	1.033	0.7854	1.107	0.081	0.162	16.68%	31.2%
M34	4	0.3692	0.2768	0.4616	0.1588	0.5796	0.1215	0.243	65.81%	73.85%

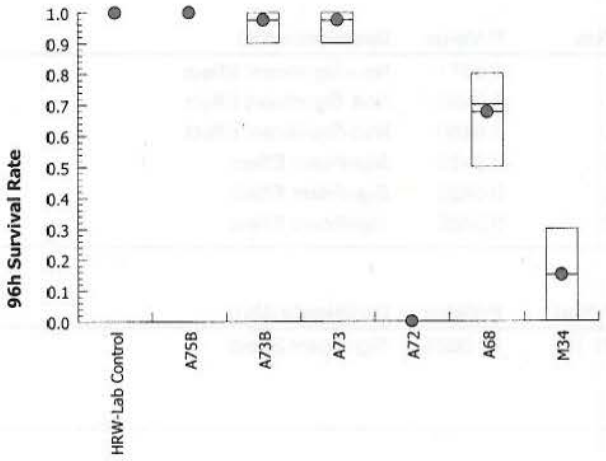
Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

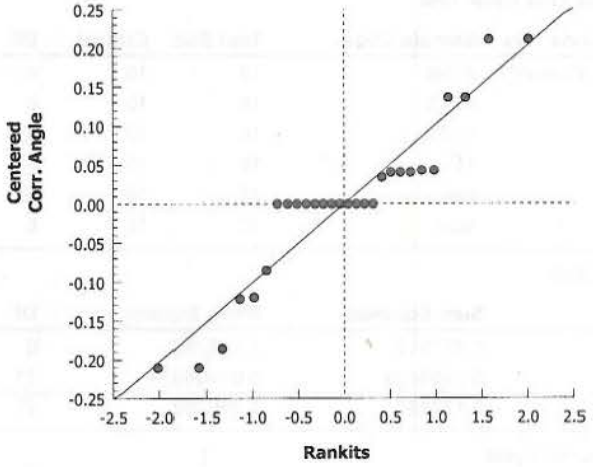
Analysis ID:	09-0066-7618	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	19 Jun-13 15:41	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4
HRW-Lab Control	1	1	1	1
A75B	1	1	1	1
A73B	1	1	0.9	1
A73	0.9	1	1	1
A72	0	0	0	0
A68	0.8	0.5	0.8	0.6
M34	0	0.3	0.3	0

Graphics





Attachment 2:

CETIS analyses of the acute toxicity data for the A72 sample diluted with HRW

CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Start Date:	19 Apr-13 14:53	**Species:**	Oncorhynchus mykiss	**Sample Code:**	639A2779
End Date:		**Protocol:**	EPA/821/R-02-012 (2002)	**Sample Source:**	Upper Animas River
Sample Date:	19 Apr-13 14:51	**Material:**	Mining Discharge/Runoff	**Sample Station:**	Control

Batch Note: Region 8: Acute RBT toxicity test using SW from Upper Animas River (Test#2, HRW/A72 dilutions)

Sample Note: Region 8: Acute RBT toxicity test using SW from Upper Animas River (Test#2, HRW/A72 dilutions)

Conc-%	Code	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
0	L	1	22	10	10	10	10	10	
0	L	2	1	10	10	10	10	10	
0	L	3	3	10	10	10	10	10	
0	L	4	7	10	10	10	10	10	
12		1	12	10	10	10	10	10	
12		2	16	10	10	10	10	10	
12		3	17	10	10	10	10	10	
12		4	26	10	10	10	10	10	
25		1	21	10	10	10	10	10	
25		2	8	10	10	10	10	10	
25		3	20	10	10	10	10	10	
25		4	13	10	10	10	10	10	
35		1	6	10	10	10	10	10	
35		2	24	10	10	10	10	10	
35		3	4	10	10	10	10	10	
35		4	19	10	10	10	10	10	
50		1	5	10	10	10	10	10	
50		2	28	10	10	10	10	10	
50		3	27	10	10	10	10	10	
50		4	2	10	10	10	10	10	
75		1	23	10	10	10	10	10	
75		2	11	10	10	10	10	10	
75		3	9	10	10	10	10	10	
75		4	15	10	10	10	10	10	
88		1	10	10	10	10	10	10	
88		2	25	10	10	10	10	10	
88		3	14	10	10	9	9	9	
88		4	18	10	10	10	10	10	

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	13-6496-9138	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	26 Jun-13 11:48	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run	88	>88	N/A	1.136	4.43%

Steel Many-One Rank Test

Control	vs	Conc-%	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
Lab Water		12	18	10	6	1	0.8571	Non-Significant Effect
		25	18	10	6	1	0.8571	Non-Significant Effect
		35	18	10	6	1	0.8571	Non-Significant Effect
		50	18	10	6	1	0.8571	Non-Significant Effect
		75	18	10	6	1	0.8571	Non-Significant Effect
		88	16	10	6	1	0.6450	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.005691285	0.0009485476	6	1	0.4512	Non-Significant Effect
Error	0.0199195	0.0009485476	21			
Total	0.02561078	0.001897095	27			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	1	3.812	0.4512	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.4261	0.8975	<0.0001	Non-normal Distribution

96h Survival Rate Summary

Conc-%	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Lab Water	4	1	1	1	1	1	0	0	0.0%	0.0%
12		4	1	1	1	1	1	0	0	0.0%	0.0%
25		4	1	1	1	1	1	0	0	0.0%	0.0%
35		4	1	1	1	1	1	0	0	0.0%	0.0%
50		4	1	1	1	1	1	0	0	0.0%	0.0%
75		4	1	1	1	1	1	0	0	0.0%	0.0%
88		4	0.975	0.956	0.994	0.9	1	0.025	0.05	5.13%	2.5%

Angular (Corrected) Transformed Summary

Conc-%	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Lab Water	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
12		4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
25		4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
35		4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
50		4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
75		4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
88		4	1.371	1.34	1.402	1.249	1.412	0.04074	0.08149	5.94%	2.89%

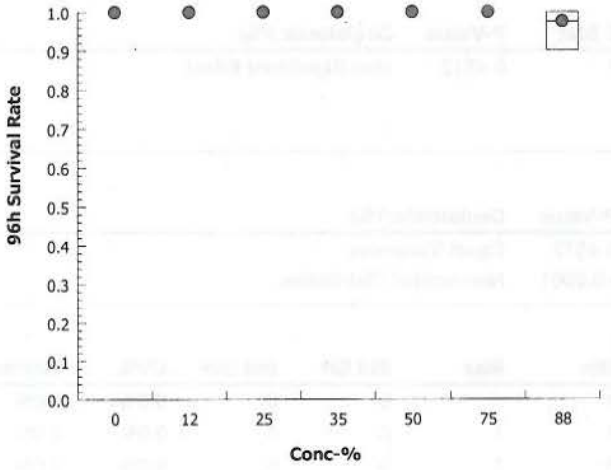
Fish 96-h Acute Survival Test — U.S. EPA Region 8 Lab

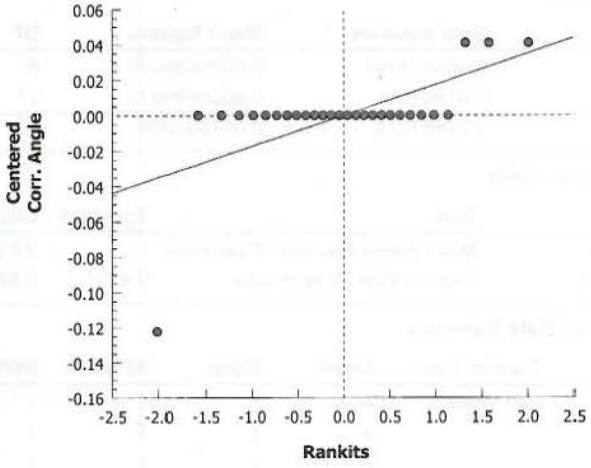
Analysis ID:	13-6496-9138	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	26 Jun-13 11:48	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Conc-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Lab Water	1	1	1	1
12		1	1	1	1
25		1	1	1	1
35		1	1	1	1
50		1	1	1	1
75		1	1	1	1
88		1	1	0.9	1

Graphics





CETIS Analytical Report

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	03-5627-1896	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	26 Jun-13 11:49	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	581076707	200	Yes	Two-Point Interpolation

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
EC5	>88	N/A	N/A	<1.136	N/A	N/A
EC10	>88	N/A	N/A	<1.136	N/A	N/A
EC15	>88	N/A	N/A	<1.136	N/A	N/A
EC20	>88	N/A	N/A	<1.136	N/A	N/A
EC25	>88	N/A	N/A	<1.136	N/A	N/A
EC40	>88	N/A	N/A	<1.136	N/A	N/A
EC50	>88	N/A	N/A	<1.136	N/A	N/A

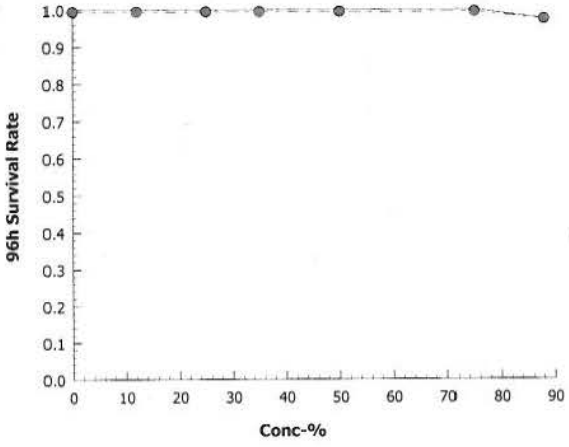
96h Survival Rate Summary

			Calculated Variate(A/B)								
Conc-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Lab Water	4	1	1	1	0	0	0.0%	0.0%	40	40
12		4	1	1	1	0	0	0.0%	0.0%	40	40
25		4	1	1	1	0	0	0.0%	0.0%	40	40
35		4	1	1	1	0	0	0.0%	0.0%	40	40
50		4	1	1	1	0	0	0.0%	0.0%	40	40
75		4	1	1	1	0	0	0.0%	0.0%	40	40
88		4	0.975	0.9	1	0.025	0.05	5.13%	2.5%	39	40

96h Survival Rate Detail

Conc-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Lab Water	1	1	1	1
12		1	1	1	1
25		1	1	1	1
35		1	1	1	1
50		1	1	1	1
75		1	1	1	1
88		1	1	0.9	1

Graphics



Attachment 3:

CETIS analyses of the acute toxicity data for the CC48/M34 sample diluted with A68 sample

CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — U.S. EPA Region 8 Lab

Start Date:	19 Apr-13 12:00	**Species:**	Oncorhynchus mykiss
End Date:		**Protocol:**	EPA/821/R-02-012 (2002)
Sample Date:	19 Apr-13 12:00	**Material:**	Mining Discharge/Runoff
Sample Code:	6D974FF3		
Sample Source:	Upper Animas River		
Sample Station:	A68/(CC48/M34)		

Batch Note: Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test#3, CC48/M34 diluted with A68)

Sample Note: Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test#3, CC48/M34 diluted with A68)

C-NA	Code	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
0	L	1	18	10	10	10	10	10	
0	L	2	9	10	10	10	10	10	
0	L	3	25	10	10	10	10	10	
0	L	4	27	10	10	10	10	10	
25		1	16	10	10	10	10	10	
25		2	11	10	10	10	10	10	
25		3	1	10	10	10	10	10	
25		4	14	10	10	10	10	10	
50		1	31	10	10	10	10	9	
50		2	2	10	10	10	9	8	
50		3	7	10	10	10	10	9	
50		4	12	10	10	10	10	10	
75		1	28	10	10	0	0	0	
75		2	19	10	10	1	0	0	
75		3	17	10	10	2	0	0	
75		4	6	10	10	0	0	0	
80		1	30	10	10	0	0	0	
80		2	21	10	10	0	0	0	
80		3	22	10	10	0	0	0	
80		4	10	10	10	0	0	0	
90		1	13	10	10	0	0	0	
90		2	4	10	10	0	0	0	
90		3	26	10	10	0	0	0	
90		4	8	10	10	0	0	0	
95		1	23	10	10	0	0	0	
95		2	15	10	10	0	0	0	
95		3	29	10	10	0	0	0	
95		4	32	10	10	1	0	0	
100		1	20	10	10	0	0	0	
100		2	3	10	10	0	0	0	
100		3	24	10	10	0	0	0	
100		4	5	10	10	0	0	0	

Fish 96-h Acute Survival Test — U.S. EPA Region 8 Lab

Analysis ID:	17-8653-3292	Endpoint:	96h Survival Rate	CETIS Version:	CETISv1.8.4
Analyzed:	02 Jul-13 9:13	Analysis:	Nonparametric-Control vs Treatments	Official Results:	Yes
Batch ID:	19-1958-6405	Test Type:	Survival (96h)	Analyst:	
Start Date:	19 Apr-13 12:00	Protocol:	EPA/821/R-02-012 (2002)	Diluent:	Not Applicable
Ending Date:		Species:	Oncorhynchus mykiss	Brine:	
Duration:	NA	Source:	Trout Lodge Fish Farm	Age:	

Data Transform	Zeta	Alt Hyp	Trials	Seed	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	NA	C > T	NA	NA	50	75	61.24		5.42%

Steel Many-One Rank Sum Test

Control	vs	C-NA	Test Stat	Critical	Ties	DF	P-Value	P-Type	Decision(α:5.4%)
Lab Water		25	18	10	1	6	0.8750	Asymp	Non-Significant Effect
		50	12	10	1	6	0.1755	Asymp	Non-Significant Effect
		75*	10	10	0	6	0.0538	Asymp	Significant Effect
		80*	10	10	0	6	0.0538	Asymp	Significant Effect
		90*	10	10	0	6	0.0538	Asymp	Significant Effect
		95*	10	10	0	6	0.0538	Asymp	Significant Effect
		100*	10	10	0	6	0.0538	Asymp	Significant Effect

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	10.87836	1.554051	7	800.7	<0.0001	Significant Effect
Error	0.04658309	0.001940962	24			
Total	10.92494		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	2.972	3.496	0.0216	Equal Variances
Variances	Levene Equality of Variance	3.436	3.496	0.0109	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.3476	0.9081	<0.0001	Non-normal Distribution

96h Survival Rate Summary

C-NA	Control Type	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	Lab Water	4	1	1	1	1	1	1	0	0.0%	0.0%
25		4	1	1	1	1	1	1	0	0.0%	0.0%
50		4	0.9	0.7701	1	0.9	0.8	1	0.04082	9.07%	10.0%
75		4	0	0	0	0	0	0	0		100.0%
80		4	0	0	0	0	0	0	0		100.0%
90		4	0	0	0	0	0	0	0		100.0%
95		4	0	0	0	0	0	0	0		100.0%
100		4	0	0	0	0	0	0	0		100.0%

Angular (Corrected) Transformed Summary

C-NA	Control Type	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	Lab Water	4	1.412	1.412	1.412	1.412	1.412	1.412	0	0.0%	0.0%
25		4	1.412	1.412	1.412	1.412	1.412	1.412	0	0.0%	0.0%
50		4	1.254	1.056	1.453	1.249	1.107	1.412	0.06231	9.94%	11.17%
75		4	0.1588	0.1588	0.1588	0.1588	0.1588	0.1588	0	0.0%	88.76%
80		4	0.1588	0.1588	0.1588	0.1588	0.1588	0.1588	0	0.0%	88.76%
90		4	0.1588	0.1588	0.1588	0.1588	0.1588	0.1588	0	0.0%	88.76%
95		4	0.1588	0.1588	0.1588	0.1588	0.1588	0.1588	0	0.0%	88.76%
100		4	0.1588	0.1588	0.1588	0.1588	0.1588	0.1588	0	0.0%	88.76%

Fish 96-h Acute Survival Test — U.S. EPA Region 8 Lab

Analysis ID:	17-8653-3292	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.4
Analyzed:	02 Jul-13 9:13	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

C-NA	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Lab Water	1	1	1	1
25		1	1	1	1
50		0.9	0.8	0.9	1
75		0	0	0	0
80		0	0	0	0
90		0	0	0	0
95		0	0	0	0
100		0	0	0	0

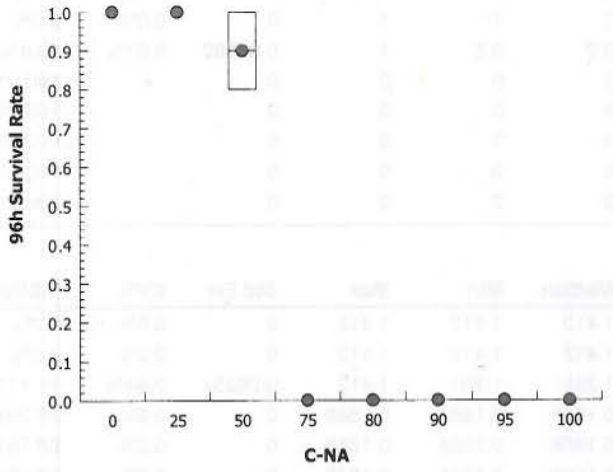
Angular (Corrected) Transformed Detail

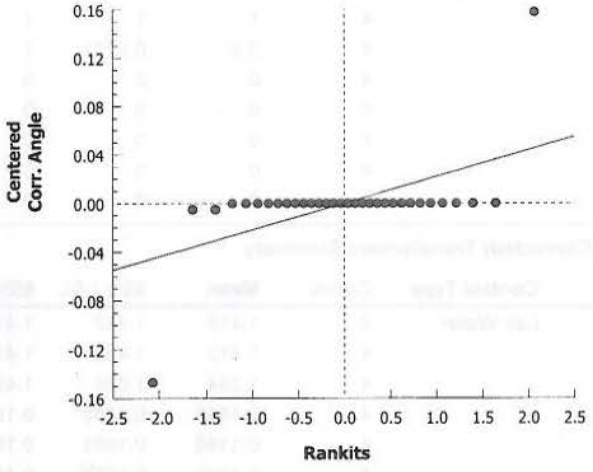
C-NA	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Lab Water	1.412	1.412	1.412	1.412
25		1.412	1.412	1.412	1.412
50		1.249	1.107	1.249	1.412
75		0.1588	0.1588	0.1588	0.1588
80		0.1588	0.1588	0.1588	0.1588
90		0.1588	0.1588	0.1588	0.1588
95		0.1588	0.1588	0.1588	0.1588
100		0.1588	0.1588	0.1588	0.1588

96h Survival Rate Binomials

C-NA	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Lab Water	10/10	10/10	10/10	10/10
25		10/10	10/10	10/10	10/10
50		9/10	8/10	9/10	10/10
75		0/10	0/10	0/10	0/10
80		0/10	0/10	0/10	0/10
90		0/10	0/10	0/10	0/10
95		0/10	0/10	0/10	0/10
100		0/10	0/10	0/10	0/10

Graphics





Fish 96-h Acute Survival Test

U.S. EPA Region 8 Lab

Analysis ID:	03-4183-4286	Endpoint:	96h Survival Rate	CETIS Version:	CETISv1.8.4
Analyzed:	02 Jul-13 9:13	Analysis:	Untrimmed Spearman-Kärber	Official Results:	Yes
Batch ID:	19-1958-6405	Test Type:	Survival (96h)	Analyst:	
Start Date:	19 Apr-13 12:00	Protocol:	EPA/821/R-02-012 (2002)	Diluent:	Not Applicable
Ending Date:		Species:	Oncorhynchus mykiss	Brine:	
Duration:	NA	Source:	Trout Lodge Fish Farm	Age:	

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	0.00%	1.763	0.01132	57.96	55.02	61.06

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

96h Survival Rate Summary

			Calculated Variate(A/B)								
C-NA	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Lab Water	4	1	1	1	0	0	0.0%	0.0%	40	40
25		4	1	1	1	0	0	0.0%	0.0%	40	40
50		4	0.9	0.8	1	0.04082	0.08165	9.07%	10.0%	36	40
75		4	0	0	0	0	0		100.0%	0	40
80		4	0	0	0	0	0		100.0%	0	40
90		4	0	0	0	0	0		100.0%	0	40
95		4	0	0	0	0	0		100.0%	0	40
100		4	0	0	0	0	0		100.0%	0	40

96h Survival Rate Detail

C-NA	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Lab Water	1	1	1	1
25		1	1	1	1
50		0.9	0.8	0.9	1
75		0	0	0	0
80		0	0	0	0
90		0	0	0	0
95		0	0	0	0
100		0	0	0	0

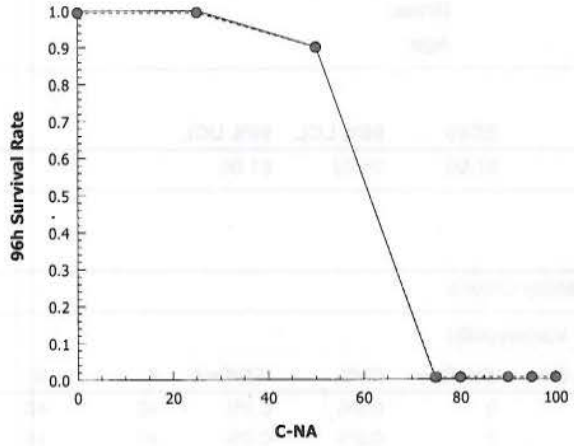
96h Survival Rate Binomials

C-NA	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Lab Water	10/10	10/10	10/10	10/10
25		10/10	10/10	10/10	10/10
50		9/10	8/10	9/10	10/10
75		0/10	0/10	0/10	0/10
80		0/10	0/10	0/10	0/10
90		0/10	0/10	0/10	0/10
95		0/10	0/10	0/10	0/10
100		0/10	0/10	0/10	0/10

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	03-4183-4286	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.4
Analyzed:	02 Jul-13 9:13	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



Attachment 4:

CETIS analyses of the acute toxicity data for the CC48/M34 sample diluted with HRW

CETIS Test Data Worksheet

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Start Date:	19 Apr-13 12:00	**Species:**	Oncorhynchus mykiss	**Sample Code:**	6E1E3D49
End Date:		**Protocol:**	EPA/821/R-02-012 (2002)	**Sample Source:**	Upper Animas River
Sample Date:	19 Apr-13 12:00	**Material:**	Mining Discharge/Runoff	**Sample Station:**	HRW/(CC48/M34)

Batch Note: Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test#4, CC48/M34 diluted with HRW)

Sample Note: Region 8:Acute RBT toxicity test using SW from Upper Animas River (Test#4, CC48/M34 diluted with HRW)

Conc-NA	Code	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
0	L	1	8	10	10	10	10	10	
0	L	2	16	10	10	10	10	10	
0	L	3	20	10	10	10	10	10	
0	L	4	17	10	10	10	10	10	
25		1	22	10	10	10	10	10	
25		2	5	10	10	10	10	10	
25		3	24	10	10	10	10	10	
25		4	11	10	10	10	10	10	
50		1	15	10	10	10	10	10	
50		2	6	10	10	10	10	10	
50		3	13	10	10	10	10	10	
50		4	18	10	10	10	10	10	
75		1	23	10	10	10	10	10	
75		2	2	10	10	10	10	10	
75		3	7	10	10	10	10	10	
75		4	21	10	10	10	10	10	
90		1	4	10	0	0	0	0	
90		2	3	10	0	0	0	0	
90		3	1	10	0	0	0	0	
90		4	14	10	1	0	0	0	
95		1	12	10	0	0	0	0	
95		2	10	10	0	0	0	0	
95		3	19	10	0	0	0	0	
95		4	9	10	0	0	0	0	

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	12-0007-8857	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	26 Jun-13 12:35	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run	75	90	82.16		2.5%

Steel Many-One Rank Test

Control	vs	Conc-NA	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
Lab Water		25	18	10	6	1	0.8333	Non-Significant Effect
		50	18	10	6	1	0.8333	Non-Significant Effect
		75	18	10	6	1	0.8333	Non-Significant Effect
		90*	10	10	6	0	0.0417	Significant Effect
		95*	10	10	6	0	0.0417	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	8.376534	1.675307	5	65540	<0.0001	Significant Effect
Error	0	0	18			
Total	8.376534	1.675307	23			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	65540	4.248	<0.0001	Unequal Variances

96h Survival Rate Summary

Conc-NA	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Lab Water	4	1	1	1	1	1	0	0	0.0%	0.0%
25		4	1	1	1	1	1	0	0	0.0%	0.0%
50		4	1	1	1	1	1	0	0	0.0%	0.0%
75		4	1	1	1	1	1	0	0	0.0%	0.0%
90		4	0	0	0	0	0	0	0		100.0%
95		4	0	0	0	0	0	0	0		100.0%

Angular (Corrected) Transformed Summary

Conc-NA	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Lab Water	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
25		4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
50		4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
75		4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
90		4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.76%
95		4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.76%

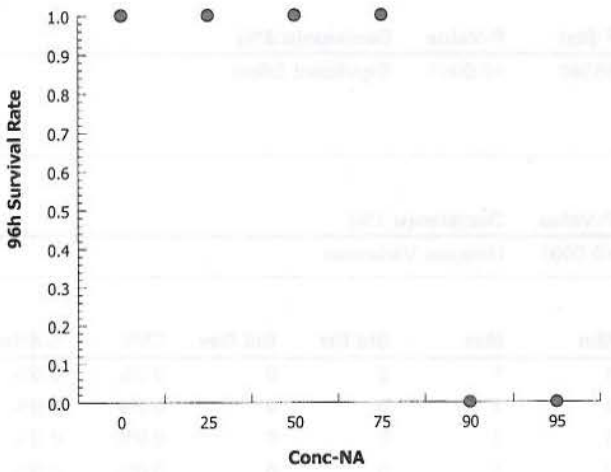
Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

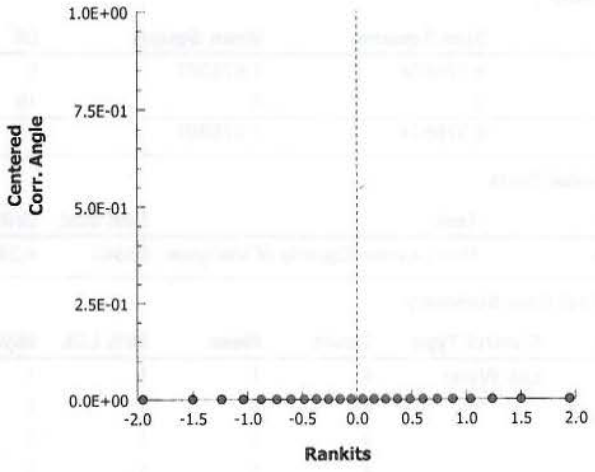
Analysis ID:	12-0007-8857	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	26 Jun-13 12:35	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Conc-NA	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Lab Water	1	1	1	1
25		1	1	1	1
50		1	1	1	1
75		1	1	1	1
90		0	0	0	0
95		0	0	0	0

Graphics





CETIS Analytical Report

Test Code: 3AE42FDC | 09-8803-2988

Fish 96-h Acute Survival Test — **U.S. EPA Region 8 Lab**

Analysis ID:	00-1126-3273	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	26 Jun-13 12:36	**Analysis:**	Binomial Method	**Official Results:**	Yes

Binomial/Graphical Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	0.00%	1.915	0	82.16	79.82	84.56

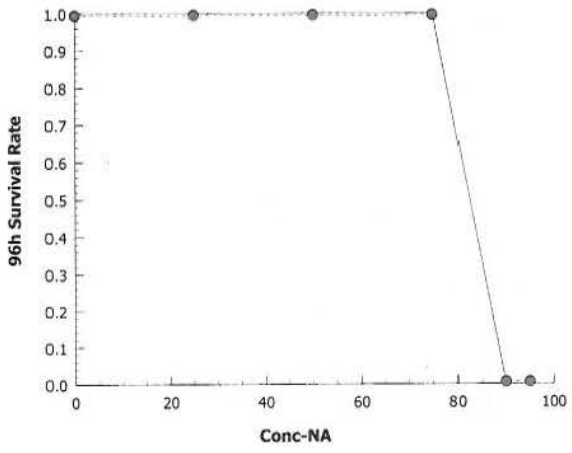
96h Survival Rate Summary — Calculated Variate(A/B)

Conc-NA	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Lab Water	4	1	1	1	0	0	0.0%	0.0%	40	40
25		4	1	1	1	0	0	0.0%	0.0%	40	40
50		4	1	1	1	0	0	0.0%	0.0%	40	40
75		4	1	1	1	0	0	0.0%	0.0%	40	40
90		4	0	0	0	0	0		100.0%	0	40
95		4	0	0	0	0	0		100.0%	0	40

96h Survival Rate Detail

Conc-NA	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Lab Water	1	1	1	1
25		1	1	1	1
50		1	1	1	1
75		1	1	1	1
90		0	0	0	0
95		0	0	0	0

Graphics



Spearman-Karber

Analyst: BGK QA: EC

Attachment 5:

CETIS analyses of the acute toxicity data for the reference toxicity test

CETIS Test Data Worksheet

Test Code: 04-7609-7282/1C60AB02

Fish 96-h Acute Survival Test — **U.S. EPA Region I Lab**

Start Date:	18 Apr-13	**Species:**	Oncorhynchus mykiss	**Sample Code:**	0413RBTARTT
End Date:	22 Apr-13	**Protocol:**	EPA/821/R-02-012 (2002)	**Sample Source:**	Reference Toxicant
Sample Date:	18 Apr-13	**Material:**	Zinc sulfate	**Sample Station:**	

Batch Note: Region 8: Concurrent RBT Reference Toxicity Test (Upper Animas River)

Sample Note: Region 8: Concurrent RBT Reference Toxicity Test (Upper Animas River)

Conc-µg/L	Code	Rep	Pos	# Exposed	24h Survival	48h Survival	72h Survival	96h Survival	Notes
5	L	1	7	10	10	10	10	10	
5	L	2	13	10	10	10	10	10	
5	L	3	6	10	10	10	10	10	
5	L	4	24	10	10	10	10	10	
88		1	11	10	10	9	9	9	
88		2	4	10	10	10	10	10	
88		3	16	10	10	10	10	10	
88		4	23	10	10	10	10	10	
155		1	20	10	10	9	9	9	
155		2	5	10	9	8	7	7	
155		3	12	10	8	8	8	8	
155		4	1	10	10	10	10	10	
305		1	18	10	3	1	1	1	
305		2	8	10	5	3	2	2	
305		3	2	10	5	2	2	2	
305		4	3	10	5	2	1	1	
525		1	10	10	0	0	0	0	
525		2	15	10	2	0	0	0	
525		3	19	10	0	0	0	0	
525		4	9	10	2	1	0	0	
1075		1	22	10	1	0	0	0	
1075		2	17	10	0	0	0	0	
1075		3	21	10	0	0	0	0	
1075		4	14	10	1	0	0	0	

Analyst: BGK QA: SJP

Fish 96-h Acute Survival Test — U.S. EPA Region I Lab

Analysis ID:	21-0193-1874	Endpoint:	96h Survival Rate	CETIS Version:	CETISv1.8.0
Analyzed:	02 Jul-13 16:25	Analysis:	Nonparametric-Control vs Treatments	Official Results:	Yes
Batch ID:	00-9361-4536	Test Type:	Survival (96h)	Analyst:	
Start Date:	18 Apr-13	Protocol:	EPA/821/R-02-012 (2002)	Diluent:	Reconstituted Water
Ending Date:	22 Apr-13	Species:	Oncorhynchus mykiss	Brine:	
Duration:	96h	Source:	Trout Lodge Fish Farm	Age:	
Sample ID:	04-0243-6777	Code:	0413RBTARTT	Client:	ESAT Region 8
Sample Date:	18 Apr-13	Material:	Zinc sulfate	Project:	Reference Toxicity Test
Receive Date:		Source:	Reference Toxicant		
Sample Age:	N/A	Station:			

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run	155	305	217.4		9.22%

Steel Many-One Rank Test

Control	vs	Conc-µg/L	Test Stat	Critical	DF	Ties	P-Value	Decision(α:5%)
5		88	16	10	6	1	0.6105	Non-Significant Effect
5		155	12	10	6	1	0.1424	Non-Significant Effect
5		305*	10	10	6	0	0.0417	Significant Effect
5		525*	10	10	6	0	0.0417	Significant Effect
5		1075*	10	10	6	0	0.0417	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	7.355389	1.471078	5	190.2	<0.0001	Significant Effect
Error	0.1392348	0.007735265	18			
Total	7.494623	1.478813	23			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	5.646	4.248	0.0027	Unequal Variances
Distribution	Shapiro-Wilk W Normality	0.8662	0.884	0.0044	Non-normal Distribution

96h Survival Rate Summary

Conc-µg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
5	Lab Water	4	1	1	1	1	1	0	0	0.0%	0.0%
88		4	0.975	0.956	0.994	0.9	1	0.025	0.05	5.13%	2.5%
155		4	0.85	0.8009	0.8991	0.7	1	0.06455	0.1291	15.19%	15.0%
305		4	0.15	0.128	0.172	0.1	0.2	0.02887	0.05774	38.49%	85.0%
525		4	0	0	0	0	0	0	0		100.0%
1075		4	0	0	0	0	0	0	0		100.0%

Angular (Corrected) Transformed Summary

Conc-µg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
5	Lab Water	4	1.412	1.412	1.412	1.412	1.412	0	0	0.0%	0.0%
88		4	1.371	1.34	1.402	1.249	1.412	0.04074	0.08149	5.94%	2.89%
155		4	1.19	1.121	1.259	0.9912	1.412	0.09091	0.1818	15.28%	15.73%
305		4	0.3927	0.3615	0.4239	0.3218	0.4636	0.04096	0.08192	20.86%	72.19%
525		4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.76%
1075		4	0.1588	0.1588	0.1588	0.1588	0.1588	0	0	0.0%	88.76%

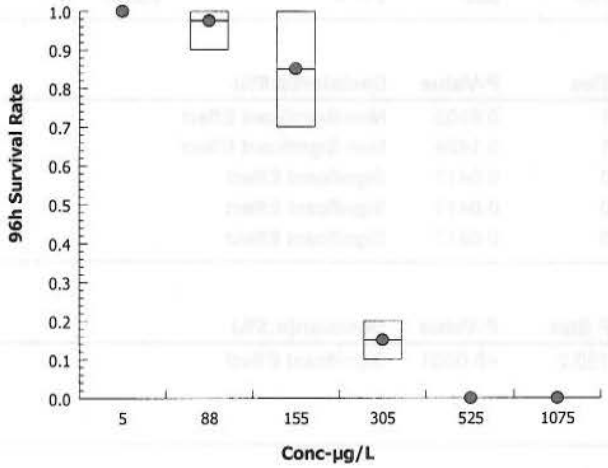
Fish 96-h Acute Survival Test — **U.S. EPA Region I Lab**

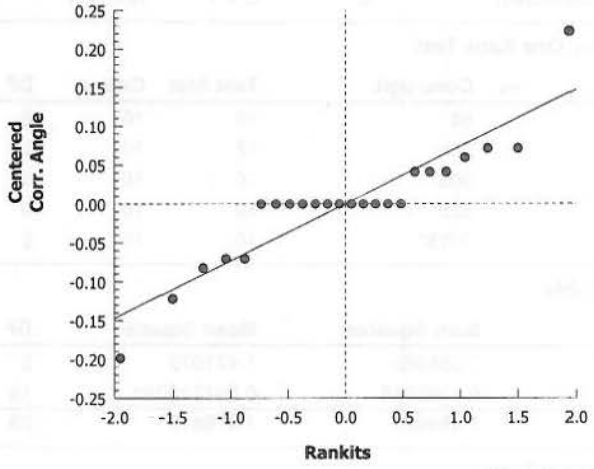
Analysis ID:	21-0193-1874	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	02 Jul-13 16:25	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Detail

Conc-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
5	Lab Water	1	1	1	1
88		0.9	1	1	1
155		0.9	0.7	0.8	1
305		0.1	0.2	0.2	0.1
525		0	0	0	0
1075		0	0	0	0

Graphics





CETIS Analytical Report

Fish 96-h Acute Survival Test — **U.S. EPA Region I Lab**

Analysis ID:	01-0250-5310	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	02 Jul-13 16:25	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes
Batch ID:	00-9361-4536	**Test Type:**	Survival (96h)	**Analyst:**	
Start Date:	18 Apr-13	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Reconstituted Water
Ending Date:	22 Apr-13	**Species:**	Oncorhynchus mykiss	**Brine:**	
Duration:	96h	**Source:**	Trout Lodge Fish Farm	**Age:**	
Sample ID:	04-0243-6777	**Code:**	0413RBTARTT	**Client:**	ESAT Region 8
Sample Date:	18 Apr-13	**Material:**	Zinc sulfate	**Project:**	Reference Toxicity Test
Receive Date:		**Source:**	Reference Toxicant		
Sample Age:	N/A	**Station:**			

Trimmed Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	2.50%	2.334	0.02257	215.8	194.5	239.4

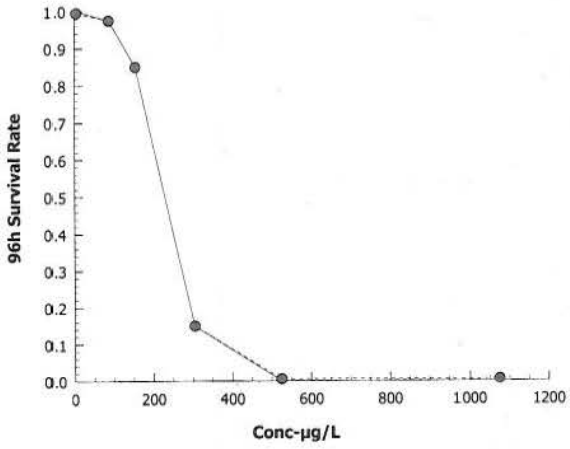
96h Survival Rate Summary

			Calculated Variate(A/B)								
Conc-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
5	Lab Water	4	1	1	1	0	0	0.0%	0.0%	40	40
88		4	0.975	0.9	1	0.025	0.05	5.13%	2.5%	39	40
155		4	0.85	0.7	1	0.06455	0.1291	15.19%	15.0%	34	40
305		4	0.15	0.1	0.2	0.02887	0.05774	38.49%	85.0%	6	40
525		4	0	0	0	0	0		100.0%	0	40
1075		4	0	0	0	0	0		100.0%	0	40

96h Survival Rate Detail

Conc-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
5	Lab Water	1	1	1	1
88		0.9	1	1	1
155		0.9	0.7	0.8	1
305		0.1	0.2	0.2	0.1
525		0	0	0	0
1075		0	0	0	0

Graphics



Appendix 10a

Sediment toxicity testing report for the Upper Animas River (December 2012)

Animas River
Sediment Toxicity Testing Report
December 2012 Sediment Collection

Prepared for:



United States Environmental Protection Agency, Region 8
Ecosystem Protection and Remediation-Program Support
1595 Wynkoop St.
Denver, CO 80202

Prepared By:



United States Environmental Protection Agency, Region 8
Environmental Services Assistance Team (ESAT)
TechLaw, Inc.
16194 W. 45th Drive
Golden, Colorado

Contract No. EPW-13-028
DCN: EP8-1-1029

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Appendix A December 2012 Animas River Sediment Toxicity Test using *H. azteca*10 Day Static Renewal Data Sheets

Appendix B Sediment Reference Toxicity Test Concurrent with the 2012 Animas River Sediment Toxicity Test 4 day Static Renewal Data Sheets

Attachment 1 CETIS Analytical Reports for the December 2012 Animas River Sediment Toxicity Test

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Abbreviation/Acronym List

BLM	Bureau of Land Management
ºC	Degrees Celsius
CDPHE	Colorado Department of Public Health and Environment
CETIS	Comprehensive Environmental Toxicity Information System
Control N	Negative laboratory control
Control P	Positive laboratory control
DO	Dissolved Oxygen
EC_{50}	50% Median Effective Concentration
EPA	Environmental Protection Agency
ESAT	Environmental Services Assistance Team
g	Grams
gpm	Gallons per minute
kg	Kilogram
LC_{50}	50% Lethal Concentration
MHRW	Moderately Hard Reconstituted Water
mg	Milligram
mL	Milliliter
NH_3	Ammonia
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SGC	Sunnyside Gold Corporation
SOP	Standard Operating Procedure
TAC	Test Acceptability Criterion
YCT	Yeast, Cerophyl, and Trout Chow
$ZnSO_4$	Zinc sulfate heptahydrate

1.0 INTRODUCTION

A 10-day, static-renewal sediment toxicity test using the amphipod, (*Hyalella azteca)*, and sediment from the Animas River (San Juan County, Colorado) was performed at the United States Environmental Protection Agency (EPA) Region 8 Laboratory in December 2012. The purpose of this toxicity test was to determine the toxicity of sediments collected from the Animas River by assessing survival and growth. A 96-hour reference toxicity test was performed concurrently with the Animas River toxicity test as a quality assurance measure. The reference toxicity test consisted of an aqueous stock solution spiked with zinc, with a test endpoint of survival. This report includes a brief background of the Animas Mining District (Section 1.1), materials and methods (Section 2.0), testing results (Section 3.0), a discussion of results (Section 4.0), and supporting references (Section 5.0).

1.1 Background

Information in this section was obtained from the *Final 2012 Sampling and Analysis Plan/Quality Assurance Project Plan, Revision 1, Upper Animas Mining District Gladstone, San Juan County, Colorado*, dated September 2012 (ESAT, 2012).

The discovery of gold and silver brought miners to the Silverton area and Animas Mining District in the early 1870's. The discovery of silver in the base-metal ores was the major factor in establishing Silverton as a permanent settlement. Between 1870 and 1890, the richer ore deposits were discovered and mined to the extent possible. Not until 1890 was any serious attempt made to mine and concentrate the larger low-grade ore bodies in the area. By 1900, there were 12 concentration mills in the valley sending products to the Kendrick and Gelder Smelter near the mouth of Cement Creek. Mining and milling operations slowed down circa 1905, and the mines were consolidated into fewer and larger operations with the facilities for milling large volumes of ore. After 1907, mining and milling continued throughout the basin whenever prices were relatively favorable. Gladstone, located about eight miles upstream of Silverton on Cement Creek, is the site of an historic mining town developed in the 1880s commensurate with the onset of mining in the surrounding area. The town was the central location and railroad terminus for the milling and shipping of mine ores from the surrounding three-square-mile valley. The town declined in the 1920's and no remnants of the town remain. By the 1970's, the Sunnyside Mine was the only year-round producing mine remaining in the county. This mine ceased production in 1991, and has since undergone reclamation efforts. The Gold King Mine's permit with DRMS is currently in inactive status; however, landowners hope to rehabilitate the mine.

Both the Sunnyside and Gold King properties were partially accessed through the American Tunnel that has its portal in Gladstone. Previously the American Tunnel drained as much as 1,600 gallons per minute (gpm) of water from the mines. A lime feed and settling pond-type treatment facility was constructed in Gladstone in 1979 by Standard Metals Corporation. Water discharging from the American Tunnel was treated as required by the water discharge permit. The facility operations and mine ownership was later transferred to the Sunnyside Gold Corporation (SGC). Under jurisdiction of a court consent decree to terminate their discharge permit, SGC installed several bulkheads within the Sunnyside Mine that greatly reduced the amount of discharge from the American Tunnel. Seventy to one hundred gpm continue to discharge, presumably from near surface groundwater.

In January 2003 the treatment facility, operations, and permit were transferred to the Gold King Mines Corporation. The settling ponds were deeded to the San Juan Corporation by SGC prior to the lease between the Gold King Mines and San Juan Corporations. The treatment facility continued to treat the remaining American Tunnel discharge and the Gold King discharge until September 2004. The San Juan Corporation required SGC to reclaim the four settling ponds (completed in 2005) following termination of the San Juan Corporation and SGC lease. The Gold King Mines Corporation was subsequently evicted and the balance of the Gold King Mines Corporation land was acquired by the San Juan Corporation as the lien holder. The American Tunnel portal reclamation and removal of some out buildings were completed in 2006. The Bureau of Land Management (BLM) manages land associated with the American Tunnel portal and vicinity; however, the San Juan Corporation owns the majority of the land surrounding the portal.

Numerous historic and now abandoned mines exist within a two-mile radius of Gladstone. They include: the Upper Gold King 7 Level, American Tunnel, Grand Mogul, Mogul, and Red and Bonita, Evelyne, Henrietta, Joe and John, and Lark mines. Some of these mines have acid mine drainage that flows between 30 and 300 gpm directly or indirectly into Cement Creek and eventually into the Animas River.

1.2 Objective

The objectives of this toxicity test were to (a) support the yearly monitoring activities at the Animas River, (b) characterize the effects of mine waste-impacted sediment samples on *H. azteca* under subchronic exposure conditions, and (c) generate data to support development of the future Baseline Ecological Risk Assessment and Remedial Investigation.

2.0 MATERIALS AND METHODS

This section outlines the materials and methods used for testing purposes, including sediment collection procedures, water preparation and delivery, test organisms, food preparation, and testing procedures. General test methods following EPA (2000) are discussed below and summarized in **Table 2.0-1**.

2.1 Study Design

The 10-day Animas River sediment toxicity test followed protocols listed in EPA Method 100.1 (EPA, 2000). *H. azteca* survival and growth were measured after the exposure period. The test used a negative laboratory control (Control N; Horsecreek Reservoir control sediment) and a positive laboratory control (Control P; laboratory control sediment spiked with 1,000 milligrams per kilogram [mg/kg] zinc) to help evaluate the overall health of the test organisms and to provide a baseline growth measurement for amphipods exposed to clean sediment. Eight replicates for each sample location and each laboratory control were used during the 10 day toxicity test.

Site sediment was thoroughly homogenized in a stainless steel pan before it was distributed into test chambers one day before the organisms were introduced. 100 milliliters (mL) of sediment was placed in each test replicate chamber before they were placed into a temperature-controlled water bath.

The water bath temperature was held at 23 ± 2ºC for the duration of the test and met the performance criterion. According to EPA Method 100.1 (EPA, 2000), the daily mean test temperature should be ± 1ºC and the instantaneous temperature must always be within ± 3ºC of the target temperature of 23ºC. Moderately Hard Reconstituted Water (MHRW) was added to each test chamber before ten organisms were counted, verified, and introduced. One mL of Yeast, Cerophyl®, and Trout Chow (YCT) feed mixture was added to each test chamber daily and the overlying water was renewed at a rate of two volumes (350 mL) per day for the 10-day test period.

The water quality measurements were collected daily as described in **Exhibit 1** (below). The water quality parameters pH, conductivity, and hardness were checked on test Day 0 and test Day 9. Dissolved Oxygen (DO) and temperature were measured daily. A syringe was used to collect ammonia samples in overlying water from each replicate on the first and last day of the test. On Day 10 of the test, temperature and DO were measured in each test chamber before samples for overlying surface water were collected as a composite sample from all replicates. All overlying water samples collected for ammonia analyses were inspected for the presence of test organisms before the samples were prepared for analysis to ensure no organisms were inadvertently removed from the test chamber.

Exhibit 1: Activities Schedule for a 10-Day Sediment Toxicity Test

Day	Activity
Day -1	Add sediment into test chambers and start renewal of overlying water.
Day 0	Measure surface water quality parameters (pH, temperature, DO, and conductivity) in each replicate. Collect a 10 mL sample from each replicate for ammonia analysis. Obtain hardness measurement by collecting a composite sample from all replicates. Collect pore water samples for dissolved metals analysis from each replicate. Transfer 10 organisms into each test chamber and release them under the surface of the water to avoid entrapment. Add 1.0 mL of YCT into each test chamber. Obtain 80 additional test organisms to measure initial dry weight.
Day 1 through 8	Feed organisms 1.0 mL YCT and measure temperature and DO in each test chamber.
Day 9	Measure surface water quality (pH, temperature, DO, and conductivity) for each replicate. Collect a 10 mL sample from each replicate for ammonia analysis. Collect a composite sample (equal volume from each replicate) for hardness measurement. Add 1.0 mL of YCT into each test chamber.
Day 10	Measure temperature and DO. Collect the surviving organisms from each replicate.

2.2 Sediment Collection

Composite sediment samples were collected in December 2012 from the Animas River, Cement Creek, and Mineral Creek in accordance with the 2012 Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) (ESAT, 2012). Sediment was collected from a depth of 0-2 inches using a Teflon hand trowel. The sample containers were placed on ice until received at the EPA Region 8 laboratory before they were placed in a 4°C cooler for preservation. Sample collection equipment was decontaminated between each sampling location in accordance with procedures outlined in the SAP/QAPP (ESAT, 2012).

2.3 Test Water Preparation and Delivery

MHRW was prepared in accordance with Smith *et al*. (1997) by adding 47.4 grams (g) of calcium sulfate, 122.8 g of magnesium sulfate, 48 g of sodium bicarbonate, and 4 g of potassium chloride to the laboratory stainless steel batch tank containing 1,000 L of deionized water. The batch tank was continuously aerated for the duration of the toxicity test after the MHRW was prepared. Water quality was measured to verify that the following parameters were met: hardness between 90 and 100 milligrams per liter (mg/L), conductivity between 330 and 360 microsiemens/centimeter, and pH between 7.8 and 8.2 standard units (EPA, 2000). **Table 2.3-1** summarizes the parameters for the MHRW used in the test, and the resulting pH and hardness. The MHRW was delivered

to each test chamber at a rate of two volumes (approximately 350 mL) of overlying water per day using a glass distribution box similar to the one described in Benoit *et al.* (1983).

Table 2.3-1 Moderately Hard Reconstituted Water Composition and Chemistry

$CaSO_4$	$MgSO_4$-$7H_2O$	$NaHCO_3$	KCl	Final pH*	Final Hardness*
47.4 g/1000 L	122.8 g/1000 L	48 g/1000 L	4 g/1000 L	7.47	73 mg/L

*an average was taken from two batches

2.4 Test Organisms

The juvenile amphipods needed for the sediment toxicity test were obtained from Aquatic Biosystems (Ft. Collins, Colorado). The organisms were kept in their shipping bag after they arrived at the laboratory and placed in a holding tank for about 48 hours for temperature acclimation. Water acclimation was not a concern because the organisms had been cultured and shipped in MHRW. Regardless, the shipping bag was slowly opened to allow a small amount of laboratory MHRW to mix with the shipping water. This procedure was repeated several times through the course of one day until laboratory MHRW and shipping water were well mixed. Test organisms were approximately 7 to 10-days old at the time of testing.

2.5 Test Food Preparation

Organisms were fed a YCT mixture daily (see **Table 2.5-1**). YCT was prepared by adding 5 g of Trout Chow® to 1 L of deionized water, followed by homogenization in a blender (EPA, 2000). The homogenized mixture was poured into a 2-L separatory funnel, aerated, and allowed to digest for one week at room temperature. The aeration apparatus was removed after the digestion period. The solid material settled out for one hour, after which the supernatant was collected using a 110 mesh Nitex screen. Yeast solution was prepared by adding 5 g of dry yeast to 1 L deionized water, followed by mixing. Cerophyl® was prepared by adding 5 g of alfalfa pellets to 1 L of deionized water, followed by homogenization in a blender. Equal parts of yeast, Trout Chow (supernatant), and Cerophyl® solutions were then added to a beaker and homogenized in a blender. The YCT mixture was stored in a freezer or refrigerator until use. Refrigerated YCT was used within two weeks of storage.

2.6 Test Procedures

The following sections describe the procedures used for the site sediment and reference toxicity tests.

2.6.1 Site Sediment Toxicity Test

Sediment samples were collected from six locations along the Animas River (A56, A68, A72, A73B, 75B, and Baker Bridge [Bbridge]), one location on Mineral Creek (M34),

and one location on Cement Creek (CC49). The two locations on the Animas River originally selected as references (i.e., A56 and A68) were determined to be impacted by mining activity, and could therefore not be used for that purpose. Testing was also performed on negative and positive control sediment for quality assurance purposes. The positive control was spiked with 1000 mg/kg zinc solution intended to substantially reduce survival and growth while the negative control was not spiked and was used to test the overall health of the organisms. The control sediment consisted of sediment collected from Horsecreek Reservoir, located 5 miles south of Hudson, Colorado.

Eight replicates for each sample location and the lab control samples were used in the test. An initial weight for the *H. azteca* was obtained at the start of the test to verify that the control organisms showed measurable growth after 10 days of exposure (See **Table 2.6-1**). The test chambers, which consisted of 300-mL beakers filled with 100 mL of sediment and 175 mL of overlying MHRW, were placed in a water bath to maintain a constant temperature during the test.

The testing took place over a 10-day period. The quality of the overlying MHRW was measured daily for DO and temperature. Overlying water was measured for hardness, conductivity, ammonia and pH (**Appendix A**) at the start (Day 0) and end (Day 9) of the test. Alkalinity was not measured due to water volume constraints. The amphipods were fed 1 mL of YCT per test chamber per day. The surviving organisms were removed (or "picked") from the sediment using pipettes, a sieve, and/or Nitex screen at the end of the 10-day test period. Personnel involved with picking organisms from the sediment were first required to show proficiency by retrieving at least 90% of organisms placed into "practice" sediment.

2.6.2 Reference Toxicity Test

The 96-hour reference toxicity test followed procedures outlined in EPA Method 100.1 (EPA, 2000) and was carried out concurrently with the site sediment toxicity test. The test chambers consisted of 200-mL beakers, filled with 100 mL of MHRW, and contained Nitex screen at the bottom as an artificial substrate. MHRW was spiked with zinc sulfate heptahydrate ($ZnSO_4$) using a serial dilution approach. $ZnSO_4$ concentrations were reduced by 50% starting with the highest concentration (referred to as 100%) until the lowest dilution (6.25%) was reached. The following values provide the dilutions and average zinc concentrations (taken from the initial and final measured dissolved Zn results): 100% concentration of $ZnSO_4$ was 857.5 µg/L, followed by 50% (477 µg/L), 25% (250 µg/L), 12.5% (119.5 µg/L), 6.25% (59.55 µg/L) and 0% (5 µg/L). The zinc concentration used for 0% is one half the laboratory detection limit of 10 µg/L. Zinc concentrations were verified using EPA Method 200.7/200.8 and are included in **Table 3.1-2**. Survival and growth were the endpoints for the reference test.

2.7 Pore Water Collection Procedures

Pore water was collected from each individual test chamber for analysis at the start of the test. These samples were collected by placing a push-point pore water sampling probe in

each test chamber and extracting the water from within the bedded sediment using a 50 mL syringe. The syringe was then fit with a 0.45 micrometer filter, and the sample was transferred to a 10 mL sample container. The sample was labeled, preserved, and stored at 4°C in the Region 8 Laboratory. The initial pore water samples were analyzed for dissolved metals using EPA Method 200.7 (EPA 1994a) and 200.8 (EPA, 1994b). Pore water samples were not collected at the end of the test due to the risk of extracting *H. azteca* from the sediment during the pore water collection.

2.8 Overlying Surface Water Collection Procedure

Samples for overlying water were collected using treatment group dedicated 60 mL syringes and water was extracted from just below the surface in each replicate for a composite sample. Composite samples were collected for total recoverable and dissolved metals samples and a discrete water sample was collected from each replicate for all ammonia samples. After 50 or 60 mL of water was pulled into the syringe a visual observation of the water was made to ensure that no organisms were inadvertently captured during this process.

3.0 RESULTS

This section presents the results for the site sediment and reference toxicity tests and addresses any issues or unforeseen conditions encountered during the test.

3.1 Site Sediment Toxicity Testing

Sediment, pore water, and overlying surface water samples were analyzed for total recoverable metals (sediment & overlying water) and dissolved metals (pore water & overlying water) using EPA Method 200.7/200.8. **Tables 3.1-1** through **3.1-4** provide the results of these analyses.

The conditions in the test chambers generally met the performance criteria (see **Table 2.0-1**). Daily water chemistry is provided in **Appendix A**. The replicates' variability in hardness met performance criteria of 50% at all sample locations except Control N which had an initial hardness of 386 and a final hardness of 127. Alkalinity was not measured. DO was maintained above the performance criterion of 2.5 mg/L throughout the test. The overlying water temperatures did not deviate more than ±2ºC from 23ºC, ranging between 21.0°C and 23.1°C during the 10-day test period.

A discrete sample of the overlying water was obtained from each replicate on Day 0 and Day 9 of the test for ammonia analysis using EPA Method 350.1 (EPA 1993). Ammonia (NH_3-N) concentrations on Day 0 (initial water chemistry) ranged from 0.0053 mg/L in Control-P-04 to 5.916 mg/L NH_3-N in A68-01. On Day 9 (final water chemistry) concentrations ranged from 0.0230 mg/L NH_3-N in Control P-05 to 1.59 mg/L NH_3-N in A68-01 (see **Table 3.1-5**). The average Day 0 and Day 9 ammonia levels measured in

the eight replicates of each of the sediment samples used in the toxicity test were compared to pH-dependent acute ammonia criteria. As shown in **Table 3.1-5,** all ammonia levels fell below their respective acute or chronic ammonia criteria. The ammonia criteria were calculated using the "salmonids present" equation, which is provided on p. 54 of the Colorado Department of Public Health and Environment Water Quality Control Commission (CDPHE): Regulation No. 31 (2012).

Surviving *H. azteca* were collected at the end of the 10 day test from each test chamber, counted, placed in aluminum weigh boats, and dried for at least 24 hrs at 80°C. Every effort was made to ensure that sediment particles were not inadvertently added to the weigh boats with the organisms. Pans with dried *H. azteca* were then weighed. All information was recorded on laboratory bench sheets.

Comprehensive Environmental Toxicity Information System (CETIS) statistical software (2011) was used to establish the significance differences between *H. azteca* survival and biomass between groups after 10 days of exposure in the sediment samples (see **Attachment 1**). **Figure 3.1-1** presents the results for survival and **Figure 3.1-2** presents the results for biomass.

Survival Results

Survival results for each replicate and average per location are included in the CETIS worksheets (**Attachment 1**). Control P and Control N both showed an average of 97.5% survival and were therefore indistinguishable from each other. Control N met the minimum performance criterion of >80% survival. Control P had unexpectedly high survival but did not influence the outcome of the toxicity test. Site sample results were only compared to Control N to determine significant survival and growth due to the impacted "reference" locations (A56 and A68). The available analytical data (see **Tables 3.1-1 to 3.1-4**) show that the Zn levels in Control P were consistently similar to those measured in Control N. An error may have occurred with the spiking procedure or perhaps zinc was washed out of the sandy substrate during the daily water exchange procedures.

Locations A56 and A68 showed 62.5 $\pm$ 8.2% and 56.3 $\pm$ 3.5% survival, respectively. Location A72 had 36.3 + 4.2% survival, location A73B had 5$\pm$ 1.9% survival, location A75B had 48.8 + 5.2% survival and location M34 had 8.8 $\pm$ 3.5% survival. None of the organisms survived at location CC49, whereas location Bbridge showed 76.3 $\pm$ 3.75% survival.

Biomass Results

Biomass results for each replicate and average per location are included in the CETIS worksheets (**Attachment 1**). Average biomass for each location was calculated by dividing the total weight of all surviving *H. azteca* per sample location by the total

number of *H. azteca* introduced per sample location on Day 0 of the test (i.e. [total weight of *H. azteca* from all eight replicates per sample location] / [8 replicates x 10 *H. azteca* introduced for each sample location]). The results show that Control N had an average biomass of 69.8 ± 3.5 µg/organism. Locations A56 and A68 had an average biomass of 20.3 ± 1.9 µg/organism and 22.6 ± 1.6 µg/organism, respectively. The following values represent the average biomass results for the remaining sample locations: A72 (16.1 ± 1.7 µg/organism), A73B (4.0 ± 1.7 µg/organism), 75B (17.8 ± 1.9 µg/organism), M34 (5.1 ± 2 µg/organism), and Bbridge (26.2 ± 1 µg/organism). Sample location CC49 had zero biomass because none of the *H. azteca* survived.

Growth Results

Growth for Control N was analyzed in order to determine if the Test Acceptability Criteria (TAC) of a measurable increase in growth between the start (Day 0) and the end (Day 10) of the test was met. All Control N growth results, along with supplemental growth results for Control P and each sample location are included in **Table 3.1-7**, which also presents the mean weight per survivor in each replicate. The average growth was analyzed for each location with the formula: ([total weight of *H. azteca* from all eight replicates per sample location] / [total surviving *H. azteca* for each sample location at the end of the test]) – initial weight). The initial average organism weight was 22.9 µg/organism (**Table 2.6-1**), whereas the final average organism weight for Control N was 71.7 µg/organism (i.e., +48.63 µg/organism or 212% growth increase). The surviving organisms exposed to sample A56 showed an +11.51 µg/organism increase (50.17% growth increase) and sample A68 showed a +17.18 µg/organism increase (74.9% growth increase).

3.2 Reference Toxicity Test

Overlying water quality parameters were consistent throughout the 96-hour reference toxicity test (see **Appendix B**). The performance criterion for EPA Method 100.1 requires no more than 50% change for alkalinity and hardness, whereas DO must be maintained above 2.5 mg/L. Test chamber temperatures ranged between 21.2°C and 22.7°C during the test period. The variability in hardness was less than 50% within each test chamber, and DO levels ranged between 5.65 mg/L and 7.72 mg/L. Alkalinity was not measured due to water volume constraints.

CETIS used the Trimmed Spearman-Karber method to calculate the EC_{50} 143 ug/L zinc with an UCL of 161 and an LCL of 127 ug/L zinc. These values correspond with historical LC50 values calculated from reference toxicity tests performed at the Region 8 Laboratory. Figure 3.2-2 shows the acute reference toxicant control chart for H. azteca exposed to zinc.

Survival Results

The surviving organisms were collected at the end of the 96-hour reference toxicity test and counted. **Figure 3.2-1** provides the results. The control (5 µg/L Zn) passed the

performance criterion of > 80% survival, with average survival of 100%. The following values show the average zinc concentrations and % survivals from the reference toxicity test: 59.55 µg/L zinc = 95% survival, 119.5 µg/L zinc = 72.5% survival, 250 µg/L zinc = 2.5% survival, 477 µg/L zinc = 0% survival and 857.5 µg/L zinc = 0% survival. A 96-hour LC_{50} of 143 µg/L was calculated using the Trimmed Spearman-Karber Estimates (see **Attachment 2**). *Note that CETIS uses the term "EC50" (Median Effective Concentration effecting 50% of the test organisms) instead of LC_{50}.*

A discrete sample of the overlying water was obtained from each replicate on Day 0 and Day 4 of the test for ammonia analysis using EPA Method 350.1 (EPA 1993). Ammonia (NH_3-N) levels on Day 0 (initial water chemistry) ranged from 0.00452 mg/L in the 50%-03 replicate to 0.01380 mg/L NH_3-N in the 100%-04 replicate. On Day 4 (final water chemistry), the ammonia levels ranged from 0.0159 mg/L NH_3-N in the 100%-02 replicate to 0.3176 mg/L NH_3-N in the 12.5%-01 replicate. **Table 3.1-6** provides the ammonia data. The average Day 0 and Day 4 ammonia levels measured in the four replicates of each of the samples used in the reference toxicity test were compared to pH-dependent acute ammonia criteria. None of the measured ammonia levels exceeded their respective criteria. Note that the acute ammonia criteria were calculated using the "salmonids present" equation, provided on p. 54 of the CDPHE (2012).

4.0 DISCUSSION

The survival and biomass results of the Animas River sediment toxicity test were compared to the negative control because the initial "reference" locations (i.e., A56 and A68) were impacted by mining contamination. The results are discussed below.

Survival

The CETIS software was used to perform a Dunnett's Multiple Comparison Test and compare Control N to all the site samples to determine the significance ($p \leq 0.05$) of the observed survival after 10 days of exposure (**Attachment 1**). The survival at all Site locations was statistically different from Control N. Note that one replicate in Control N had 11 *H. azteca* at test termination. The results were entered into CETIS to include 11 organisms exposed for that replicate representing 100% survival.

Biomass

CETIS was used to perform a Steel Many-One Rank Test (for Control N comparisons against all the Site samples) and Steel Many-One Rank Test (for Control N comparison against Site samples) to determine significant ($p \leq 0.05$) difference in observed biomass after 10 days of exposure (**Attachment 1**). Biomass in all the Site samples was statistically lower compared to Control N.

Growth

Control N passed TAC with measurable growth. The final average weight per organism in Control N was 71.7µg. This value represented a growth increase of about 48.63 µg/organism when compared to the initial average weight of *H. azteca* (22.94 µg/organism). Results consistently show that survival and biomass at all site locations are significantly impacted when compared to Control N.

5.0 REFERENCES

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Tables

Table 2.0-1 Test Conditions and Acceptability Criteria for 10 Day Sediment Toxicity Testing Using *H. azteca*

Parameter	Conditions
Test Type	Whole sediment toxicity test with renewal of overlying water
Test Duration	10 days
Temperature	Daily Mean Test Temperature 23 +/- 1°C; Instantaneous temperature 23 +/- 3°C
Light Quality	Wide spectrum flourescent lights
Illuminance	100 to 1000 lux
Photoperiod	16 light 8 dark
Test Chamber	300 mL beaker
Sediment Volume	100 mL
Overlying Water Volume	175 mL
Renewal of Overlying Water	2 volumes per day; continuous or intermittent
Age of Organisms	7-14 day old at start of test;1 to 2 day range in age
Number of Organisms/chamber	10
Number of Replicates	8 for whole sediment; 4 for reference test
Feeding	YCT food fed 1.0 mL per day to each test chamber
Aeration	None
Overlying Water	Moderately Hard Reconstituted Water
Test Chamber Cleaning	Clean screens if clogged
Overlying Water Quality	Initial and final measurements of: hardness, alkalinity, conductivity, pH, ammonia (hardness, alkalinity and ammonia should not vary more than 50%) Daily measurements of: temperature and dissolved oxygen
Endpoints	Survival, biomass, and rowth
Test Acceptability	Minimum mean control survival of 80% and measurable growth of test organisms in the control sediment

Table 2.5-1 Initial Feed Weight Data Sheets

December 2012 Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Static Renewal

YCT Dry Weight

Feed Dry Weight Rep #1		
Weigh boat	1.5406	g
Weigh boat + 1 mL wet feed	2.5935	g
1 mL wet feed	1.0529	g
Weight boat + dry feed	1.5432	g
Dry feed	0.0026	g/mL
Dry feed	2.6	g/L

Feed Dry Weight Rep #2		
Weigh boat	1.5271	g
Weigh boat + 1 mL wet feed	2.5548	g
1 mL wet feed	1.0277	g
Weight boat + dry feed	1.53	g
Dry feed	0.0029	g/mL
Dry feed	2.9	g/L

Feed Dry Weight Rep#3		
Weigh boat	1.542	g
Weigh boat + 1 mL wet feed	2.515	g
1 mL wet feed	0.973	g
Weight boat + dry feed	1.5446	g
Dry feed	0.0026	g/mL
Dry feed	2.6	g/L

Table 2.6-1 Initial *H. azteca* Weight Data Sheet
December 2012 Animas River Sediment Toxicity Test
10-Day Static Renewal

Initial Dry Weight: 80 Organisms		
Weigh Boat (empty)		208543.1 µg
Weigh Boat with 80 organisms (dried)		210378.4 µg
	Average Organism	22.94 µg

Table 3.1-1
December 2012 Animas River Sediment Toxicity Test Using *H. azteca*
Initial Pore Water Dissolved Metals Results (µg/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Hardness	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Control-P	232	<0.500U	1.14J	26.3	<2.00U	<0.100U	28700	<1.00U	<0.100U	26.4	118	<100U	0.428	12000	4870	0.663J	3910	0.659J	<0.500U	27000	285	<0.500U	<2.00U	33.5
Control-N	32.8J	1.29	5.68	27.1	<2.00U	<0.100U	309000	<1.00U	4.58	12.8	98	<100U	0.203	10300	6180	1.96	4480	<0.500U	<0.500U	24100	289	<0.500U	<2.00U	29.0
A56	57.1	1.71	1.93J	66.2	<2.00U	0.124J	27500	<1.00U	0.362	15.1	182	<100U	8.13	15100	9290	1.62	3130	0.775J	<0.500U	29200	453	<0.500U	<2.00U	27.5
A68	146	<0.500U	3.77	121	<2.00U	0.123J	22200	<1.00U	0.163J	25.6	120	<100U	13.3	13500	14500	1.27	3290	1.13	<0.500U	25300	235	<0.500U	<2.00U	27.6
A72	27.6J	<0.500U	<0.500U	28.3	<2.00U	0.931	47900	<1.00U	0.916	12.1	143	<100U	0.161J	15100	9630	0.662J	5000	1.57	<0.500U	28100	301	<0.500U	<2.00U	26.1
A73B	48.2J	<0.500U	<0.500U	32.4	<2.00U	0.213	25700	<1.00U	3.71	9.54	133	224J	<0.100U	14400	7320	0.545J	4130	0.977J	<0.500U	27700	285	<0.500U	<2.00U	38.0
A75B	47.8J	<0.500U	1.14J	33.2	<2.00U	<0.100U	32500	<1.00U	3.12	5.45	161	820	0.165J	15300	6180	5.67	2790	0.879J	<0.500U	26300	405	<0.500U	<2.00U	516
M-34	38.8J	<0.500U	0.559J	28.5	<2.00U	0.412	36200	<1.00U	14.6	6.06	1150	3680	0.168J	91700	1670	10.5	18500	10.2	<0.500U	267000	1720	<0.500U	<2.00U	13.1J
CC-49	1120	<0.500U	<0.500U	12.9	<2.00U	1.91	39000	<1.00U	31.5	26.4	107	2120	14.5	8670	3.57J	2.20	4120	1.53	<0.500U	26100	217	<0.500U	3.31	13.4J
Bbridge	79.3	<0.500U	0.802J	49.3	<2.00U	<0.100U	29700	<1.00U	2.35	5.93	158	169J	0.140J	16500	8920	2.68	3370	1.53	<0.500U	28200	308	<0.500U	<2.00U	37.9

Qualifiers:
J = estimated
U = non-detect

Table 3.1-2
December 2012 Animas River Sediment Toxicity Test Using *H. azteca*
Overlying Water Dissolved Metals Results

Initial (µg/L)

STATION ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Control-P	232	<0.500U	1.14J	26.3	<2.00U	<0.100U	28700	<1.00U	<0.100U	26.4	<100U	0.428	8670	3.57J	2.20	4120	1.53	<0.500U	26100	217	<0.500U	3.31	13.4J
Control-N	<20.0U	1.29	5.68	27.1	<2.00U	<0.100U	101000	<1.00U	4.58	12.8	<100U	0.203	32600	1670	10.5	8410	10.2	<0.500U	103000	567	<0.500U	<2.00U	13.1J
A56	57.1	1.71	1.93J	66.2	<2.00U	0.124J	27500	<1.00U	0.362	15.1	<100U	8.13	12000	4870	0.663J	3910	0.659J	<0.500U	27000	285	<0.500U	<2.00U	33.5
A68	83.6	<0.500U	3.70	74.6	<2.00U	<0.100U	21100	<1.00U	<0.100U	9.63	<100U	2.59	12900	4500	0.637J	4540	2.15	<0.500U	25600	229	<0.500U	<2.00U	22.4
A72	33.0J	<0.500U	<0.500U	20.2	<2.00U	1.12	42400	<1.00U	<0.100U	0.701J	<100U	<0.100U	17000	6250	<0.500U	3120	0.512J	<0.500U	29500	376	<0.500U	<2.00U	<10.0U
A73B	48.2J	<0.500U	<0.500U	32.4	<2.00U	0.213	25700	<1.00U	3.71	9.54	224J	<0.100U	13500	14500	1.27	3290	1.13	<0.500U	25300	235	<0.500U	<2.00U	27.6
A75B	47.8J	<0.500U	1.14J	33.2	<2.00U	<0.100U	32500	<1.00U	3.12	5.45	820	0.165J	15100	9630	0.662J	5000	1.57	<0.500U	28100	301	<0.500U	<2.00U	26.1
M-34	38.8J	<0.500U	0.559J	28.5	<2.00U	0.412	36200	<1.00U	14.6	6.06	3680	0.168J	16500	8920	2.68	3370	1.53	<0.500U	28200	308	<0.500U	<2.00U	37.9
CC-49	1120	<0.500U	<0.500U	12.9	<2.00U	1.91	39000	<1.00U	31.5	26.4	2120	14.5	15300	6180	5.67	2790	0.879J	<0.500U	26300	405	<0.500U	<2.00U	516
Bbridge	79.3	<0.500U	0.802J	49.3	<2.00U	<0.100U	29700	<1.00U	2.35	3.32	169J	<0.100U	14400	7320	<0.500U	4130	1.65	<0.500U	27700	285	<0.500U	<2.00U	38.0
Reference Toxicity Test																							
100%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13700	<1.00U	<0.100U	3.34	<100U	<0.100U	14800	<2.00U	<0.500U	2240	1.13	<0.500U	26300	79.0	<0.500U	<2.00U	881
50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	14000	<1.00U	<0.100U	2.39	<100U	0.246	15200	2.07J	<0.500U	2280	0.633J	<0.500U	27000	79.6	<0.500U	<2.00U	466
25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13900	<1.00U	<0.100U	2.27	<100U	<0.100U	15100	<2.00U	<0.500U	2280	<0.500U	<0.500U	27000	79.9	<0.500U	<2.00U	229
12.50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	14100	<1.00U	<0.100U	2.18	<100U	<0.100U	15200	<2.00U	<0.500U	2300	<0.500U	<0.500U	27000	80.2	<0.500U	<2.00U	115
6.25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13900	<1.00U	<0.100U	2.21	<100U	<0.100U	15200	<2.00U	<0.500U	2320	<0.500U	<0.500U	27200	80.3	<0.500U	<2.00U	58.6
Ref. Control	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13700	<1.00U	<0.100U	2.55	<100U	<0.100U	14900	<2.00U	<0.500U	2260	<0.500U	<0.500U	26700	79.9	<0.500U	<2.00U	<10.0U

Final (µg/L)

STATION ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Control-P	25.6J	<0.500U	<0.500U	10.9	<2.00U	<0.100U	15400	<1.00U	<0.100U	4.29	<100U	2.02	11800	43.2	<0.500U	2280	<0.500U	<0.500U	24700	99.9	<0.500U	<2.00U	<10.0U
Control-N	<20.0U	<0.500U	<0.500U	14.3	<2.00U	<0.100U	23500	<1.00U	<0.100U	2.86	<100U	0.106J	16600	5.39	<0.500U	2970	<0.500U	<0.500U	30600	144	<0.500U	<2.00U	<10.0U
A56	<20.0U	<0.500U	0.633J	11.1	<2.00U	<0.100U	17100	<1.00U	<0.100U	4.06	<100U	0.157J	15600	49.4	<0.500U	3040	<0.500U	<0.500U	29800	125	<0.500U	<2.00U	12.1J
A68	<20.0U	<0.500U	1.13J	24.6	<2.00U	<0.100U	16100	<1.00U	<0.100U	3.19	<100U	0.852	15200	875	<0.500U	2970	<0.500U	<0.500U	28300	130	<0.500U	<2.00U	13.2J
A72	25.7J	<0.500U	<0.500U	10.2	<2.00U	0.179J	18900	<1.00U	<0.100U	3.13	<100U	0.121J	15900	1260	<0.500U	2750	<0.500U	<0.500U	29500	138	<0.500U	<2.00U	<10.0U
A73B	23.2J	<0.500U	<0.500U	7.85J	<2.00U	0.191J	16400	<1.00U	0.342	3.08	<100U	<0.100U	15600	2810	<0.500U	2740	<0.500U	<0.500U	29000	112	<0.500U	<2.00U	11.2J
A75B	<20.0U	<0.500U	<0.500U	6.58J	<2.00U	<0.100U	18000	<1.00U	<0.100U	3.46	<100U	<0.100U	16400	492	<0.500U	3020	0.613J	<0.500U	30300	130	<0.500U	<2.00U	18.1J
M-34	<20.0U	<0.500U	<0.500U	6.48J	<2.00U	<0.100U	16400	1.94J	0.142J	0.613J	<100U	<0.100U	16300	567	<0.500U	2820	<0.500U	<0.500U	29900	107	<0.500U	<2.00U	<10.0U
CC-49	<20.0U	<0.500U	<0.500U	6.74J	<2.00U	0.197J	17000	<1.00U	3.59	3.16	118J	0.222	15500	724	0.562J	2620	<0.500U	<0.500U	28700	125	<0.500U	<2.00U	39.8
Bbridge	<20.0U	<0.500U	<0.500U	7.17J	<2.00U	<0.100U	16700	2.76	<0.100U	0.972J	<100U	<0.100U	15600	26.8	<0.500U	2910	<0.500U	<0.500U	29100	119	<0.500U	<2.00U	<10.0U
Reference Toxicity Test																							
100%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	14200	1.55J	<0.100U	3.90	<100U	0.149J	15200	<2.00U	<0.500U	2350	<0.500U	<0.500U	28000	84.4	<0.500U	<2.00U	834
50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	15000	1.91J	<0.100U	2.47	<100U	<0.100U	16300	<2.00U	<0.500U	2580	<0.500U	<0.500U	29300	87.4	<0.500U	<2.00U	488
25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	14700	1.59J	<0.100U	2.62	<100U	0.173J	16000	<2.00U	<0.500U	2570	<0.500U	<0.500U	28900	87.2	<0.500U	<2.00U	271
12.50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	15500	2.22	<0.100U	2.80	<100U	0.628	16900	4.36J	<0.500U	2760	<0.500U	<0.500U	30300	91.0	<0.500U	<2.00U	124
6.25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	15400	2.14	<0.100U	2.45	<100U	<0.100U	16800	<2.00U	<0.500U	2670	<0.500U	<0.500U	30200	89.2	<0.500U	<2.00U	60.5
Ref. Control	<20.0U	<0.500U	<0.500U	10.3	<2.00U	<0.100U	16000	<1.00U	<0.100U	4.20	<100U	1.91	17300	4.52J	<0.500U	2930	<0.500U	<0.500U	31200	93.1	<0.500U	<2.00U	<10.0U

Qualifiers:
J = estimated
U = non-detect

Table 3.1-3
December 2012 Animas River Sediment Toxicity Test Using *H. azteca*
Pore Water Total Recoverable Metals Results

Initial (µg/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Control-N	554	<2.50U	<2.50U	32.0JD	<2.00U	<0.500U	99700	8.39JD	<0.500U	3.93JD	534	1.06D	31600	66.9	<2.50U	8380	<2.50U	<2.50U	101000	580	<2.50U	<10.0U	16.1J
Control-P	876	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	19200	9.77JD	<0.500U	3.04JD	593	0.797JD	11300	10.6	<2.50U	3150	<2.50U	<2.50U	25000	140	<2.50U	<10.0U	16.0J
A56	131	<2.50U	<2.50U	40.7JD	<2.00U	<0.500U	26100	9.57JD	<0.500U	15.4D	192J	24.8D	13500	2650	<2.50U	3900	<2.50U	<2.50U	27400	256	<2.50U	<10.0U	73.0
A68	150	<2.50U	<2.50U	76.0D	<2.00U	<0.500U	19800	8.58JD	<0.500U	18.5D	265	21.7D	12200	4440	<2.50U	4310	<2.50U	<2.50U	24500	227	<2.50U	<10.0U	49.6
A72	209	<2.50U	<2.50U	<25.0U	<2.00U	1.08D	39400	7.36JD	<0.500U	<2.50U	246J	2.71D	16000	6100	<2.50U	3060	<2.50U	<2.50U	28300	374	<2.50U	<10.0U	15.8J
A73B	81.7	<2.50U	<2.50U	25.1JD	<2.00U	<0.500U	24300	7.83JD	2.45D	<2.50U	<100U	0.632JD	14100	11800	<2.50U	3240	<2.50U	<2.50U	25500	216	<2.50U	<10.0U	24.4
A75B	125	<2.50U	<2.50U	25.2JD	<2.00U	<0.500U	29500	6.42JD	1.94D	2.87JD	169J	1.16D	15500	7930	<2.50U	4750	<2.50U	<2.50U	27700	279	<2.50U	<10.0U	48.0
M-34	651	<2.50U	<2.50U	27.1JD	<2.00U	0.592JD	34600	8.89JD	14.9D	3.01JD	926	0.702JD	16800	8390	<2.50U	3360	<2.50U	<2.50U	28400	300	<2.50U	<10.0U	48.1
CC-49	1170	<2.50U	<2.50U	<25.0U	<2.00U	1.63D	36600	5.36JD	31.0D	25.0D	1170	17.7D	15200	5800	4.69JD	2740	<2.50U	<2.50U	26400	387	<2.50U	<10.0U	455
Bbridge	110	<2.50U	<2.50U	30.6JD	<2.00U	<0.500U	27000	<5.00U	1.30D	3.30JD	123J	1.45D	15000	5210	<2.50U	3840	<2.50U	<2.50U	26800	253	<2.50U	<10.0U	45.6
Reference Toxicity Test																							
100%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12500	6.67JD	<0.500U	<2.50U	<100U	0.603JD	13900	<2.00U	<2.50U	2160	2.57JD	<2.50U	25300	76.8	4.42JD	<10.0U	799
50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12900	8.88JD	<0.500U	<2.50U	<100U	<0.500U	14300	<2.00U	<2.50U	2180	<2.50U	<2.50U	26000	79.1	<2.50U	<10.0U	418
25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12900	6.17JD	<0.500U	<2.50U	<100U	<0.500U	14400	<2.00U	<2.50U	2180	<2.50U	<2.50U	26200	79.8	<2.50U	<10.0U	210
12.50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12600	5.16JD	<0.500U	<2.50U	<100U	<0.500U	14000	<2.00U	<2.50U	2150	<2.50U	<2.50U	25600	77.5	<2.50U	<10.0U	104
6.25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12700	9.26JD	<0.500U	<2.50U	<100U	<0.500U	14100	<2.00U	<2.50U	2170	<2.50U	<2.50U	25600	77.5	<2.50U	<10.0U	53.8
Ref. Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	9.27JD	<0.500U	<2.50U	<100U	<0.500U	14400	<2.00U	<2.50U	2240	<2.50U	<2.50U	26400	79.0	<2.50U	<10.0U	<10.0U

Final (µg/L)

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
Control-P	416	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	14600	7.14JD	<0.500U	<2.50U	279	0.754JD	11300	48.2	<2.50U	2250	<2.50U	<2.50U	23700	98.4	<2.50U	<10.0U	10.1J
Control-N	43.2J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	22800	6.05JD	<0.500U	<2.50U	<100U	<0.500U	16000	7.76	<2.50U	2930	<2.50U	<2.50U	29800	144	<2.50U	<10.0U	<10.0U
A56	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	16300	8.83JD	<0.500U	<2.50U	<100U	1.13D	15000	54.4	<2.50U	3020	<2.50U	<2.50U	28900	125	<2.50U	<10.0U	15.3J
A68	30.7J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	15700	8.84JD	<0.500U	<2.50U	<100U	4.42D	14800	911	<2.50U	2960	<2.50U	<2.50U	27600	131	<2.50U	<10.0U	19.8J
A72	159	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	18600	<5.00U	<0.500U	<2.50U	233J	2.15D	15700	1230	<2.50U	2780	<2.50U	<2.50U	29000	137	<2.50U	<10.0U	<10.0U
A73B	63.0	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	15800	8.06JD	<0.500U	<2.50U	<100U	0.723JD	15200	2890	<2.50U	2720	<2.50U	<2.50U	28200	113	<2.50U	<10.0U	12.9J
A75B	28.5J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	17500	7.80JD	<0.500U	<2.50U	<100U	<0.500U	15800	502	<2.50U	2990	<2.50U	<2.50U	29400	131	<2.50U	<10.0U	20.9
M-34	26.1J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	16000	7.84JD	<0.500U	<2.50U	<100U	<0.500U	16000	619	<2.50U	2860	<2.50U	<2.50U	29500	110	<2.50U	<10.0U	<10.0U
CC-49	97.8	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	16600	<5.00U	3.56D	<2.50U	5100	3.43D	15000	738	<2.50U	2560	<2.50U	<2.50U	28000	126	<2.50U	<10.0U	47.8
Bbridge	39.4J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	16600	8.35JD	<0.500U	<2.50U	<100U	<0.500U	15400	36.8	<2.50U	2950	<2.50U	<2.50U	29000	127	<2.50U	<10.0U	11.9J
Reference Toxicity Test																							
100%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	14500	5.98JD	<0.500U	<2.50U	<100U	0.728JD	15700	<2.00U	<2.50U	2490	<2.50U	<2.50U	28700	87.1	4.97JD	<10.0U	853
50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	14500	7.67JD	<0.500U	<2.50U	<100U	0.541JD	15800	<2.00U	<2.50U	2580	<2.50U	<2.50U	28800	90.3	<2.50U	<10.0U	482
25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	14800	6.56JD	<0.500U	<2.50U	<100U	0.603JD	16200	<2.00U	<2.50U	2660	<2.50U	<2.50U	29300	90.1	<2.50U	<10.0U	268
12.50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	15000	<5.00U	<0.500U	7.70D	<100U	0.513JD	16400	<2.00U	<2.50U	2760	<2.50U	<2.50U	29500	90.7	<2.50U	<10.0U	119
6.25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	14900	8.88JD	<0.500U	<2.50U	<100U	<0.500U	16300	2.49J	<2.50U	2690	<2.50U	<2.50U	29300	90.1	<2.50U	<10.0U	60.2
Ref. Control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	15500	8.73JD	<0.500U	<2.50U	<100U	0.803JD	16900	3.35J	<2.50U	2910	<2.50U	<2.50U	30900	94.4	<2.50U	<10.0U	10.0J

Qualifiers:
D = diluted sample
J = estimated
U = non-detect

Prepared by: EC 7/15/13
Reviewed by: BGK 7/23/13

Table 3.1-4
December 2012 Animas River Sediment Toxicity Test Using *H. azteca*
Initial Sediment Total Recoverable Metals Results

STATION_ID	ANALYSIS	UNITS	Aluminum	Barium	Beryllium	Calcium	Copper	Iron	Lead	Magnesium	Manganese	Potassium	Sodium	Strontium	Zinc
Control-P	ICPOE Tot. Rec. Metals	mg/kg dry wt	1300D	16.2D	<1.99U	930D	2.19D	2720D	<9.94U	434D	34.3D	347JD	<249U	8.44JD	21.6D
Control-N	ICPOE Tot. Rec. Metals	mg/kg dry wt	1340D	28.7D	<1.96U	2770D	2.78D	2860D	<9.81U	610D	76.6D	420JD	337JD	18.6D	19.8D
A56	ICPOE Tot. Rec. Metals	mg/kg dry wt	9790D	113D	2.76JD	4430D	306D	28700D	2070D	4630D	6020D	900JD	<255U	44.9D	3530D
A68	ICPOE Tot. Rec. Metals	mg/kg dry wt	14500D	190D	5.14D	5330D	605D	43900D	2600D	5040D	12100D	1200D	<250U	75.6D	7630D
A72	ICPOE Tot. Rec. Metals	mg/kg dry wt	24800D	195D	<2.01U	4270D	198D	60600D	704D	6570D	4320D	1420D	<252U	87.9D	968D
A73B	ICPOE Tot. Rec. Metals	mg/kg dry wt	17200D	103D	<1.99U	2880D	232D	48500D	557D	4040D	4430D	567JD	<249U	42.4D	1240D
A75B	ICPOE Tot. Rec. Metals	mg/kg dry wt	47400D	145D	5.63D	6320D	415D	81400D	436D	3980D	4440D	1360D	<251U	99.9D	4980D
M-34	ICPOE Tot. Rec. Metals	mg/kg dry wt	32800D	105D	<1.96U	4290D	91.4D	62300D	152D	5340D	1220D	935JD	<245U	61.4D	323D
CC-49	ICPOE Tot. Rec. Metals	mg/kg dry wt	4140D	55.7D	<1.96U	1200D	57.8D	289000D	206D	1720D	307D	450JD	<245U	17.8D	132D
Bbridge	ICPOE Tot. Rec. Metals	mg/kg dry wt	44800D	206D	5.72D	7890D	377D	78500D	471D	4330D	8790D	1350D	<252U	123D	9060D

STATION_ID	ANALYSIS	UNITS	Antimony	Arsenic	Cadmium	Chromium	Cobalt	Nickel	Selenium	Silver	Thallium	Vanadium
Control-P	ICPMS Tot. Rec. Metals	ug/kg dry wt	<497U	745JD	<99.4U	2830D	1160D	2070D	<497U	<497U	<497U	2170JD
Control-N	ICPMS Tot. Rec. Metals	ug/kg dry wt	<490U	<490U	133JBD	2890D	1790D	2110D	<490U	<490U	<490U	2160JD
A56	ICPMS Tot. Rec. Metals	ug/kg dry wt	9530D	79600D	9220BD	5480D	13100D	8580D	<510U	10300D	<510U	14300D
A68	ICPMS Tot. Rec. Metals	ug/kg dry wt	9340D	82400D	16700BD	8800D	15400D	15200D	1220D	12000D	1160D	18300D
A72	ICPMS Tot. Rec. Metals	ug/kg dry wt	1790D	45600D	3280BD	4660D	21800D	7180D	<503U	3530D	688JD	23200D
A73B	ICPMS Tot. Rec. Metals	ug/kg dry wt	2270D	29100D	5220BD	4700D	21200D	11500D	<498U	3290D	<498U	17300D
A75B	ICPMS Tot. Rec. Metals	ug/kg dry wt	2060D	37500D	10300BD	5420D	29900D	16100D	1110D	2070D	540JD	22900D
M-34	ICPMS Tot. Rec. Metals	ug/kg dry wt	<491U	21000D	1060BD	3640D	14800D	4520D	<491U	558JD	<491U	20500D
CC-49	ICPMS Tot. Rec. Metals	ug/kg dry wt	1510D	66700D	338BD	4710D	2520D	1890D	<490U	1200D	<490U	56200D
Bbridge	ICPMS Tot. Rec. Metals	ug/kg dry wt	2110D	40200D	16900BD	5260D	60800D	31000D	<503U	2200D	547JD	24200D

Qualifiers:
D = diluted sample
J = estimated
U = non-detect

Table 3.1-5: Initial and Final Average Ammonia Results for December 2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*

Replicate ID	Initial Measured Ammonia Conc. (mg N/L)	Initial Measured pH	Initial Average Measured Ammonia Conc. (mg N/L)	Initial Average Measured pH	Initial Ammonia Criterion (mg N/L)[a]	Final Measured Ammonia Conc. (mg N/L)[b]	Final Measured pH[b]	Final Average Measured Ammonia Conc. (mg N/L)	Final Average Measured pH	Final Ammonia Criterion (mg N/L)[a]
Control-P-01	0.0230	7.4	0.0085	7.45	14.40	0.0384	6.7	0.0405	6.74	29.08
Control-P-02	0.0061	7.4				0.0547	6.7			
Control-P-03	0.0069	7.5				0.0544	6.7			
Control-P-04	0.0053	7.5				0.0408	6.7			
Control-P-05	0.0062	7.4				0.0230	6.7			
Control-P-06	0.0063	7.5				0.0301	6.8			
Control-P-07	0.0088	7.4				0.0323	6.8			
Control-P-08	0.0054	7.5				0.0501	6.8			
Control-N-01	1.2810	6.9	1.4109	6.97	24.65	0.4570	5.8	0.4732	6.23	35.29
Control-N-02	1.5980	6.9				0.4690	6.0			
Control-N-03	1.3630	7.0				0.5375	6.1			
Control-N-04	1.3190	6.9				0.4327	6.2			
Control-N-05	1.5660	6.9				0.5155	6.4			
Control-N-06	1.2860	7.1				0.3950	6.4			
Control-N-07	1.5280	7.0				0.5453	6.5			
Control-N-08	1.3460	7.1				0.4339	6.5			
A56-01	1.7380	7.1	1.6259	7.24	18.78	0.0422	7.1	0.0427	7.11	21.67
A56-02	1.9840	7.2				0.0450	7.1			
A56-03	1.2580	7.2				0.0340	7.1			
A56-04	1.7850	7.2				0.0375	7.1			
A56-05	1.3480	7.3				0.0463	7.1			
A56-06	1.5650	7.3				0.0376	7.1			
A56-07	1.6000	7.3				0.0528	7.1			
A56-08	1.7290	7.3				0.0465	7.2			
A68-01	5.9160	7.4	5.0698	7.51	13.06	1.5900	7.2	1.2675	7.22	19.25
A68-02	5.0510	7.5				1.1350	7.2			
A68-03	5.0770	7.5				1.1840	7.2			
A68-04	4.8800	7.5				1.5560	7.2			
A68-05	5.0990	7.5				1.2010	7.2			
A68-06	4.5280	7.6				1.1580	7.3			
A68-07	5.1330	7.6				1.2630	7.2			
A68-08	4.8740	7.6				1.0530	7.3			
A72-01	0.2228	7.1	0.2050	7.08	22.44	0.0654	7.0	0.1057	7.01	23.87
A72-02	0.1624	7.1				0.0584	7.0			
A72-03	0.2154	7.1				0.2117	7.0			
A72-04	0.2423	7.1				0.1607	7.0			
A72-05	0.2230	7.1				0.1321	7.0			
A72-06	0.1938	7.1				0.0595	7.0			
A72-07	0.1964	7.0				0.0979	7.0			
A72-08	0.1840	7.1				0.0603	7.0			
A73B-01	1.0890	7.5	0.8890	7.38	15.71	0.0664	7.2	0.0416	7.15	20.76
A73B-02	0.6481	7.4				0.0455	7.2			
A73B-03	0.9262	7.4				0.0338	7.2			
A73B-04	0.8286	7.4				0.0344	7.2			
A73B-05	0.9758	7.4				0.0421	7.1			
A73B-06	0.8755	7.3				0.0399	7.1			
A73B-07	0.9011	7.3				0.0346	7.1			
A73B-08	0.8677	7.3				0.0364	7.1			
A75B-01	1.8390	7.0	1.7875	7.06	22.87	0.0432	7.0	0.0521	6.99	24.23
A75B-02	1.8770	7.0				0.0935	7.0			
A75B-03	1.7820	7.0				0.0393	7.0			
A75B-04	1.5890	7.1				0.0537	7.0			
A75B-05	1.9480	7.1				0.0457	7.0			
A75B-06	1.8490	7.1				0.0415	7.0			
A75B-07	1.7990	7.1				0.0450	7.0			
A75B-08	1.6170	7.1				0.0545	7.0			

Replicate ID	Initial Measured Ammonia Conc. (mg N/L)	Initial Measured pH	Initial Average Measured Ammonia Conc. (mg N/L)	Initial Average Measured pH	Initial Ammonia Criterion (mg N/L)[a]	Final Measured Ammonia Conc. (mg N/L)[b]	Final Measured pH[b]	Final Average Measured Ammonia Conc. (mg N/L)	Final Average Measured pH	Final Ammonia Criterion (mg N/L)[a]
M34-01	0.1279	6.2	0.1313	6.27	34.95	0.3956	6.2	0.4178	6.48	32.86
M34-02	0.1294	6.2				0.3824	6.3			
M34-03	0.1302	6.2				0.3438	6.5			
M34-04	0.1424	6.3				0.4928	6.5			
M34-05	0.1385	6.3				0.4676	6.6			
M34-06	0.1294	6.3				0.4916	6.6			
M34-07	0.1335	6.3				0.4146	6.6			
M34-08	0.1187	6.4				0.3536	6.6			
CC49-01	0.1200	7.3	0.1009	6.47	32.98	0.3776	7.1	0.4138	5.09	38.70
CC49-02	0.1235	7.2				0.4361	5.4			
CC49-03	0.1396	6.7				0.4105	4.3			
CC49-04	0.0770	6.4				0.3095	4.9			
CC49-05	0.0956	6.3				0.4655	4.2			
CC49-06	0.0900	6.1				0.5554	4.8			
CC49-07	0.0856	5.9				0.4005	4.8			
CC49-08	0.0756	5.9				0.3551	5.2			
Bbridge-01	2.3670	6.5	2.1519	6.85	27.21	0.0411	6.8	0.0415	6.89	18.31
Bbridge-02	1.6270	6.7				0.0387	6.9			
Bbridge-03	2.3920	6.8				0.0468	6.8			
Bbridge-04	2.1860	6.8				0.0418	6.9			
Bbridge-05	2.3110	6.9				0.0420	6.9			
Bbridge-06	2.2140	7.0				0.0394	6.9			
Bbridge-07	2.0910	7.0				0.0441	7.0			
Bbridge-08	2.0270	7.0				0.0379	7.0			

a The sample-specific acute ammonia criterion was calculated using the "salmon present" formula on p. 54 of the Colorado Department of Public Health and Environment, Water Quality Control Commission, Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31).

[b]Values shown are either the measurements made at the end of the test (day 10) or earlier if all test organisms died before the 10-day exposure period was completed.

Prepared by: EC 7/19/13
Reviewed by: BGK 7/23/13

Table 3.1-6 Initial and Final Average Ammonia Results for December 2012 Upper Animas River Concurrent Reference Toxicity Test Using *H. azteca*

Replicate ID	Initial Measured Ammonia Conc. (mg N/L)[a]	Initial Measured pH	Initial Average Measured Ammonia Conc. (mg N/L)	Initial Average Measured pH	Initial Ammonia Criterion (mg N/L)[a]	Final Measured Ammonia Conc. (mg N/L)	Final Measured pH	Final Average Measured Ammonia Conc. (mg N/L)	Final Average Measured pH	Final Ammonia Criterion (mg N/L)[a]
Ref Control-01	0.00543	7.16	0.0061	7.23	19.17	0.2191	7.35	0.1850	7.16	20.67
Ref Control-02	0.00575	7.20				0.1978	7.38			
Ref Control-03	0.00559	7.25				0.1799	6.84			
Ref Control-04	0.00755	7.29				0.1431	7.06			
6.25%-01	0.00494	7.34	0.0052	7.38	15.77	0.1444	7.00	0.1198	7.05	23.14
6.25%-02	0.00577	7.36				0.1128	7.02			
6.25%-03	0.00533	7.39				0.1045	7.06			
6.25%-04	0.00481	7.43				0.1174	7.10			
12.5%-01	0.00865	7.45	0.0072	7.48	13.63	0.3176	7.14	0.1735	7.20	19.67
12.5%-02	0.00947	7.46				0.1355	7.18			
12.5%-03	0.00519	7.49				0.1141	7.23			
12.5%-04	0.00541	7.53				0.1267	7.26			
25%-01	0.00471	7.53	0.0053	7.54	12.45	0.0949	--	0.0998	7.29	17.73
25%-02	0.00501	7.53				0.0842	--			
25%-03	0.00598	7.54				0.0792	--			
25%-04	0.00560	7.57				0.1408	7.29			
50%-01	0.00568	7.54	0.0050	7.54	12.50	0.0505	--	0.0384	NC	NA
50%-02	0.00510	7.48				0.0313	--			
50%-03	0.00452	7.61				0.0362	--			
50%-04	0.00458	7.53				0.0356	--			
100%-01	0.00493	7.55	0.0075	7.55	12.31	0.0171	--	0.0181	NC	NA
100%-02	0.00471	7.55				0.0159	--			
100%-03	0.00665	7.50				0.0198	--			
100%-04	0.01380	7.60				0.0194	--			

NA = Not available
NC = Not calculated

[a] The sample-specific acute ammonia criterion was calculated using the "salmon present" formula on p. 54 of the Colorado Department of Public Health and Environment, Water Quality Control Commission, Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31).

[b]Values shown are either the measurements made at the end of the test (day 4) or earlier if all test organisms died before the 4-day exposure period was completed.

Prepared by: EC 7/19/13
Reviewed by: BGK 7/23/13

Table 3.1-7 December 2012 Animas River Sediment Toxicity Test Using *H. azteca*

Weight Data Sheets: 10-Day Static Renewal

Start Date	12/10/12	Drying Time	24 hours
End Date	12/20/12	Oven Temp (^{o}C)	70°C
Weighing Date	01/09/13	Organism	*H. azteca*
No. of Replicates	8	Initial Weight (µg)	22.94
Feed Rate/Type	YCT/Daily	Analysts	SA,LC,CL

Replicate I.D.	Weight of Oven Dried Pan (µg)	Pan + Dried Organisms (µg)	Dry Organisms (µg)	Number of Survivors	Mean Weight per Survivor (µg)	Sample Mean (µg)
Control-P-01	207294.6	207694	399.4	10	39.94	43.71
Control-P-02	207493.7	207886.2	392.5	10	39.25	
Control-P-03	207230.1	207778.4	548.3	10	54.83	
Control-P-04	206113.8	206463.3	349.5	9	38.83	
Control-P-05	209306.2	209611	304.8	10	30.48	
Control-P-06	208216.3	208784.9	568.6	10	56.86	
Control-P-07	208942.2	209243.6	301.4	10	30.14	
Control-P-08	205478.8	206013.1	534.3	9	59.37	
Control-N-01	207119	207723	604	10	60.40	71.57
Control-N-02	206639.5	207242.9	603.4	9	67.04	
Control-N-03	209331.6	210156.3	824.7	11	74.97	
Control-N-04	206219.7	207130.9	911.2	10	91.12	
Control-N-05	207477.6	208092.5	614.9	9	68.32	
Control-N-06	207049.1	207710.5	661.4	10	66.14	
Control-N-07	208251	208904.2	653.2	9	72.58	
Control-N-08	208054	208774.1	720.1	10	72.01	
A56-01	209603.7	209717.5	113.8	3	37.93	34.45
A56-02	209189.1	209456.2	267.1	7	38.16	
A56-03	207747.3	207921.2	173.9	5	34.78	
A56-04	206852.2	207075.9	223.7	8	27.96	
A56-05	209002.3	209244.5	242.2	9	26.91	
A56-06	205403.1	205621.2	218.1	7	31.16	
A56-07	207791.3	207936.4	145.1	3	48.37	
A56-08	208463.9	208706.5	242.6	8	30.33	
A68-01	208033	208234	201	5	40.20	40.12
A68-02	206546.4	206746.1	199.7	6	33.28	
A68-03	205690	205981.9	291.9	7	41.70	
A68-04	206756.1	206977.3	221.2	6	36.87	
A68-05	209336.4	209583.3	246.9	6	41.15	
A68-06	207295.6	207443.7	148.1	4	37.03	
A68-07	208476.6	208705.8	229.2	5	45.84	
A68-08	207653.5	207923.0	269.5	6	44.92	
A72-01	207566.1	207684.6	118.5	2	59.25	45.64
A72-02	207038.5	207180.8	142.3	4	35.57	
A72-03	206675.8	206749.4	73.6	2	36.80	
A72-04	206609.1	206778.9	169.8	3	56.60	
A72-05	207490.5	207677.7	187.2	4	46.80	
A72-06	205252.2	205461.6	209.4	5	41.88	
A72-07	204860	205041.0	181	5	36.20	
A72-08	205829.8	206038.0	208.2	4	52.05	

Table 3.1-7 December 2012 Animas River Sediment Toxicity Test Using *H. azteca*

Weight Data Sheets: 10-Day Static Renewal

Start Date	12/10/12	Drying Time	24 hours
End Date	12/20/12	Oven Temp (^{o}C)	70°C
Weighing Date	01/09/13	Organism	*H. azteca*
No. of Replicates	8	Initial Weight (µg)	22.94
Feed Rate/Type	YCT/Daily	Analysts	SA,LC,CL

Replicate I.D.	Weight of Oven Dried Pan (µg)	Pan + Dried Organisms (µg)	Dry Organisms (µg)	Number of Survivors	Mean Weight per Survivor (µg)	Sample Mean (µg)
A73B-01	208092	--	--	0	--	79.38
A73B-02	205437.5	--	--	0	--	
A73B-03	206460.1	--	--	0	--	
A73B-04	205380.7	205445	64.3	1	64.30	
A73B-05	204644.8	--	--	0	--	
A73B-06	205767.8	205865.9	98.1	1	98.10	
A73B-07	206877.7	206998.2	120.5	1	120.50	
A73B-08	206120.5	206155.1	34.6	1	34.60	
A75B-01	205789.7	205981.8	192.1	6	32.02	37.13
A75B-02	208670.9	208846.4	175.5	6	29.25	
A75B-03	208836.3	208926.6	90.3	3	30.10	
A75B-04	208491.7	208720.8	229.1	5	45.82	
A75B-05	207661.2	207809.1	147.9	5	29.58	
A75B-06	206346.2	206473.2	127	3	42.33	
A75B-07	203809.8	204014.4	204.6	4	51.15	
A75B-08	207994	208251.4	257.4	7	36.77	
M34-01	209594.3	--	--	0	--	61.88
M34-02	206387.3	206533.4	146.1	3	48.70	
M34-03	206176.2	--	--	0	--	
M34-04	207572.2	207686.7	114.5	1	114.50	
M34-05	208422	--	--	0	--	
M34-06	206302.5	206312	9.5	1	9.50	
M34-07	208254.3	208334	79.7	1	79.70	
M34-08	207897.3	207954.3	57	1	57.00	
CC49-01	205074.4	--	--	0	--	#DIV/0!
CC49-02	207328	--	--	0	--	
CC49-03	205978.1	--	--	0	--	
CC49-04	205910.7	--	--	0	--	
CC49-05	204673.6	--	--	0	--	
CC49-06	206851.3	--	--	0	--	
CC49-07	204953.4	--	--	0	--	
CC49-08	207055.2	--	--	0	--	
BBRIDGE-01	205991.7	206249.9	258.2	9	28.69	34.78
BBRIDGE-02	206000.4	206248.9	248.5	8	31.06	
BBRIDGE-03	208297.6	208609.1	311.5	8	38.94	
BBRIDGE-04	205253	205496.6	243.6	8	30.45	
BBRIDGE-05	208943.9	209240.2	296.3	8	37.04	
BBRIDGE-06	208583.4	208820.8	237.4	6	39.57	
BBRIDGE-07	208898	209129.3	231.3	6	38.55	
BBRIDGE-08	208620.5	208892.3	271.8	8	33.97	

Figures

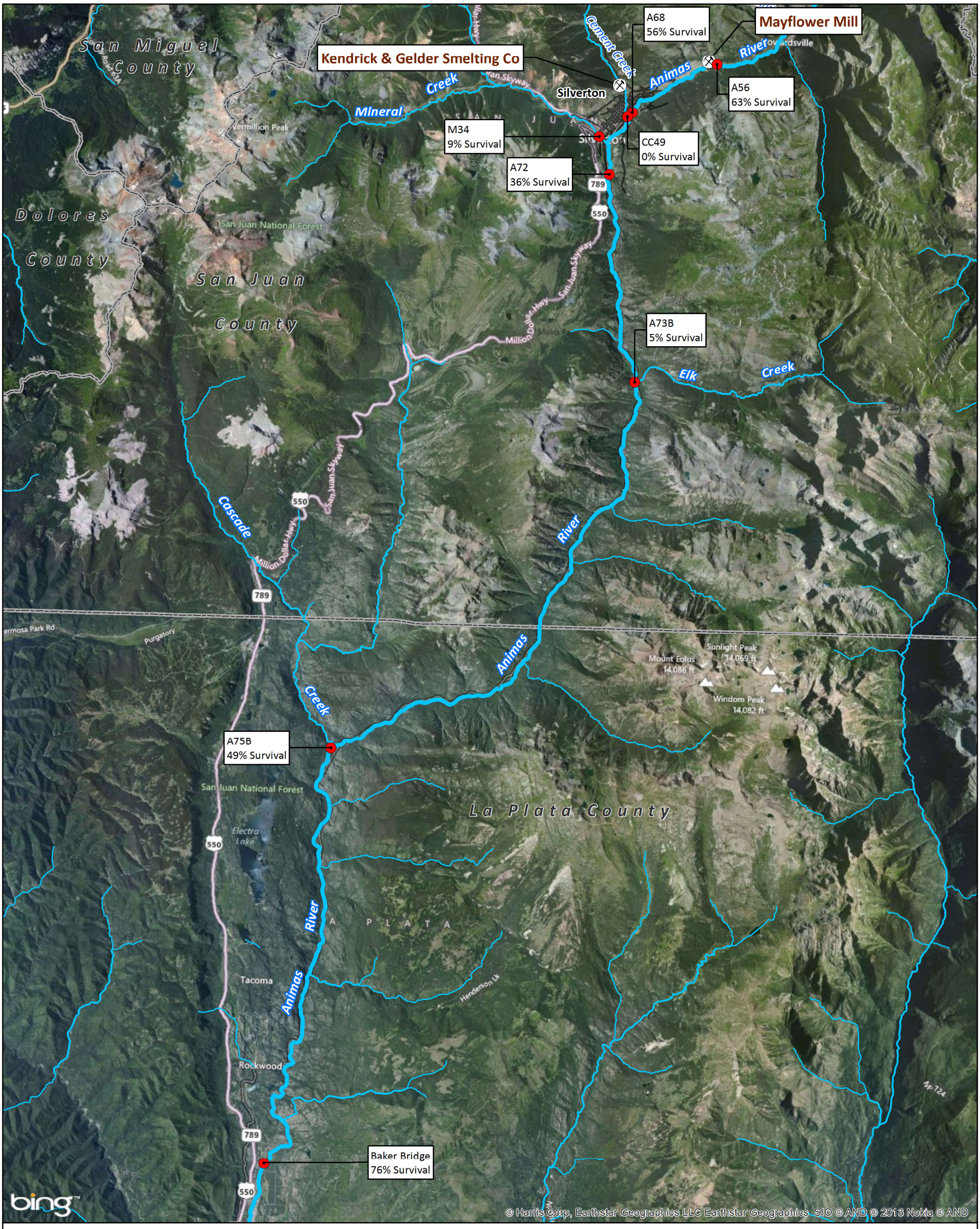


Figure 2.2-1
2012 Upper Animas River
Sediment Toxicity Test Sample Locations

Sample Locations

Mine Locations

Rivers and Streams

County Boundaries

Date: November 12, 2013

Data Sources:
Sample Locations: U.S. EPA Region 8 (2012)
Mine Locations: U.S. EPA and ESAT (2012)
Rivers and Streams: CDOW 1:24k (2004)
County Boundaries: U.S. Census Bureau (2011)
Imagery: Microsoft Bing Web Service (2013)

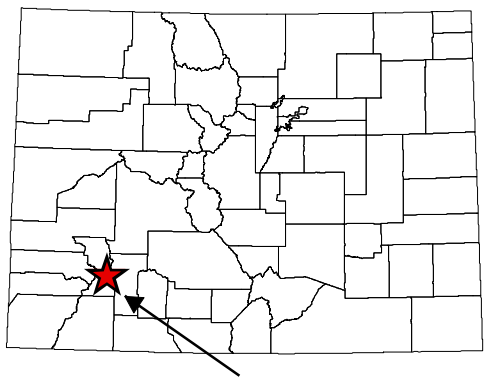
Coordinate System/Projection:
UTM Zone 13 North, NAD 83, Meters

N W E S

0 1 2 Miles

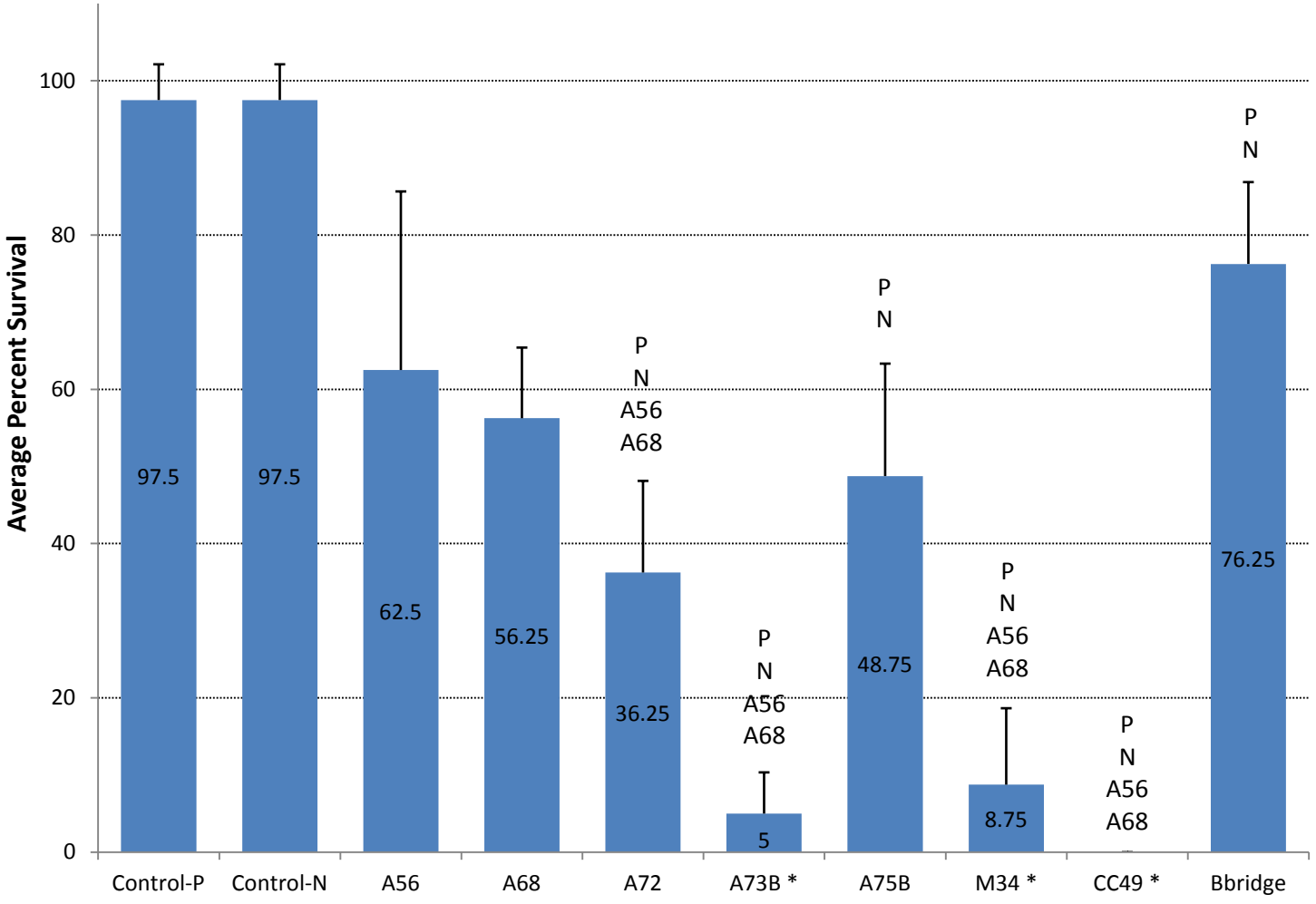
0 1 2 Kilometers

Colorado



Area of Interest

Figure 3.1-1
2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*
Average Percent Survival + 1 SD per Sampling Location



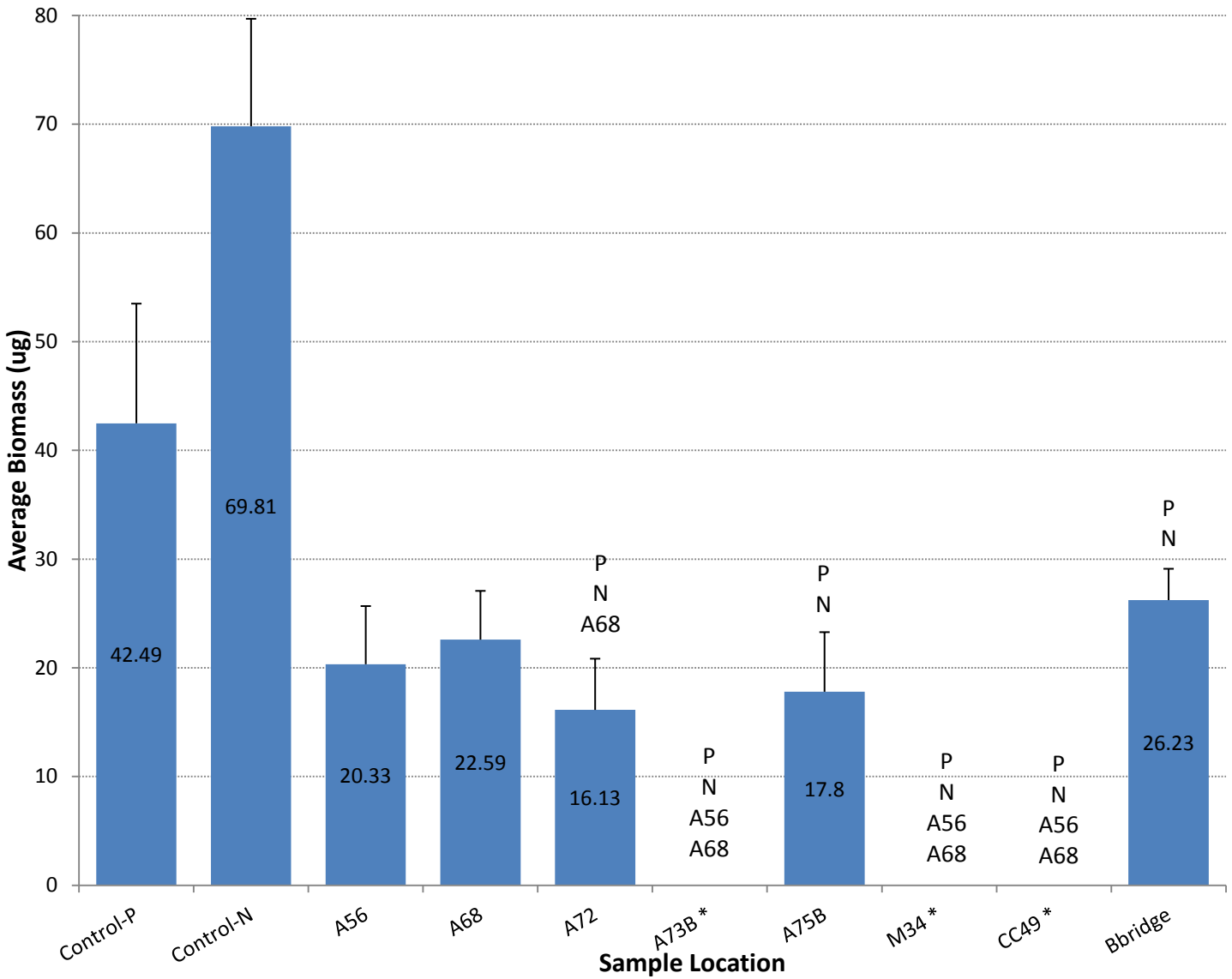
P = Average survival is statistically different when compared to Control P

N = Average survival is statistically different when compared to Control N

A56 = Average survival is statistically different when compared to reference A56

A68 = Average survival is statistically different when compared to reference A68

Figure 3.1-2
2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*
Average Biomass + 1 SD per Sampling Location



P = Average biomass is statistically different when compared to Control P

N = Average biomass is statistically different when compared to Control N

A56 = Average biomass is statistically different when compared to reference A56

A68 = Average biomass is statistically different when compared to reference A68

* = These samples had large negative biomass values due to low survival at all locations.

Figure 3.2-1
2012 Upper Animas River Concurrent Acute Reference Toxicity Test using *H.azteca* and Zinc Sulfate ($ZnSO_4$)
Average Percent Survival + 1 SD per Zinc Concentration

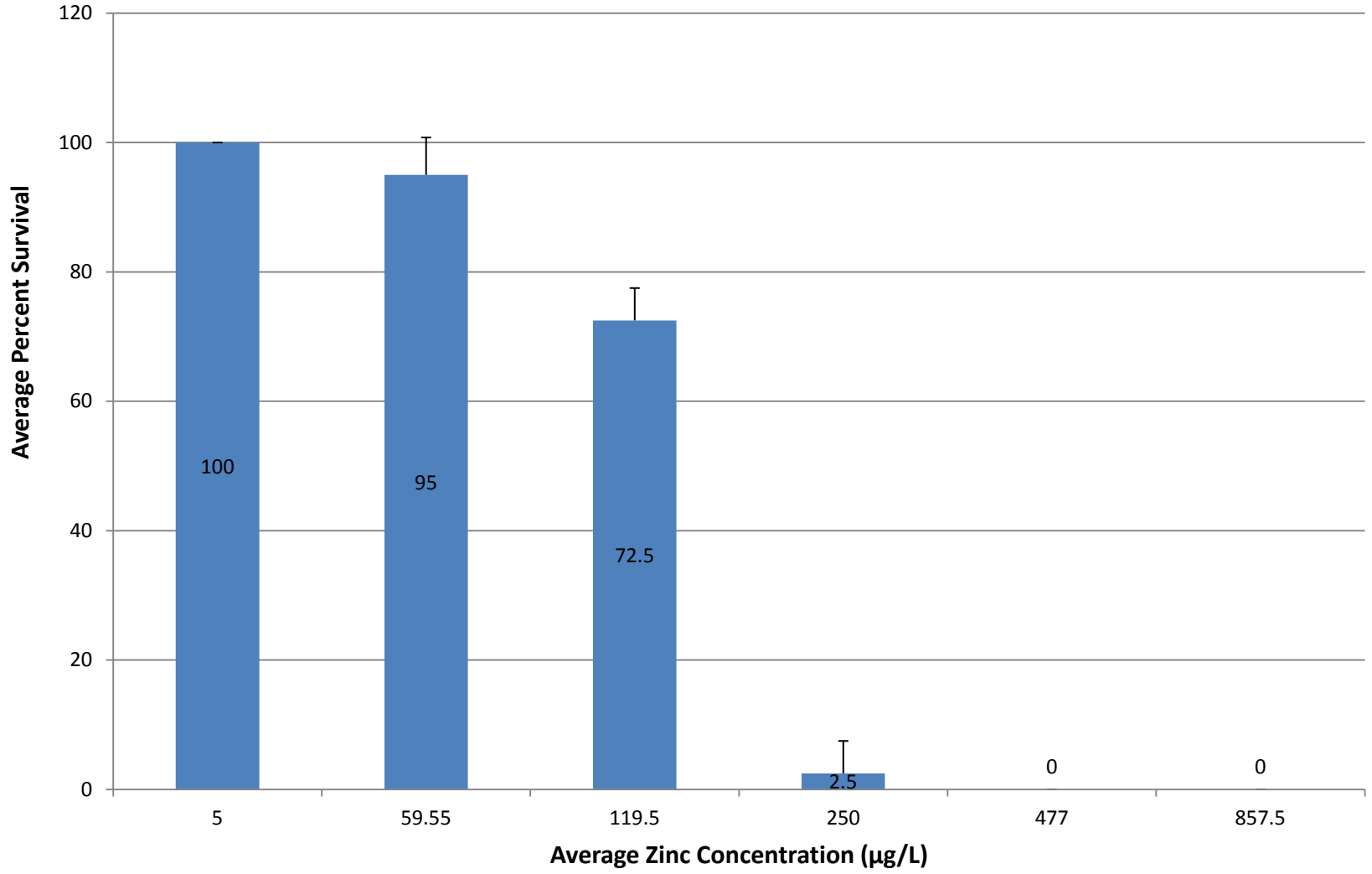
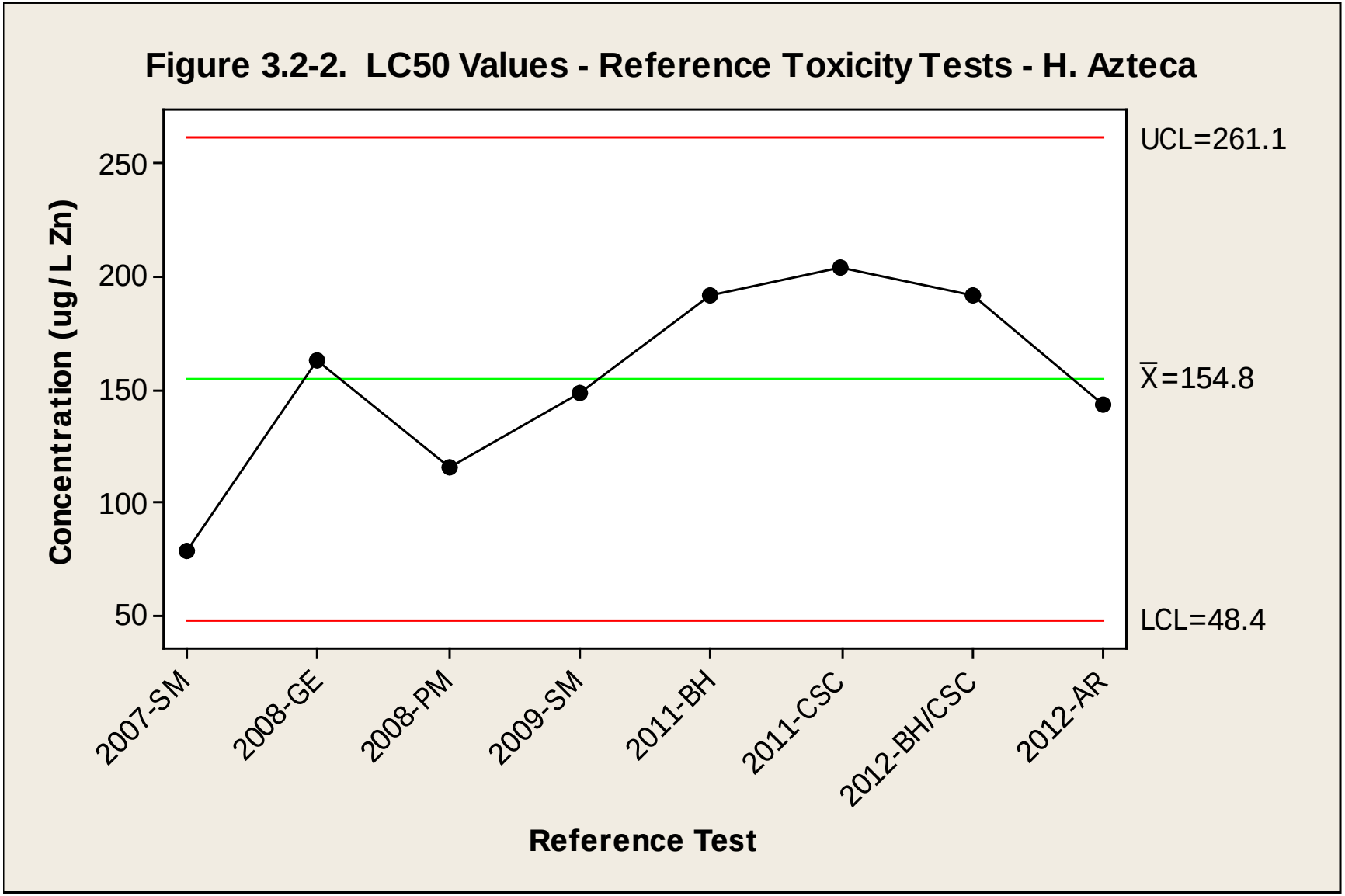


Figure 3.2-2. LC50 Values - Reference Toxicity Tests - H. Azteca



UCL = Upper Control Limit Based off of 3 standard deviations
LCL = Lower Control Limit Based off of 3 standard deviations
X = Mean LC50 values across all tests

Appendix A. December 2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	8
End Date	12/20/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Control-P-01	pH	7.4									6.66	
Control-P-01	Conductivity (us/cm)	383.4									307.4	
Control-P-01	D.O. (mg/L)	6.98	4.33	4.74	4.64	5.21	5.41	4.58	4.87	5.06	6.39	4.82
Control-P-01	Temp (C)	22.7	22.7	22.4	22.5	22.5	21.9	22.7	22.3	22.7	22.28	22.8
Control-P-01	Hardness	107										87
Control-P-01	Alkalinity	*										*
Control-P-02	pH	7.36									6.69	
Control-P-02	Conductivity (us/cm)	402									312.8	
Control-P-02	D.O. (mg/L)	7.17	4.37	4.65	4.52	5.72	5.25	4.64	4.76	4.98	6.4	4.64
Control-P-02	Temp (C)	22.6	22.7	22.4	22.7	22.7	22.5	22.6	22.3	22.6	22.31	22.8
Control-P-02	Hardness	107										87
Control-P-02	Alkalinity	*										*
Control-P-03	pH	7.46									6.71	
Control-P-03	Conductivity (us/cm)	395.6									270.1	
Control-P-03	D.O. (mg/L)	6.69	4.4	4.87	5.08	5.51	5.2	4.66	4.8	5.48	6.73	4.83
Control-P-03	Temp (C)	22.7	22.7	22.3	22.7	22.3	22	22.6	22.3	22.7	22.21	22.8
Control-P-03	Hardness	107										87
Control-P-03	Alkalinity	*										*
Control-P-04	pH	7.45									6.74	
Control-P-04	Conductivity (us/cm)	309.7									295	
Control-P-04	D.O. (mg/L)	6.88	4.31	4.65	4.93	5.69	5.01	4.83	4.69	5.29	5.28	4.82
Control-P-04	Temp (C)	22.6	22.7	22.4	22.6	22.2	22	22.3	22.2	22.6	22.02	22.8
Control-P-04	Hardness	107										87
Control-P-04	Alkalinity	*										*
Control-P-05	pH	7.44									6.74	
Control-P-05	Conductivity (us/cm)	383.6									322.9	
Control-P-05	D.O. (mg/L)	7.02	4.25	4.85	4.81	5.2	5.24	3.95	4.55	4.96	5.42	4.64
Control-P-05	Temp (C)	22.6	22.9	22.2	22.8	22.5	22	22.8	22.3	22.8	22.36	22.8
Control-P-05	Hardness	107										87
Control-P-05	Alkalinity	*										*
Control-P-06	pH	7.51									6.8	
Control-P-06	Conductivity (us/cm)	295.1									296.4	
Control-P-06	D.O. (mg/L)	7.2	4.41	4.91	5.01	5.42	5.17	4.17	4.32	4.88	5.71	4.59
Control-P-06	Temp (C)	22.6	23	22.5	22.8	22.8	22.2	22.6	22.5	22.8	22.28	22.8
Control-P-06	Hardness	107										87
Control-P-06	Alkalinity	*										*
Control-P-07	pH	7.44									6.77	
Control-P-07	Conductivity (us/cm)	372.9									319.4	
Control-P-07	D.O. (mg/L)	7.03	4.23	4.64	4.77	5.63	5.23	4.37	4.46	4.73	5.42	4.66
Control-P-07	Temp (C)	22.8	23	22.6	22.9	22.8	22.2	22.6	22.5	23	22.4	23
Control-P-07	Hardness	107										87
Control-P-07	Alkalinity											
Control-P-08	pH	7.5									6.82	
Control-P-08	Conductivity (us/cm)	285.6									277.8	
Control-P-08	D.O. (mg/L)	7.08	4.18	4.73	4.49	5.53	5.12	4.43	4.34	4.83	5.19	4.62
Control-P-08	Temp (C)	22	23.1	22.6	22.7	22.8	22.3	22.9	22.6	22.7	22.32	23
Control-P-08	Hardness	107										87
Control-P-08	Alkalinity	*										*

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Appendix A. December 2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	8
End Date	12/20/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Control-N-01	pH	6.86									5.75	
Control-N-01	Conductivity (us/cm)	1198									402.5	
Control-N-01	D.O. (mg/L)	7.14	4.11	4.73	5.13	5.3	5.27	4.89	4.85	4.97	6.6	5.26
Control-N-01	Temp (C)	22.5	22.8	22.3	22.6	22.5	22.2	22.6	22.5	22.8	22.2	22.8
Control-N-01	Hardness	386										127
Control-N-01	Alkalinity	*										*
Control-N-02	pH	6.92									5.96	
Control-N-02	Conductivity (us/cm)	1246									401.2	
Control-N-02	D.O. (mg/L)	6.6	4.52	4.85	5.15	5.62	5.14	4.83	4.72	5.08	6.22	4.92
Control-N-02	Temp (C)	22.6	22.8	22.3	22.6	22.5	22.1	22.6	22.4	22.8	22.27	22.8
Control-N-02	Hardness	386										127
Control-N-02	Alkalinity	*										*
Control-N-03	pH	6.96									6.13	
Control-N-03	Conductivity (us/cm)	1107									415.3	
Control-N-03	D.O. (mg/L)	6.68	4.63	4.84	5.18	5.22	5.33	4.76	4.7	5.01	6.37	4.99
Control-N-03	Temp (C)	22.1	22.4	21.9	22.3	22.2	21.5	22.4	22.3	22.4	22.09	22.7
Control-N-03	Hardness	386										127
Control-N-03	Alkalinity	*										*
Control-N-04	pH	6.89									6.22	
Control-N-04	Conductivity (us/cm)	1101									384	
Control-N-04	D.O. (mg/L)	6.44	4.49	4.87	5.05	5.3	5.6	4.74	4.57	5.26	6.03	4.88
Control-N-04	Temp (C)	22.2	22.6	22.1	22.3	22.1	22	22.2	22.1	22.6	22.1	22.6
Control-N-04	Hardness	386										127
Control-N-04	Alkalinity	*										*
Control-N-05	pH	6.94									6.36	
Control-N-05	Conductivity (us/cm)	1230									416.1	
Control-N-05	D.O. (mg/L)	6.52	4.39	4.79	5.21	5.74	5.23	4.63	4.28	5.33	6.46	4.94
Control-N-05	Temp (C)	21.9	22.6	21.6	22	22.2	21.3	22.3	22.2	22.4	21.91	22.6
Control-N-05	Hardness	386										127
Control-N-05	Alkalinity	*										*
Control-N-06	pH	7.05									6.39	
Control-N-06	Conductivity (us/cm)	1045									383.1	
Control-N-06	D.O. (mg/L)	5.88	4.5	4.93	5.2	5.71	5.26	4.61	4.53	4.99	6.31	4.81
Control-N-06	Temp (C)	22.07	22.7	21.6	22.2	22.2	21.1	22.3	22	22.6	21.95	22.6
Control-N-06	Hardness	386										127
Control-N-06	Alkalinity	*										*
Control-N-07	pH	7.04									6.49	
Control-N-07	Conductivity (us/cm)	1296									417.1	
Control-N-07	D.O. (mg/L)	6.41	4.41	4.77	5.15	5.71	5.38	4.66	4.72	4.92	6.48	4.91
Control-N-07	Temp (C)	22.3	22.8	22.1	22.1	22.7	21.6	22.5	22.5	23	22.09	22.8
Control-N-07	Hardness	386										127
Control-N-07	Alkalinity	*										*
Control-N-08	pH	7.13									6.53	
Control-N-08	Conductivity (us/cm)	1072									394.4	
Control-N-08	D.O. (mg/L)	6.63	4.38	4.85	5.16	5.78	5.37	4.81	4.78	4.85	6.01	4.81
Control-N-08	Temp (C)	22.2	22.8	22.3	22.5	22.7	21.6	22.5	22.3	22.6	22.12	22.7
Control-N-08	Hardness	386										127
Control-N-08	Alkalinity	*										*

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Appendix A. December 2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	8
End Date	12/20/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A56-01	pH	7.13									7.06	
A56-01	Conductivity (us/cm)	400.1									318.4	
A56-01	D.O. (mg/L)	4.75	4.95	4.91	5.38	5.4	5.67	4.76	4.69	5.17	6.11	3.93
A56-01	Temp (C)	21.1	22.3	22.3	22.5	22.2	22.2	22.5	22.3	22.6	22.07	23.1
A56-01	Hardness	118										107
A56-01	Alkalinity	*										*
A56-02	pH	7.19									7.07	
A56-02	Conductivity (us/cm)	412									356	
A56-02	D.O. (mg/L)	5.54	4.58	4.94	5.36	5.56	5.43	4.59	4.56	4.91	4.87	4.11
A56-02	Temp (C)	22.1	22.4	22.1	22.2	22.1	21.6	22.2	22	22.3	22.05	22.8
A56-02	Hardness	118										107
A56-02	Alkalinity	*										*
A56-03	pH	7.21									7.1	
A56-03	Conductivity (us/cm)	399.4									359.1	
A56-03	D.O. (mg/L)	2.59	4.75	4.99	5.57	5.66	5.34	4.6	4.54	5.11	5.52	4.08
A56-03	Temp (C)	22.5	22.3	21.8	22	22.2	21.4	22.8	22.4	22.6	22.18	22.8
A56-03	Hardness	118										107
A56-03	Alkalinity	*										*
A56-04	pH	7.22									7.11	
A56-04	Conductivity (us/cm)	417.4									355.1	
A56-04	D.O. (mg/L)	3.26	4.62	4.86	5.63	5.64	5.27	4.62	4.69	5.05	5.15	4.18
A56-04	Temp (C)	22.5	22.4	22.2	22.2	22.2	21.6	22.5	22.1	22.4	22.03	22.8
A56-04	Hardness	118										107
A56-04	Alkalinity	*										*
A56-05	pH	7.28									7.13	
A56-05	Conductivity (us/cm)	386									352.8	
A56-05	D.O. (mg/L)	3.96	4.61	5.12	5.33	5.58	5.3	4.34	4.55	5.14	5.89	3.78
A56-05	Temp (C)	22.5	22	21.8	21.6	21.3	21.2	22.3	21.7	22.4	21.42	22.6
A56-05	Hardness	118										107
A56-05	Alkalinity	*										*
A56-06	pH	7.29									7.14	
A56-06	Conductivity (us/cm)	391.2									336.5	
A56-06	D.O. (mg/L)	5.05	4.63	5.15	5.66	5.85	5.16	4.5	4.68	5.21	4.46	3.98
A56-06	Temp (C)	22.5	22.5	21.9	22	21.8	21.2	22.2	22.1	22.6	21.95	22.7
A56-06	Hardness	118										107
A56-06	Alkalinity	*										*
A56-07	pH	7.3									7.14	
A56-07	Conductivity (us/cm)	389.2									353.1	
A56-07	D.O. (mg/L)	5.19	4.58	5.23	5.54	5.77	5.26	4.45	4.58	5	5.13	3.67
A56-07	Temp (C)	22.5	22.3	21.7	22	21.8	21.8	22.3	22.2	22.6	21.55	22.5
A56-07	Hardness	118										107
A56-07	Alkalinity	*										*
A56-08	pH	7.32									7.15	
A56-08	Conductivity (us/cm)	390.4									331.4	
A56-08	D.O. (mg/L)	6.02	4.62	4.97	5.48	5.95	5.23	4.51	4.63	5.11	4.58	4.48
A56-08	Temp (C)	22.5	22.8	21.8	22	21.8	22.1	22.6	22.1	22.7	21.89	22.5
A56-08	Hardness	118										107
A56-08	Alkalinity	*										*

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Appendix A. December 2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	8
End Date	12/20/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A68-01	pH	7.43									7.15	
A68-01	Conductivity (us/cm)	404									352.6	
A68-01	D.O. (mg/L)	5.86	3.89	4.49	4.81	5.05	4.49	4.42	4.39	4.4	4.67	4.12
A68-01	Temp (C)	21.1	22	22	21.3	22	21.5	22.7	21.9	22.1	21.72	22.5
A68-01	Hardness	106										103
A68-01	Alkalinity	*										*
A68-02	pH	7.46									7.2	
A68-02	Conductivity (us/cm)	377.3									351.7	
A68-02	D.O. (mg/L)	3.19	3.91	4.83	4.98	5.14	4.9	4.29	4.32	4.91	4.83	4.19
A68-02	Temp (C)	22.1	22	22.1	21.8	22.1	21	22.7	22.1	22.3	21.81	22.7
A68-02	Hardness	106										103
A68-02	Alkalinity	*										*
A68-03	pH	7.49									7.21	
A68-03	Conductivity (us/cm)	381.6									349.4	
A68-03	D.O. (mg/L)	4.18	3.95	4.62	4.8	5.23	5.08	4.32	4.32	4.94	4.21	4.24
A68-03	Temp (C)	21.8	22.4	21.5	21.8	21.7	21.2	22.8	21.3	21.8	21.73	22.7
A68-03	Hardness	106										103
A68-03	Alkalinity	*										*
A68-04	pH	7.52									7.23	
A68-04	Conductivity (us/cm)	367.5									359.1	
A68-04	D.O. (mg/L)	3.73	3.92	4.72	4.98	5.22	4.81	4.12	4.24	4.57	4.55	4.09
A68-04	Temp (C)	21.6	21.8	21	21.5	20.8	21.5	22.5	21.5	22.1	21.49	22.6
A68-04	Hardness	106										103
A68-04	Alkalinity	*										*
A68-05	pH	7.54									7.23	
A68-05	Conductivity (us/cm)	385.5									351.3	
A68-05	D.O. (mg/L)	4.19	3.96	4.68	5.16	5.01	4.97	3.98	4.16	4.73	4.79	4.19
A68-05	Temp (C)	21.8	22.2	21.8	22.1	21.4	21.3	22.7	21.7	22.5	21.95	22.8
A68-05	Hardness	106										103
A68-05	Alkalinity	*										*
A68-06	pH	7.55									7.25	
A68-06	Conductivity (us/cm)	373.3									355	
A68-06	D.O. (mg/L)	3.93	4.2	4.75	5.05	5.45	4.95	3.97	4.1	4.65	5.05	3.96
A68-06	Temp (C)	22	22.3	22	22	21.2	21.8	22.6	22	22.5	21.93	22.8
A68-06	Hardness	106										103
A68-06	Alkalinity	*										*
A68-07	pH	7.55									7.23	
A68-07	Conductivity (us/cm)	391.6									349.2	
A68-07	D.O. (mg/L)	4.4	3.84	4.63	4.88	5.21	4.91	4.13	4.22	4.78	4.6	4.07
A68-07	Temp (C)	22	22.3	22.3	22.2	21.8	21.9	22.7	22.2	22.5	22.17	23.1
A68-07	Hardness	106										103
A68-07	Alkalinity	*										*
A68-08	pH	7.55									7.27	
A68-08	Conductivity (us/cm)	382.1									347.1	
A68-08	D.O. (mg/L)	4.77	4.01	4.49	4.91	5.44	5.09	4.48	4.31	5.27	5.1	4.15
A68-08	Temp (C)	22.3	22.4	22	22.2	21.8	21.8	22.7	22	22.6	22.16	23
A68-08	Hardness	106										103
A68-08	Alkalinity	*										*

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Appendix A. December 2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	8
End Date	12/20/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A72-01	pH	7.13									7.01	
A72-01	Conductivity (us/cm)	517									377.2	
A72-01	D.O. (mg/L)	5.13	5.27	5.6	5.75	6.1	5.8	4.94	5.11	5.55	5.03	4.86
A72-01	Temp (C)	22	22.5	21.8	22	21.2	21.8	22.6	21.7	22.3	21.84	22.2
A72-01	Hardness	176										113
A72-01	Alkalinity	*										*
A72-02	pH	7.11									7.01	
A72-02	Conductivity (us/cm)	496.3									372.4	
A72-02	D.O. (mg/L)	5.57	5.64	5.78	5.95	6.33	5.64	5.26	5.08	5.51	5.53	4.9
A72-02	Temp (C)	22	22.1	21.3	22.4	21.7	21.5	22.5	21.7	22.3	21.67	22.8
A72-02	Hardness	176										113
A72-02	Alkalinity	*										*
A72-03	pH	7.08									7.01	
A72-03	Conductivity (us/cm)	502.9									375.7	
A72-03	D.O. (mg/L)	5.35	5.52	5.85	6.16	5.66	5.82	5.32	5.17	5.74	6.34	5.02
A72-03	Temp (C)	21.7	21.8	21.3	21.9	21.6	21	22	21.7	22.2	21.53	22.5
A72-03	Hardness	176										113
A72-03	Alkalinity	*										*
A72-04	pH	7.07									7.02	
A72-04	Conductivity (us/cm)	511.4									370.9	
A72-04	D.O. (mg/L)	4.84	5.57	5.74	5.99	5.97	5.66	5.49	5.36	5.67	5.14	5.07
A72-04	Temp (C)	21.3	21.9	21.5	21.2	21.2	21.1	21.8	21.4	22.6	21.59	22.7
A72-04	Hardness	176										113
A72-04	Alkalinity	*										*
A72-05	pH	7.06									7.02	
A72-05	Conductivity (us/cm)	500									375.5	
A72-05	D.O. (mg/L)	5.95	5.4	5.57	5.87	6.17	5.82	5.11	5.15	5.48	6.32	4.83
A72-05	Temp (C)	22.1	22.2	21.7	21.3	21.3	21.5	22.2	22.2	22.7	21.72	22.7
A72-05	Hardness	176										113
A72-05	Alkalinity	*										*
A72-06	pH	7.07									7.01	
A72-06	Conductivity (us/cm)	488.6									370	
A72-06	D.O. (mg/L)	6.02	5.38	5.71	5.85	6.03	5.65	5.04	5.19	5.44	6.22	4.77
A72-06	Temp (C)	21.4	22	22.2	21.3	21.3	21.6	22.2	21.9	22.2	21.71	22.8
A72-06	Hardness	176										113
A72-06	Alkalinity	*										*
A72-07	pH	7.04									7.01	
A72-07	Conductivity (us/cm)	518.9									364.9	
A72-07	D.O. (mg/L)	6.97	5.27	5.62	5.92	5.88	5.75	5.4	5.13	5.54	5.49	4.69
A72-07	Temp (C)	22.5	22.8	22	22.1	22.1	21.7	22.3	22.2	22.4	22.19	22.7
A72-07	Hardness	176										113
A72-07	Alkalinity	*										*
A72-08	pH	7.06									7	
A72-08	Conductivity (us/cm)	491.8									370.3	
A72-08	D.O. (mg/L)	6.75	5.06	5.47	5.86	6.27	5.75	5.27	5.3	5.45	5.8	4.14
A72-08	Temp (C)	22	22.7	22.2	22.3	22.1	21.4	22.4	22.1	22.2	22.11	22.7
A72-08	Hardness	176										113
A72-08	Alkalinity	*										*

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Appendix A. December 2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	8
End Date	12/20/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A73B-01	pH	7.48									7.18	
A73B-01	Conductivity (us/cm)	441									358.3	
A73B-01	D.O. (mg/L)	5.19	4.45	5.04	4.97	4.71	5.01	4.38	4.29	4.89	4.19	4.74
A73B-01	Temp (C)	21.6	22.5	22	22.3	21.9	21.7	22.8	22.3	22.5	21.93	22.7
A73B-01	Hardness	120										105
A73B-01	Alkalinity	*										*
A73B-02	pH	7.44									7.19	
A73B-02	Conductivity (us/cm)	388.7									341.4	
A73B-02	D.O. (mg/L)	4.45	4.49	5.18	5.38	5.37	5.16	4.52	4.58	4.46	4.87	4.33
A73B-02	Temp (C)	22	22.5	22	21.9	21.7	21.6	22.5	22	22.2	21.93	22.7
A73B-02	Hardness	120										105
A73B-02	Alkalinity	*										*
A73B-03	pH	7.41									7.17	
A73B-03	Conductivity (us/cm)	429.7									355.6	
A73B-03	D.O. (mg/L)	4.78	4.71	5.13	5.09	5.82	5.46	4.72	4.5	4.15	5.78	4.5
A73B-03	Temp (C)	21.9	22.3	22	22.2	21.6	21.5	22.6	21.6	22.6	21.77	22.7
A73B-03	Hardness	120										105
A73B-03	Alkalinity	*										*
A73B-04	pH	7.37									7.16	
A73B-04	Conductivity (us/cm)	423.4									354.2	
A73B-04	D.O. (mg/L)	4.77	4.7	5	4.98	5.18	5.31	4.76	4.53	4.46	4.4	4.37
A73B-04	Temp (C)	22	22.1	21.8	21.9	21.9	21.5	22.3	21.5	22.3	21.76	22.6
A73B-04	Hardness	120										105
A73B-04	Alkalinity	*										*
A73B-05	pH	7.36									7.14	
A73B-05	Conductivity (us/cm)	435.8									356.1	
A73B-05	D.O. (mg/L)	6.04	4.52	4.85	5.16	5.44	5.06	4.55	4.43	4.84	4.58	4.47
A73B-05	Temp (C)	22	22.3	22.1	22.3	21.7	22	22.6	22.1	22.5	21.99	22.8
A73B-05	Hardness	120										105
A73B-05	Alkalinity	*										*
A73B-06	pH	7.34									7.14	
A73B-06	Conductivity (us/cm)	423.8									353.1	
A73B-06	D.O. (mg/L)	5.31	4.45	5.06	4.96	5.06	5.21	4.63	4.56	5.01	5.03	4.34
A73B-06	Temp (C)	22.1	22.6	21.7	22.3	21.3	21.1	22.7	22.2	22.5	21.84	22.8
A73B-06	Hardness	120										105
A73B-06	Alkalinity	*										*
A73B-07	pH	7.34									7.12	
A73B-07	Conductivity (us/cm)	432.7									356.5	
A73B-07	D.O. (mg/L)	5.64	4.41	5.01	4.9	5.41	5.08	4.67	4.42	4.77	5.66	4.54
A73B-07	Temp (C)	22	22.7	21.9	22.5	21.8	21.9	22.7	22.5	22.8	22.18	23
A73B-07	Hardness	120										105
A73B-07	Alkalinity	*										*
A73B-08	pH	7.32									7.13	
A73B-08	Conductivity (us/cm)	428.2									315.1	
A73B-08	D.O. (mg/L)	5.97	4.36	4.88	4.91	5.53	5.14	4.7	4.53	4.69	5.87	4.48
A73B-08	Temp (C)	22.6	22.5	22.2	22.3	22	21.8	22.6	22.4	22.7	21.92	23
A73B-08	Hardness	120										105
A73B-08	Alkalinity	*										*

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Appendix A. December 2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	8
End Date	12/20/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A75B-01	pH	6.95									6.99	
A75B-01	Conductivity (us/cm)	459									362.1	
A75B-01	D.O. (mg/L)	4.46	5.52	5.42	5.86	6.05	5.71	5.13	5.17	5.13	6.52	4.78
A75B-01	Temp (C)	21.8	22.3	21.7	21.8	21.5	21.7	22.2	21.7	22.2	21.53	22.9
A75B-01	Hardness	143										112
A75B-01	Alkalinity	*										*
A75B-02	pH	7									6.98	
A75B-02	Conductivity (us/cm)	475.5									361.5	
A75B-02	D.O. (mg/L)	5.51	5.68	5.61	5.61	6.21	5.74	4.78	4.62	5.36	6.36	4.85
A75B-02	Temp (C)	21.6	22.1	22.2	22.1	21.9	22.2	22.2	22.5	22.7	21.6	23
A75B-02	Hardness	143										112
A75B-02	Alkalinity	*										*
A75B-03	pH	7.02									6.98	
A75B-03	Conductivity (us/cm)	465.6									363.7	
A75B-03	D.O. (mg/L)	4.64	5.72	5.66	5.87	5.85	5.69	5.03	4.69	5.58	6.25	4.82
A75B-03	Temp (C)	21.5	21.4	21	21.6	20.8	21.8	22.1	22	22.3	21.52	22.1
A75B-03	Hardness	143										112
A75B-03	Alkalinity	*										*
A75B-04	pH	7.08									7	
A75B-04	Conductivity (us/cm)	448.8									358.4	
A75B-04	D.O. (mg/L)	5.4	5.34	5.55	5.93	5.86	5.64	5.2	5.37	5.38	5.39	4.76
A75B-04	Temp (C)	21.5	21.6	21.5	21.5	21.5	21.3	22	21.5	22.1	21.45	22.8
A75B-04	Hardness	143										112
A75B-04	Alkalinity	*										*
A75B-05	pH	7.07									6.99	
A75B-05	Conductivity (us/cm)	460.2									361.7	
A75B-05	D.O. (mg/L)	4.97	5.31	5.56	5.62	5.84	5.49	5.06	5.08	5.53	6.16	4.38
A75B-05	Temp (C)	21.9	21.9	21.8	21.2	21.3	21	22.2	21.4	21.8	21.52	22.6
A75B-05	Hardness	143										112
A75B-05	Alkalinity	*										*
A75B-06	pH	7.1									6.99	
A75B-06	Conductivity (us/cm)	468.5									369	
A75B-06	D.O. (mg/L)	5.45	5.24	5.51	5.75	5.94	5.58	4.87	5.26	5.51	6	4.52
A75B-06	Temp (C)	21.7	22.1	21.8	21.2	21.1	21.1	22.2	21.3	22.3	21.77	22.8
A75B-06	Hardness	143										112
A75B-06	Alkalinity	*										*
A75B-07	pH	7.11									7	
A75B-07	Conductivity (us/cm)	460.9									358.7	
A75B-07	D.O. (mg/L)	5.41	5.39	5.27	5.79	5.93	5.48	4.88	5.02	5.42	5.48	4.67
A75B-07	Temp (C)	21.5	22.8	21.8	21.5	21.3	21.4	22.4	21.7	22.4	21.97	22.8
A75B-07	Hardness	143										112
A75B-07	Alkalinity	*										*
A75B-08	pH	7.13									7.02	
A75B-08	Conductivity (us/cm)	461.3									355.6	
A75B-08	D.O. (mg/L)	5.52	5.42	5.53	5.67	5.84	5.62	5.06	5.07	5.58	5.91	4.73
A75B-08	Temp (C)	21.9	22.5	22.2	21.6	21.3	21.5	22.4	21.7	22.4	22.08	22.7
A75B-08	Hardness	143										112
A75B-08	Alkalinity	*										*

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Appendix A. December 2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	8
End Date	12/20/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
M34-01	pH	6.17									6.22	
M34-01	Conductivity (us/cm)	499.6									368	
M34-01	D.O. (mg/L)	7.27	6.88	6.1	6.45	6.7	6.41	5.9	6.14	5.29	6.82	5.96
M34-01	Temp (C)	21.3	21.2	21.1	21.7	21.2	22.3	22.4	21.2	21.4	21.19	22.6
M34-01	Hardness	158										108
M34-01	Alkalinity	*										*
M34-02	pH	6.21									6.3	
M34-02	Conductivity (us/cm)	502.7									363.9	
M34-02	D.O. (mg/L)	6.67	6.79	6.26	6.51	6.85	6.1	6.03	6.17	6.14	6.83	5.61
M34-02	Temp (C)	21.4	21.2	21	21.5	21.3	21.2	22.8	21.3	21.7	21.42	22.3
M34-02	Hardness	158										108
M34-02	Alkalinity	*										*
M34-03	pH	6.24									6.48	
M34-03	Conductivity (us/cm)	505.2									359.4	
M34-03	D.O. (mg/L)	6.8	6.72	6.16	6.39	6.66	6.34	5.91	6.14	6.45	6.97	5.53
M34-03	Temp (C)	21.4	21.7	21.1	21.3	21.3	21.2	22.5	21.5	21.3	21.27	22.6
M34-03	Hardness	158										108
M34-03	Alkalinity	*										*
M34-04	pH	6.28									6.51	
M34-04	Conductivity (us/cm)	487.2									368.7	
M34-04	D.O. (mg/L)	5.73	6.44	6.3	6.49	6.85	6.16	5.96	6.12	6.24	6.86	5.57
M34-04	Temp (C)	21.5	21.5	21	21.1	21.5	21.5	22.7	21.6	21.3	21.53	22.6
M34-04	Hardness	158										108
M34-04	Alkalinity	*										*
M34-05	pH	6.28									6.55	
M34-05	Conductivity (us/cm)	518.1									368.2	
M34-05	D.O. (mg/L)	6.44	6.52	6.21	6.29	6.69	5.95	5.87	5.91	6.73	6.97	5.27
M34-05	Temp (C)	21.4	21.7	21.5	21.2	21.7	21.5	22.3	21.6	21.8	21.2	22.3
M34-05	Hardness	158										108
M34-05	Alkalinity	*										*
M34-06	pH	6.32									6.56	
M34-06	Conductivity (us/cm)	488.6									366	
M34-06	D.O. (mg/L)	5.57	6.54	6.13	6.38	6.73	6.17	5.56	5.84	6.32	6.77	5.43
M34-06	Temp (C)	21.7	21.5	21.3	21.7	21.4	21.7	22.5	21.6	21.7	21.68	22.3
M34-06	Hardness	158										108
M34-06	Alkalinity	*										*
M34-07	pH	6.32									6.59	
M34-07	Conductivity (us/cm)	506.9									363.3	
M34-07	D.O. (mg/L)	6.38	6.49	6.03	6.31	6.81	6.23	6.01	5.76	6.29	6.65	5.44
M34-07	Temp (C)	21.9	21.6	21.6	21.9	21.5	21.7	22.5	21.9	21.6	21.92	22.6
M34-07	Hardness	158										108
M34-07	Alkalinity	*										*
M34-08	pH	6.35									6.62	
M34-08	Conductivity (us/cm)	481.4									350.5	
M34-08	D.O. (mg/L)	5.54	6.44	5.93	6.27	6.67	6.19	6.04	5.82	6.25	6.48	5.25
M34-08	Temp (C)	21.2	22.3	22.1	22.2	20.9	21.2	22.5	22	21.1	21.94	22.8
M34-08	Hardness	158										108
M34-08	Alkalinity	*										*

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Appendix A. December 2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	8
End Date	12/20/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
CC49-01	pH	7.27									7.14	
CC49-01	Conductivity (us/cm)	493.6									366.4	
CC49-01	D.O. (mg/L)	6.8	4.49	4.79	5.23	5.56	5.42	5.02	4.85	4.98	4.72	5.92
CC49-01	Temp (C)	22.3	22.3	22	22.2	21.9	21.5	22.5	22.1	22.6	22.08	22.5
CC49-01	Hardness	161										106
CC49-01	Alkalinity	*										
CC49-02	pH	7.2									5.38	
CC49-02	Conductivity (us/cm)	520.3									321.4	
CC49-02	D.O. (mg/L)	5.59	4.44	4.89	4.6	5.5	5.49	5.09	4.84	4.87	6.24	4.84
CC49-02	Temp (C)	21.5	22.6	22.2	22.5	22.2	21.6	22.5	22.2	22.5	22.05	22.7
CC49-02	Hardness	161										106
CC49-02	Alkalinity	*										*
CC49-03	pH	6.65									4.34	
CC49-03	Conductivity (us/cm)	512.1									371.1	
CC49-03	D.O. (mg/L)	6.46	4.62	5.04	4.97	5.67	5.54	5.01	5.02	5.1	4.34	4.83
CC49-03	Temp (C)	21.8	21.9	21.8	21.8	21.5	21.5	22.3	21.8	22.2	21.93	22.6
CC49-03	Hardness	161										106
CC49-03	Alkalinity	*										*
CC49-04	pH	6.42									4.89	
CC49-04	Conductivity (us/cm)	481.5									364.2	
CC49-04	D.O. (mg/L)	6.95	4.53	5.04	4.78	5.68	5.65	5.07	4.81	5.04	5.52	4.41
CC49-04	Temp (C)	22	22.2	22	22.3	21.5	21.3	22.4	21.8	22.2	21.89	22.7
CC49-04	Hardness	161										106
CC49-04	Alkalinity	*										*
CC49-05	pH	6.27									4.19	
CC49-05	Conductivity (us/cm)	499.5									374.8	
CC49-05	D.O. (mg/L)	7.02	4.44	4.8	4.93	5.1	5.52	4.94	5.06	5.12	3.27	4.69
CC49-05	Temp (C)	21.7	22	22	22	21.7	21.2	22.3	21.8	22.3	21.85	22.6
CC49-05	Hardness	161										106
CC49-05	Alkalinity	*										*
CC49-06	pH	6.07									4.79	
CC49-06	Conductivity (us/cm)	503.7									388	
CC49-06	D.O. (mg/L)	7.05	4.58	4.95	5.17	5.34	5.37	4.86	5.07	4.95	5.19	4.47
CC49-06	Temp (C)	21.5	22.3	21.6	22.1	21.8	21.3	22.2	22.1	22.2	21.67	22.5
CC49-06	Hardness	161										106
CC49-06	Alkalinity	*										*
CC49-07	pH	5.93									4.78	
CC49-07	Conductivity (us/cm)	499									366.7	
CC49-07	D.O. (mg/L)	7.11	4.64	4.94	5.23	5.5	5.41	5.04	4.91	5.07	3.63	4.58
CC49-07	Temp (C)	21.8	22.4	21.9	22.3	22.2	21.6	22.5	22.4	22.8	22.09	22.5
CC49-07	Hardness	161										106
CC49-07	Alkalinity	*										*
CC49-08	pH	5.94									5.24	
CC49-08	Conductivity (us/cm)	466									370.2	
CC49-08	D.O. (mg/L)	6.83	4.64	5.05	5.42	5.27	5.3	5.13	5.01	5.03	5.76	4.77
CC49-08	Temp (C)	22.1	22.7	22.3	22.1	22.5	22.2	22.5	22.2	22.7	21.97	22.8
CC49-08	Hardness	161										106
CC49-08	Alkalinity	*										*

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Appendix A. December 2012 Upper Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	8
End Date	12/20/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
BBRIDGE-01	pH	6.52									6.78	
BBRIDGE-01	Conductivity (us/cm)	435.7									359.8	
BBRIDGE-01	D.O. (mg/L)	6.27	5.9	5.8	5.94	6.11	5.64	5.27	5.55	5.87	6.64	4.87
BBRIDGE-01	Temp (C)	21.6	22.2	22.1	22	22.1	22	22.2	22.1	21.2	21.56	22.3
BBRIDGE-01	Hardness	133										106
BBRIDGE-01	Alkalinity	*										*
BBRIDGE-02	pH	6.73									6.93	
BBRIDGE-02	Conductivity (us/cm)	403.1									346.4	
BBRIDGE-02	D.O. (mg/L)	6.12	5.93	5.83	6.18	6.49	5.92	5.22	5.61	5.1	6.56	4.83
BBRIDGE-02	Temp (C)	21.4	22.2	21	21.4	21.7	21.5	22.2	22.1	21	21.74	22.7
BBRIDGE-02	Hardness	133										106
BBRIDGE-02	Alkalinity	*										*
BBRIDGE-03	pH	6.8									6.84	
BBRIDGE-03	Conductivity (us/cm)	429.1									359.6	
BBRIDGE-03	D.O. (mg/L)	6.56	5.89	5.75	6.14	6.61	5.82	5.28	5.25	5.76	6.01	4.97
BBRIDGE-03	Temp (C)	21.7	21.9	21.5	21.5	21.6	21	22.1	21.7	21.8	21.44	22.3
BBRIDGE-03	Hardness	133										106
BBRIDGE-03	Alkalinity	*										*
BBRIDGE-04	pH	6.84									6.86	
BBRIDGE-04	Conductivity (us/cm)	433.9									355.1	
BBRIDGE-04	D.O. (mg/L)	6.76	5.82	5.77	5.94	6.5	6.04	5.45	5.23	5.65	5.33	4.82
BBRIDGE-04	Temp (C)	21.3	22.2	21.6	21.3	21.5	21.6	22.1	22	22.2	21.56	22.7
BBRIDGE-04	Hardness	133										106
BBRIDGE-04	Alkalinity	*										*
BBRIDGE-05	pH	6.9									6.88	
BBRIDGE-05	Conductivity (us/cm)	430.6									354.6	
BBRIDGE-05	D.O. (mg/L)	4.82	5.68	5.5	5.68	6.09	5.83	5.24	5.21	5.71	6.29	4.64
BBRIDGE-05	Temp (C)	21.8	22.2	21.8	21.5	21.8	21.8	22.2	21.5	22.1	21.46	22.6
BBRIDGE-05	Hardness	133										106
BBRIDGE-05	Alkalinity	*										*
BBRIDGE-06	pH	6.96									6.91	
BBRIDGE-06	Conductivity (us/cm)	428.8									361	
BBRIDGE-06	D.O. (mg/L)	5.7	5.67	5.62	5.79	6.23	5.66	4.98	5.13	5.75	5.64	4.71
BBRIDGE-06	Temp (C)	21.7	22.1	21.7	21.5	21.8	21.8	22.3	21.4	22.2	21.71	23
BBRIDGE-06	Hardness	133										106
BBRIDGE-06	Alkalinity	*										*
BBRIDGE-07	pH	6.99									6.95	
BBRIDGE-07	Conductivity (us/cm)	419.9									357.8	
BBRIDGE-07	D.O. (mg/L)	6.37	5.55	5.57	5.62	5.59	5.43	5.28	5.02	5.54	5.96	4.57
BBRIDGE-07	Temp (C)	21.8	22.2	22	22	22	21.8	22.4	22.2	22.5	21.63	22.7
BBRIDGE-07	Hardness	133										106
BBRIDGE-07	Alkalinity	*										*
BBRIDGE-08	pH	7.02									6.96	
BBRIDGE-08	Conductivity (us/cm)	413.6									353.2	
BBRIDGE-08	D.O. (mg/L)	6.53	5.68	5.51	5.55	6.07	5.71	5.21	5.34	5.34	6.03	4.79
BBRIDGE-08	Temp (C)	21.6	22.3	21.3	21.9	22	21.1	22.4	22.2	22.5	21.36	23
BBRIDGE-08	Hardness	133										106
BBRIDGE-08	Alkalinity	*										*

*Alkalinity was not analyzed due to water volume constraints.

Prepared by: EC 7/15/13

Reviewed by: BGK 7/24/12

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Appendix B Sediment Reference Toxicity Test

Concurrent with the 2012 Upper Animas River Sediment Toxicity Test

4-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	4
End Date	12/14/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
Control-01	No. Alive	10	10	10	10	10
Control-01	pH	7.16				7.35
Control-01	Conductivity (us/cm)	320.2				360.7
Control-01	D.O. (mg/L)	7.72	6.1	6.63	5.85	6.85
Control-01	Temp (C)	22.3	22.7	22.3	22.6	22.1
Control-01	Hardness	96				111
Control-01	Alkalinity	*				*
Control-02	No. Alive	10	10	10	10	10
Control-02	pH	7.2				7.38
Control-02	Conductivity (us/cm)	320.3				366.2
Control-02	D.O. (mg/L)	7.66	5.62	6.16	5.63	6.83
Control-02	Temp (C)	22.5	22.8	22.3	22.6	22.3
Control-02	Hardness	96				111
Control-02	Alkalinity	*				*
Control-03	No. Alive	10	10	10	10	10
Control-03	pH	7.25				6.84
Control-03	Conductivity (us/cm)	319.5				361.3
Control-03	D.O. (mg/L)	7.62	5.79	6.49	6.15	6.8
Control-03	Temp (C)	22.4	22.7	22	22.5	22.25
Control-03	Hardness	96				111
Control-03	Alkalinity	*				*
Control-04	No. Alive	10	10	10	10	10
Control-04	pH	7.29				7.06
Control-04	Conductivity (us/cm)	319.5				356.1
Control-04	D.O. (mg/L)	7.61	5.8	6.52	6.14	6.8
Control-04	Temp (C)	22.5	22.7	22	22.5	22.3
Control-04	Hardness	96				111
Control-04	Alkalinity	*				*

Appendix B Sediment Reference Toxicity Test

Concurrent with the 2012 Upper Animas River Sediment Toxicity Test

4-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	4
End Date	12/14/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
6.25%%-01	No. Alive	10	10	10	9	9
6.25%%-01	pH	7.34				7
6.25%%-01	Conductivity (us/cm)	318.8				353.2
6.25%%-01	D.O. (mg/L)	7.59	5.96	6.32	5.83	6.81
6.25%%-01	Temp (C)	22.4	22.7	21.7	22.2	22.2
6.25%%-01	Hardness	97				108
6.25%%-01	Alkalinity	*				*
6.25%%-02	No. Alive	10	10	10	10	10
6.25%%-02	pH	7.36				7.02
6.25%%-02	Conductivity (us/cm)	318.9				354.3
6.25%%-02	D.O. (mg/L)	7.57	5.74	6.42	5.69	6.82
6.25%%-02	Temp (C)	22.45	22.7	21.7	22.2	22.2
6.25%%-02	Hardness	97				108
6.25%%-02	Alkalinity	*				*
6.25%%-03	No. Alive	10	10	10	9	9
6.25%%-03	pH	7.39				7.06
6.25%%-03	Conductivity (us/cm)	319.6				353.6
6.25%%-03	D.O. (mg/L)	7.55	5.84	6.34	6.19	6.83
6.25%%-03	Temp (C)	22.3	22.7	21.7	22.2	22.2
6.25%%-03	Hardness	97				108
6.25%%-03	Alkalinity	*				*
6.25%%-04	No. Alive	10	10	10	10	10
6.25%%-04	pH	7.43				7.1
6.25%%-04	Conductivity (us/cm)	319.7				351.7
6.25%%-04	D.O. (mg/L)	7.56	6.04	6.57	5.73	6.83
6.25%%-04	Temp (C)	22.5	22.7	21.6	22.3	22.2
6.25%%-04	Hardness	97				108
6.25%%-04	Alkalinity	*				*

Appendix B Sediment Reference Toxicity Test

Concurrent with the 2012 Upper Animas River Sediment Toxicity Test

4-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	4
End Date	12/14/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
12.5%-01	No. Alive	10	10	10	7	7
12.5%-01	pH	7.45				7.14
12.5%-01	Conductivity (us/cm)	321.1				357.7
12.5%-01	D.O. (mg/L)	7.53	5.71	6.51	5.65	6.76
12.5%-01	Temp (C)	22.5	22.7	22	22.4	22.3
12.5%-01	Hardness	98				108
12.5%-01	Alkalinity	*				*
12.5%-02	No. Alive	10	10	8	7	7
12.5%-02	pH	7.46				7.18
12.5%-02	Conductivity (us/cm)	318.6				352.9
12.5%-02	D.O. (mg/L)	7.58	5.82	6.87	6.24	6.68
12.5%-02	Temp (C)	22.5	22.8	21.8	22.3	22.3
12.5%-02	Hardness	98				108
12.5%-02	Alkalinity	*				*
12.5%-03	No. Alive	10	10	8	8	8
12.5%-03	pH	7.49				7.23
12.5%-03	Conductivity (us/cm)	319.8				350.2
12.5%-03	D.O. (mg/L)	7.59	5.75	6.78	6.3	6.25
12.5%-03	Temp (C)	22.5	22.7	21.6	22.3	22.2
12.5%-03	Hardness	98				108
12.5%-03	Alkalinity	*				*
12.5%-04	No. Alive	10	10	7	7	7
12.5%-04	pH	7.53				7.26
12.5%-04	Conductivity (us/cm)	318.3				355.7
12.5%-04	D.O. (mg/L)	7.59	6.02	6.74	6.2	6.76
12.5%-04	Temp (C)	22.5	22.8	21.6	22.3	22.2
12.5%-04	Hardness	98				108
12.5%-04	Alkalinity	*				*

Appendix B Sediment Reference Toxicity Test

Concurrent with the 2012 Upper Animas River Sediment Toxicity Test

4-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	4
End Date	12/14/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
25%-01	No. Alive	10	3	1	0	-
25%-01	pH	7.53			-	-
25%-01	Conductivity (us/cm)	318.2			-	-
25%-01	D.O. (mg/L)	7.6	5.77	6.43	5.72	-
25%-01	Temp (C)	22.4	22.6	21.5	22.6	-
25%-01	Hardness	97			103	-
25%-01	Alkalinity	*			*	-
25%-02	No. Alive	10	7	4	0	-
25%-02	pH	7.53			-	-
25%-02	Conductivity (us/cm)	318.7			-	-
25%-02	D.O. (mg/L)	7.6	6.12	6.76	5.53	-
25%-02	Temp (C)	22.4	22.7	21.3	22.6	-
25%-02	Hardness	97			103	-
25%-02	Alkalinity	*			*	-
25%-03	No. Alive	10	2	0	0	-
25%-03	pH	7.54			-	-
25%-03	Conductivity (us/cm)	319			-	-
25%-03	D.O. (mg/L)	7.61	5.84	6.6	5.85	-
25%-03	Temp (C)	22.5	22.7	21.2	22.6	-
25%-03	Hardness	97			103	-
25%-03	Alkalinity	*			*	-
25%-04	No. Alive	10	5	1	1	1
25%-04	pH	7.57				7.29
25%-04	Conductivity (us/cm)	318.8				371.3
25%-04	D.O. (mg/L)	7.6	6.1	6.61	5.72	6.77
25%-04	Temp (C)	22.4	22.7	21.2	22.7	22.27
25%-04	Hardness	97				103
25%-04	Alkalinity	*				*

Appendix B Sediment Reference Toxicity Test

Concurrent with the 2012 Upper Animas River Sediment Toxicity Test

4-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	4
End Date	12/14/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
50%-01	No. Alive	10	5	0	-	-
50%-01	pH	7.54			-	-
50%-01	Conductivity (us/cm)	295			-	-
50%-01	D.O. (mg/L)	7.57	6.55	6	-	-
50%-01	Temp (C)	22.5	22.8	22.6	-	-
50%-01	Hardness	97		105		
50%-01	Alkalinity	*		*		
50%-02	No. Alive	10	1	0	-	-
50%-02	pH	7.48			-	-
50%-02	Conductivity (us/cm)	318.5			-	-
50%-02	D.O. (mg/L)	7.61	6.54	6.32	-	-
50%-02	Temp (C)	22.5	22.7	22.6	-	-
50%-02	Hardness	97		105	-	-
50%-02	Alkalinity	*		*	-	-
50%-03	No. Alive	10	1	0	-	-
50%-03	pH	7.61			-	-
50%-03	Conductivity (us/cm)	318.2			-	-
50%-03	D.O. (mg/L)	7.61	6.48	6.2	-	-
50%-03	Temp (C)	22.6	22.7	22.5	-	-
50%-03	Hardness	97		105	-	-
50%-03	Alkalinity	*		*	-	-
50%-04	No. Alive	10	1	0	-	-
50%-04	pH	7.53			-	-
50%-04	Conductivity (us/cm)	318.1			-	-
50%-04	D.O. (mg/L)	7.63	6.31	6.14	-	-
50%-04	Temp (C)	22.6	22.7	22.5	-	-
50%-04	Hardness	97		105	-	-
50%-04	Alkalinity	*		*	-	-

Appendix B Sediment Reference Toxicity Test

Concurrent with the 2012 Upper Animas River Sediment Toxicity Test

4-Day Flow Through Data Sheets

Start Date	12/10/12	No. of Replicates	4
End Date	12/14/12	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Replicate ID	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4
100%-01	No. Alive	10	0	-	-	-
100%-01	pH	7.55				-
100%-01	Conductivity (us/cm)	319.1				-
100%-01	D.O. (mg/L)	7.63	6.29	-	-	-
100%-01	Temp (C)	22.5	22.6	-	-	-
100%-01	Hardness	95	98	-	-	-
100%-01	Alkalinity	*	*	-	-	-
100%-02	No. Alive	10	0	-	-	-
100%-02	pH	7.55				-
100%-02	Conductivity (us/cm)	319.1				-
100%-02	D.O. (mg/L)	7.62	6.54	-	-	-
100%-02	Temp (C)	22.4	22.6	-	-	-
100%-02	Hardness	95	98	-	-	-
100%-02	Alkalinity	*	*	-	-	-
100%-03	No. Alive	10	0	-	-	-
100%-03	pH	7.5				-
100%-03	Conductivity (us/cm)	318.8				-
100%-03	D.O. (mg/L)	7.65	6.01	-	-	-
100%-03	Temp (C)	22.4	22.7	-	-	-
100%-03	Hardness	95	98	-	-	-
100%-03	Alkalinity	*	*	-	-	-
100%-04	No. Alive	10	0	-	-	-
100%-04	pH	7.6				-
100%-04	Conductivity (us/cm)	320.7				-
100%-04	D.O. (mg/L)	7.6	6.16	-	-	-
100%-04	Temp (C)	22.4	22.7	-	-	-
100%-04	Hardness	95	98	-	-	-
100%-04	Alkalinity	*	*	-	-	-

*Alkalinity was not analyzed due to water volume constraints.

Prepared by: EC 7/15/13

Reviewed by:

CETIS Test Data Worksheet

Hyalella 10-d Survival and Growth Sediment Test — U.S. EPA Region I Lab

Start Date:	10 Dec-12	**Species:**	Hyalella azteca	**Sample Code:**	Control-P
End Date:	20 Dec-12	**Protocol:**	EPA/600/R-99/064 (2000)	**Sample Source:**	Upper Animas River
Sample Date:	10 Dec-12	**Material:**	Lab Control	**Sample Station:**	positive control

Batch Note: Region 8: Upper Animas River H. azteca 10-day sediment toxicity test

Sample Code	Rep	Pos	# Exposed	# Survived	Total Weight-mg	Tare Weight-mg	Pan Count	Mean Length-mm	Notes
Control-P	1	74	10	10	207.694	207.2946	10		
Control-P	2	18	10	10	207.8862	207.4937	10		
Control-P	3	33	10	10	207.7784	207.2301	10		
Control-P	4	71	10	9	206.4633	206.1138	9		
Control-P	5	50	10	10	209.611	209.3062	10		
Control-P	6	27	10	10	208.7849	208.2163	10		
Control-P	7	52	10	10	209.2436	208.9422	10		
Control-P	8	76	10	9	206.0131	205.4788	9		
Control N	1	30	10	10	207.723	207.119	10		
Control N	2	34	9	9	207.2429	206.6395	9		
Control N	3	12	11	11	210.1563	209.3316	11		
Control N	4	14	10	10	207.1309	206.2197	10		
Control N	5	2	10	9	208.0925	207.4776	9		
Control N	6	7	10	10	207.7105	207.0491	10		
Control N	7	60	10	9	208.9042	208.251	9		
Control N	8	54	10	10	208.7741	208.054	10		
A56	1	38	10	3	209.7175	209.6037	3		
A56	2	37	10	7	209.4562	209.1891	7		
A56	3	10	10	5	207.9212	207.7473	5		
A56	4	80	10	8	207.0759	206.8522	8		
A56	5	64	10	9	209.2445	209.0023	9		
A56	6	73	10	7	205.6212	205.4031	7		
A56	7	79	10	3	207.9364	207.7913	3		
A56	8	41	10	8	208.7065	208.4639	8		
A68	1	5	10	5	208.234	208.033	5		
A68	2	55	10	6	206.7461	206.5464	6		
A68	3	29	10	7	205.9819	205.69	7		
A68	4	69	10	6	206.9773	206.7561	6		
A68	5	67	10	6	209.5833	209.3364	6		
A68	6	9	10	4	207.4437	207.2956	4		
A68	7	36	10	5	208.7058	208.4766	5		
A68	8	28	10	6	207.923	207.6535	6		
A72	1	1	10	2	207.6846	207.5661	2		
A72	2	39	10	4	207.1808	207.0385	4		
A72	3	72	10	2	206.7494	206.6758	2		
A72	4	75	10	3	206.7789	206.6091	3		
A72	5	51	10	4	207.6777	207.4905	4		
A72	6	58	10	5	205.4616	205.2522	5		
A72	7	13	10	5	205.041	204.86	5		
A72	8	44	10	4	206.038	205.8298	4		
A73B	1	66	10	0	0	0	0		
A73B	2	23	10	0	0	0	0		
A73B	3	42	10	0	0	0	0		
A73B	4	25	10	1	205.445	205.3807	1		
A73B	5	68	10	0	0	0	0		
A73B	6	77	10	1	205.8659	205.7678	1		

CETIS Test Data Worksheet

Sample Code	Rep	Pos	# Exposed	# Survived	Total Weight-mg	Tare Weight-mg	Pan Count	Mean Length-mm	Notes
A73B	7	26	10	1	206.9982	206.8777	1		
A73B	8	59	10	1	206.1551	206.1205	1		
A75B	1	70	10	6	205.9818	205.7897	6		
A75B	2	47	10	6	208.8464	208.6709	6		
A75B	3	8	10	3	208.9266	208.8363	3		
A75B	4	15	10	5	208.7208	208.4917	5		
A75B	5	35	10	5	207.8091	207.6612	5		
A75B	6	49	10	3	206.4732	206.3462	3		
A75B	7	43	10	4	204.0144	203.8098	4		
A75B	8	24	10	7	208.2514	207.994	7		
M34	1	32	10	0	0	0	0		
M34	2	46	10	3	206.5334	206.3873	3		
M34	3	21	10	0	0	0	0		
M34	4	45	10	1	207.6867	207.5722	1		
M34	5	63	10	0	0	0	0		
M34	6	17	10	1	206.312	206.3025	1		
M34	7	53	10	1	208.334	208.2543	1		
M34	8	57	10	1	207.9543	207.8973	1		
CC49	1	20	10	0	0	0	0		
CC49	2	40	10	0	0	0	0		
CC49	3	16	10	0	0	0	0		
CC49	4	31	10	0	0	0	0		
CC49	5	62	10	0	0	0	0		
CC49	6	22	10	0	0	0	0		
CC49	7	56	10	0	0	0	0		
CC49	8	19	10	0	0	0	0		
Bbridge	1	11	10	9	206.2499	205.9917	9		
Bbridge	2	4	10	8	206.2489	206.0004	8		
Bbridge	3	65	10	8	208.6091	208.2976	8		
Bbridge	4	3	10	8	205.4966	205.253	8		
Bbridge	5	6	10	8	209.2402	208.9439	8		
Bbridge	6	61	10	6	208.8208	208.5834	6		
Bbridge	7	48	10	6	209.1293	208.898	6		
Bbridge	8	78	10	8	208.8923	208.6205	8		

Hyalella 10-d Survival and Growth Sediment Test — **U.S. EPA Region I Lab**

Analysis ID:	00-4242-1801	**Endpoint:**	Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	24 Feb-15 9:43	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Batch Note: Region 8: Upper Animas River H. azteca 10-day sediment toxicity test

Sample Code	Sample Notes
Control N	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
A56	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
A68	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
A72	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
A73B	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
A75B	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
M34	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
CC49	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
Bbridge	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	9.46%	

Steel Many-One Rank Sum Test

Sample Code	vs	Sample Code	Test Stat	Critical	Ties	DF	P-Value	P-Type	Decision(α:5%)
Control N		A56	36	45	0	14	0.0028	Asymp	Significant Effect
		A68	36	45	0	14	0.0028	Asymp	Significant Effect
		A72	36	45	0	14	0.0028	Asymp	Significant Effect
		A73B	36	45	0	14	0.0028	Asymp	Significant Effect
		A75B	36	45	0	14	0.0028	Asymp	Significant Effect
		M34	36	45	0	14	0.0028	Asymp	Significant Effect
		CC49	36	45	0	14	0.0028	Asymp	Significant Effect
		Bbridge	36	45	0	14	0.0028	Asymp	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.02740658	0.003425822	8	116.5	<0.0001	Significant Effect
Error	0.00185279	2.940936E-05	63			
Total	0.02925937		71			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	1.801	2.808	0.0936	Equal Variances
Variances	Levene Equality of Variance	3.302	2.808	0.0033	Unequal Variances
Distribution	Shapiro-Wilk W Normality	0.9467	0.9538	0.0042	Non-normal Distribution

Mean Dry Biomass-mg Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control N	8	0.06981	0.06154	0.07808	0.06659	0.0604	0.09112	0.003497	14.17%	0.0%
A56	8	0.02033	0.01586	0.0248	0.02209	0.01138	0.02671	0.001891	26.31%	70.88%
A68	8	0.02259	0.01884	0.02634	0.02252	0.01481	0.02919	0.001586	19.86%	67.64%
A72	8	0.01613	0.01219	0.02006	0.01754	0.007361	0.02094	0.001665	29.21%	76.9%
A73B	8	0.003969	-0.00014	0.008074	0.00173	0	0.01205	0.001736	123.7%	94.32%
A75B	8	0.0178	0.01322	0.02238	0.01838	0.00903	0.02574	0.001938	30.79%	74.5%
M34	8	0.005085	0.000245	0.009925	0.003325	0	0.01461	0.002047	113.9%	92.72%
CC49	8	0	0	0	0	0	0	0		100.0%
Bbridge	8	0.02623	0.02383	0.02864	0.02533	0.02313	0.03115	0.001018	10.98%	62.42%

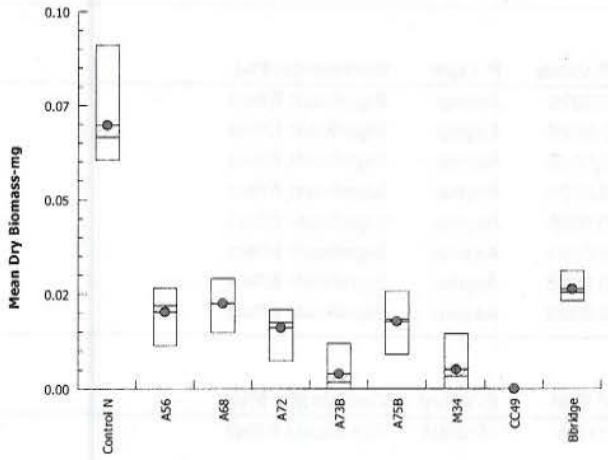
Hyalella 10-d Survival and Growth Sediment Test — U.S. EPA Region I Lab

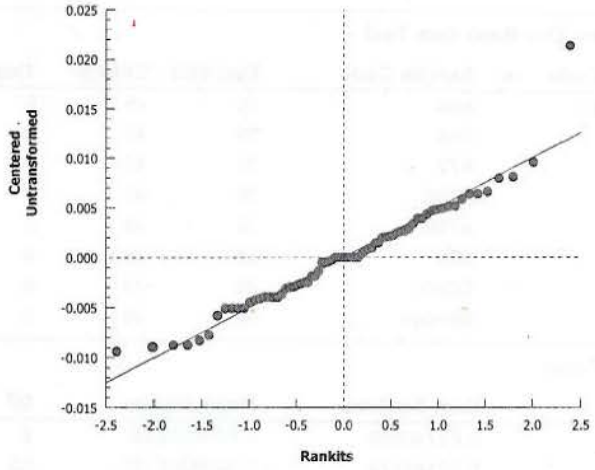
Analysis ID:	00-4242-1801	**Endpoint:**	Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	24 Feb-15 9:43	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Mean Dry Biomass-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
Control N	0.0604	0.06705	0.07497	0.09112	0.06149	0.06614	0.06532	0.07201
A56	0.01138	0.02671	0.01739	0.02237	0.02422	0.02181	0.01451	0.02426
A68	0.0201	0.01997	0.02919	0.02212	0.02469	0.01481	0.02292	0.02695
A72	0.01185	0.01423	0.007361	0.01698	0.01872	0.02094	0.0181	0.02082
A73B	0	0	0	0.00643	0	0.00981	0.01205	0.003461
A75B	0.01921	0.01755	0.00903	0.02291	0.01479	0.0127	0.02046	0.02574
M34	0	0.01461	0	0.01145	0	0.000949	0.00797	0.005701
CC49	0	0	0	0	0	0	0	0
Bbridge	0.02582	0.02485	0.03115	0.02436	0.02963	0.02374	0.02313	0.02718

Graphics





Hyalella 10-d Survival and Growth Sediment Test — **U.S. EPA Region I Lab**

Analysis ID:	00-5869-2302	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	24 Feb-15 9:43	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch Note: Region 8: Upper Animas River H. azteca 10-day sediment toxicity test

Sample Code	Sample Notes
Control N	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
A56	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
A68	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
A72	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
A73B	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
A75B	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
M34	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
CC49	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test
Bbridge	Region 8: Upper Animas River H. azteca 10-day sediment toxicity test

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Angular (Corrected)	NA	C > T	NA	NA	10.2%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Control N		A56	6.746	2.436	0.162	14	<0.0001	CDF	Significant Effect
		A68	7.875	2.436	0.162	14	<0.0001	CDF	Significant Effect
		A72	11	2.436	0.162	14	<0.0001	CDF	Significant Effect
		A73B	17.05	2.436	0.162	14	<0.0001	CDF	Significant Effect
		A75B	9.031	2.436	0.162	14	<0.0001	CDF	Significant Effect
		M34	16.26	2.436	0.162	14	<0.0001	CDF	Significant Effect
		CC49	18.28	2.436	0.162	14	<0.0001	CDF	Significant Effect
		Bbridge	4.547	2.436	0.162	14	<0.0001	CDF	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	10.70319	1.337899	8	76.06	<0.0001	Significant Effect
Error	1.108184	0.01759022	63			
Total	11.81138		71			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Mod Levene Equality of Variance	2.587	2.808	0.0164	Equal Variances
Variances	Levene Equality of Variance	5.134	2.808	<0.0001	Unequal Variances
Distribution	Shapiro-Wilk W Normality	0.9559	0.9538	0.0131	Normal Distribution

Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control N	8	0.975	0.9363	1	1	0.9	1	0.01637	4.75%	0.0%
A56	8	0.625	0.4315	0.8185	0.7	0.3	0.9	0.08183	37.03%	35.9%
A68	8	0.5625	0.4859	0.6391	0.6	0.4	0.7	0.03239	16.29%	42.31%
A72	8	0.3625	0.2632	0.4618	0.4	0.2	0.5	0.04199	32.77%	62.82%
A73B	8	0.05	0.005313	0.09469	0.05	0	0.1	0.0189	106.9%	94.87%
A75B	8	0.4875	0.3656	0.6094	0.5	0.3	0.7	0.05154	29.9%	50.0%
M34	8	0.0875	0.004648	0.1704	0.1	0	0.3	0.03504	113.3%	91.03%
CC49	8	0	0	0	0	0	0	0		100.0%
Bbridge	8	0.7625	0.6738	0.8512	0.8	0.6	0.9	0.0375	13.91%	21.79%

Hyalella 10-d Survival and Growth Sediment Test — U.S. EPA Region I Lab

Analysis ID: 00-5869-2302 Endpoint: Survival Rate CETIS Version: CETISv1.8.7
Analyzed: 24 Feb-15 9:43 Analysis: Parametric-Control vs Treatments Official Results: Yes

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control N	8	1.371	1.308	1.434	1.412	1.249	1.419	0.02668	5.5%	0.0%
A56	8	0.9238	0.7146	1.133	0.9912	0.5796	1.249	0.08845	27.08%	32.63%
A68	8	0.8489	0.771	0.9268	0.8861	0.6847	0.9912	0.03295	10.98%	38.09%
A72	8	0.6415	0.5347	0.7482	0.6847	0.4636	0.7854	0.04514	19.9%	53.21%
A73B	8	0.2403	0.1674	0.3131	0.2403	0.1588	0.3218	0.0308	36.26%	82.48%
A75B	8	0.7723	0.6474	0.8971	0.7854	0.5796	0.9912	0.05279	19.33%	43.68%
M34	8	0.2929	0.1748	0.4109	0.3218	0.1588	0.5796	0.04991	48.2%	78.64%
CC49	8	0.1588	0.1588	0.1588	0.1588	0.1588	0.1588	0	0.0%	88.42%
Bbridge	8	1.07	0.9664	1.173	1.107	0.8861	1.249	0.04363	11.54%	21.99%

Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
Control N	1	1	1	1	0.9	1	0.9	1
A56	0.3	0.7	0.5	0.8	0.9	0.7	0.3	0.8
A68	0.5	0.6	0.7	0.6	0.6	0.4	0.5	0.6
A72	0.2	0.4	0.2	0.3	0.4	0.5	0.5	0.4
A73B	0	0	0	0.1	0	0.1	0.1	0.1
A75B	0.6	0.6	0.3	0.5	0.5	0.3	0.4	0.7
M34	0	0.3	0	0.1	0	0.1	0.1	0.1
CC49	0	0	0	0	0	0	0	0
Bbridge	0.9	0.8	0.8	0.8	0.8	0.6	0.6	0.8

Angular (Corrected) Transformed Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
Control N	1.412	1.403	1.419	1.412	1.249	1.412	1.249	1.412
A56	0.5796	0.9912	0.7854	1.107	1.249	0.9912	0.5796	1.107
A68	0.7854	0.8861	0.9912	0.8861	0.8861	0.6847	0.7854	0.8861
A72	0.4636	0.6847	0.4636	0.5796	0.6847	0.7854	0.7854	0.6847
A73B	0.1588	0.1588	0.1588	0.3218	0.1588	0.3218	0.3218	0.3218
A75B	0.8861	0.8861	0.5796	0.7854	0.7854	0.5796	0.6847	0.9912
M34	0.1588	0.5796	0.1588	0.3218	0.1588	0.3218	0.3218	0.3218
CC49	0.1588	0.1588	0.1588	0.1588	0.1588	0.1588	0.1588	0.1588
Bbridge	1.249	1.107	1.107	1.107	1.107	0.8861	0.8861	1.107

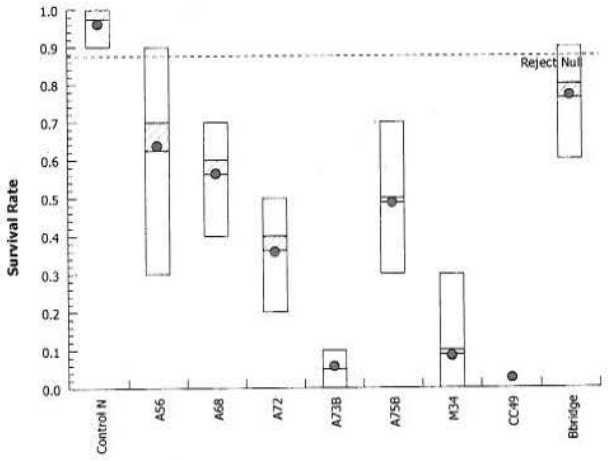
Survival Rate Binomials

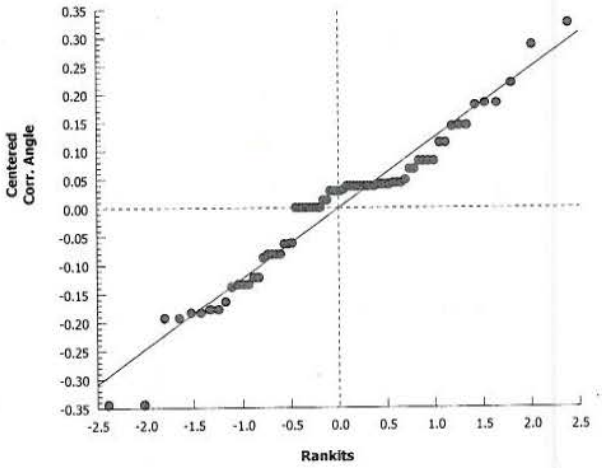
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
Control N	10/10	9/9	11/11	10/10	9/10	10/10	9/10	10/10
A56	3/10	7/10	5/10	8/10	9/10	7/10	3/10	8/10
A68	5/10	6/10	7/10	6/10	6/10	4/10	5/10	6/10
A72	2/10	4/10	2/10	3/10	4/10	5/10	5/10	4/10
A73B	0/10	0/10	0/10	1/10	0/10	1/10	1/10	1/10
A75B	6/10	6/10	3/10	5/10	5/10	3/10	4/10	7/10
M34	0/10	3/10	0/10	1/10	0/10	1/10	1/10	1/10
CC49	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10
Bbridge	9/10	8/10	8/10	8/10	8/10	6/10	6/10	8/10

Hyalella 10-d Survival and Growth Sediment Test — **U.S. EPA Region I Lab**

Analysis ID:	00-5869-2302	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	24 Feb-15 9:43	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Graphics





Appendix 10b

Sediment toxicity testing report for the Upper Animas River (November 2014)

Animas River
Sediment Toxicity Testing Report
November 2015

Prepared for:

United States Environmental Protection Agency, Region 8
Ecosystem Protection and Remediation-Program Support
1595 Wynkoop St.
Denver, CO 80202

Prepared By:

United States Environmental Protection Agency, Region 8
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April 2015

Contract No. EPW-13-028
DCN: EP8-2-1223

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Appendix A November 2014 Animas River Sediment Toxicity Test using *H. azteca* 10 Day Static Renewal Data Sheets

Appendix B Sediment Reference Toxicity Test Concurrent with the 2014 Animas River Sediment Toxicity Test 4 day Static Renewal Data Sheets

Attachment 1 CETIS Analytical Reports for the November 2014 Animas River Sediment Toxicity Test

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Abbreviation and Acronym List

BLM	Bureau of Land Management
ºC	Degrees Celsius
CDPHE	Colorado Department of Public Health and Environment
CETIS	Comprehensive Environmental Toxicity Information System
Control N	Negative laboratory control
Control P	Positive laboratory control
DO	Dissolved Oxygen
DRMS	Colorado Division of Reclamation, Mining and Safety
EC_{50}	50% Median Effective Concentration
EPA	Environmental Protection Agency
ESAT	Environmental Services Assistance Team
g	Grams
gpm	Gallons per minute
kg	Kilogram
LC_{50}	50% Lethal Concentration
MHRW	Moderately Hard Reconstituted Water
mg	Milligram
mL	Milliliter
NH_3	Ammonia
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SGC	Sunnyside Gold Corporation
SOP	Standard Operating Procedure
TAC	Test Acceptability Criterion
YCT	Yeast, Cerophyl, and Trout Chow
$ZnSO_4$	Zinc sulfate heptahydrate

1.0 INTRODUCTION

A 10-day, static-renewal sediment toxicity test using the amphipod, *Hyalella azteca*, and sediment collected from the Animas River (San Juan County, Colorado) was performed at the United States Environmental Protection Agency (EPA) Region 8 Laboratory in November 2014. The purpose of this toxicity test was to determine the toxicity of sediments collected from the Animas River by assessing survival and growth. A 96-hour reference toxicity test was performed concurrently with the Animas River toxicity test as a quality assurance measure. The reference toxicity test consisted of an aqueous stock solution spiked with zinc, with a test endpoint of survival. This report includes a brief background of the Animas Mining District (Section 1.1), materials and methods (Section 2.0), testing results (Section 3.0), a discussion of results (Section 4.0), and supporting references (Section 5.0).

1.1 Background

Information in this section was obtained from the *Final 2014 Sampling and Analysis Plan/Quality Assurance Project Plan, Revision 1, Upper Animas Mining District Gladstone, San Juan County, Colorado*, dated September 2014 (ESAT, 2014).

The discovery of gold and silver brought miners to the Silverton area and Animas Mining District in the early 1870's. The discovery of silver in the base-metal ores was the major factor in establishing Silverton as a permanent settlement. Between 1870 and 1890, the richer ore deposits were discovered and mined to the extent possible. Not until 1890 was any serious attempt made to mine and concentrate the larger low-grade ore bodies in the area. By 1900, there were 12 concentration mills in the valley sending products to the Kendrick and Gelder Smelter near the mouth of Cement Creek. Mining and milling operations slowed down circa 1905, and the mines were consolidated into fewer and larger operations with the facilities for milling large volumes of ore. After 1907, mining and milling continued throughout the basin whenever prices were relatively favorable. Gladstone, located about eight miles upstream of Silverton on Cement Creek, is the site of a historic mining town developed in the 1880s commensurate with the onset of mining in the surrounding area. The town was the central location and railroad terminus for the milling and shipping of mine ores from the surrounding three-square-mile valley. The town declined in the 1920's and no remnants of the town remain. By the 1970's, the Sunnyside Mine was the only year-round producing mine remaining in the county. This mine ceased production in 1991, and has since undergone reclamation efforts. The Gold King Mine's permit with Colorado Division of Reclamation, Mining and Safety (DRMS) is currently in inactive status; however, landowners hope to rehabilitate the mine.

Both the Sunnyside and Gold King properties were partially accessed through the American Tunnel that has its portal in Gladstone. Previously the American Tunnel drained as much as 1,600 gallons per minute (gpm) of water from the mines. A lime feed and settling pond-type treatment facility was constructed in Gladstone in 1979 by Standard Metals Corporation. Water discharging from the American Tunnel was treated as required by the water discharge permit. The facility operations and mine ownership was later transferred to the Sunnyside Gold Corporation (SGC). Under jurisdiction of a court consent decree to terminate their discharge permit, SGC installed several bulkheads within the Sunnyside Mine that greatly reduced the amount of discharge from the American Tunnel. Seventy to one hundred gpm continue to discharge, presumably from near surface groundwater.

In January 2003 the treatment facility, operations, and permit were transferred to the Gold King Mines Corporation. The settling ponds were deeded to the San Juan Corporation by SGC prior to the lease between the Gold King Mines and San Juan Corporations. The treatment facility continued to treat the remaining American Tunnel discharge and the Gold King discharge until September 2004. The San Juan Corporation required SGC to reclaim the four settling ponds (completed in 2005) following termination of the San Juan Corporation and SGC lease. The Gold King Mines Corporation was subsequently evicted and the balance of the Gold King Mines Corporation land was acquired by the San Juan Corporation as the lien holder. The American Tunnel portal reclamation and removal of some out buildings were completed in 2006. The Bureau of Land Management (BLM) manages land associated with the American Tunnel portal and vicinity; however, the San Juan Corporation owns the majority of the land surrounding the portal.

Numerous historic and now abandoned mines exist within a two-mile radius of Gladstone. They include: the Upper Gold King 7 Level, American Tunnel, Grand Mogul, Mogul, Red and Bonita, Evelyne, Henrietta, Joe and John, and Lark mines. Some of these mines have acid mine drainage that flows between 30 and 300 gpm directly or indirectly into Cement Creek and eventually into the Animas River.

1.2 Objective

The objectives of this toxicity test were to (a) support the yearly monitoring activities at the Animas River, (b) characterize the effects of mine waste-impacted sediment samples on *H. azteca* under subchronic exposure conditions, and (c) generate data to support development of the future Baseline Ecological Risk Assessment and Remedial Investigation.

2.0 MATERIALS AND METHODS

This section outlines the materials and methods used for testing purposes, including sediment collection procedures, water preparation and delivery, test organisms, food

preparation, and testing procedures. General test methods following EPA (2000) are discussed below and summarized in **Table 2.0-1**.

2.1 Study Design

The 10-day Animas River sediment toxicity test followed protocols found in EPA Test Method 100.1 (EPA, 2000). *H. azteca* survival and growth were measured at the end of the exposure period. The test included a negative laboratory control (Control N; Horsecreek Reservoir control sediment) and a positive laboratory control (Control P; laboratory control sediment spiked with 1,000 milligrams per kilogram [mg/kg] zinc wet weight) to help evaluate the overall health of the test organisms and to provide a baseline growth measurement for amphipods exposed to clean sediment. The location on the Animas River originally selected as reference (i.e. A75CC) was determined to be impacted by mining activity, and could therefore not be used for that purpose. Eight replicates for each sample location and each laboratory control were used during the 10 day toxicity test.

Site sediment was thoroughly homogenized in a stainless steel pan before it was distributed into test chambers one day before the organisms were introduced. 100 milliliters (mL) of sediment was placed in each test replicate chamber before they were placed into a temperature-controlled water bath.

The water bath temperature was held at 23 ± 2ºC for the duration of the test and met the performance criterion. According to EPA Test Method 100.1 (EPA, 2000) the daily mean test temperature should be ± 1ºC and the instantaneous temperature must always be within ± 3ºC of the target temperature of 23ºC. Overlying water [175 mL of Moderately Hard Reconstituted Water (MHRW)] was added to each test chamber before ten organisms were counted, verified, and introduced. One mL of Yeast, Cerophyl®, and Trout Chow (YCT) feed mixture was added to each test chamber daily and the overlying water was renewed at a rate of two volumes (350 mL) per day for the 10-day test period.

The water quality measurements were collected daily as described in **Exhibit 1**. The water quality parameters pH, conductivity, and hardness were checked on test Day 0 and test Day 9. Dissolved oxygen (DO) and temperature were measured daily. A syringe was used to collect samples from overlying water from each replicate on the first and last day of the test. On Day 10 of the test, temperature and DO were measured in each test chamber before samples of overlying water from each replicate were collected and pooled for total and dissolved metals analyses. All overlying water samples collected for ammonia analyses were inspected for the presence of test organisms before the samples were prepared for analysis to ensure no organisms were inadvertently removed from the test chamber.

Exhibit 1: Activities Schedule for a 10-Day Sediment Toxicity Test

Day	Activity

Day -1	Add sediment into test chambers and start renewal of overlying water.
Day 0	Measure overlying water quality parameters (pH, temperature, DO, conductivity, and ammonia) in each replicate. Obtain hardness measurement by collecting an overlying water sample from each replicate and pooling for analysis. Collect pore water samples from each replicate and pool for dissolved metals analysis. Transfer 10 organisms into each test chamber and release them under the surface of the water to avoid entrapment. Add 1.0 mL of YCT into each test chamber. Obtain 80 additional test organisms to measure initial dry weight.
Day 1 through 8	Feed organisms 1.0 mL YCT and measure temperature and DO in each test chamber.
Day 9	Measure overlying water quality (pH, temperature, DO, conductivity, and ammonia) for each replicate. Collect an overlying water sample and a pore water sample from each replicate and pool for metals analysis. Add 1.0 mL of YCT into each test chamber.
Day 10	Measure temperature and DO. Collect the surviving organisms from each replicate.

2.2 Sediment Collection

Composite sediment samples were collected in early September 2014 from sample locations on the Animas River, Cement Creek, and Mineral Creek in accordance with the 2014 Sampling and Analysis Plan/Quality Assurance Project Plans (SAP/QAPP) (ESAT, 2014; USFWS, 2012). Sediment was collected from a depth of 0-2 inches using a Teflon hand trowel. The sample containers were placed on ice until received at the EPA Region 8 laboratory before they were placed in a 4°C cooler for preservation. Sample collection equipment was station dedicated, therefore, decontamination of this equipment was not necessary.

2.3 Test Water Preparation and Delivery

MHRW was prepared in accordance with Smith *et al*. (1997) by adding 47.4 grams (g) of calcium sulfate, 123g of magnesium sulfate heptahydrate, 96 g of sodium bicarbonate, and 4 g of potassium chloride to the laboratory stainless steel batch tank containing 1,000 L of deionized water. The batch tank was continuously aerated for the duration of the toxicity test after the MHRW was prepared. Water quality was measured to verify that the following parameters were met: hardness between 90 and 100 milligrams per liter (mg/L), conductivity between 330 and 360 microsiemens/centimeter, and pH between 7.8 and 8.2 standard units (EPA, 2000). **Table 2.3-1** summarizes the chemical constituents for the MHRW used in the test, and the resulting pH and hardness. Hardness and pH fell slightly below the recommended values as stated in Section 7, Water, Formulated Sediment, Reagents, and Standards, of *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates*

(EPA, 2000). This slight deviation in water chemistry would not have any substantial effect on the outcome of the toxicity test. The MHRW was delivered to each test chamber at a rate of two volumes (approximately 350 mL) of overlying water per day using a glass distribution box similar to the one described in Benoit *et al.* (1983).

Table 2.3-1 Moderately Hard Reconstituted Water Composition and Chemistry

$CaSO_4$	$MgSO_4$-$7H_2O$	$NaHCO_3$	KCl	Final pH*	Final Hardness*
47.4 g/1000 L	123g/1000 L	96 g/1000 L	4 g/1000 L	6.92	75.4 mg/L

*an average was taken from two batches

2.4 Test Organisms

The juvenile amphipods needed for the sediment toxicity test were obtained from Aquatic Biosystems (Ft. Collins, Colorado). The organisms were kept in their shipping bag after they arrived at the laboratory and placed in a holding tank for about 48 hours for temperature acclimation. Acclimation of the organisms to the laboratory MHRW was not a concern because the organisms had been cultured and shipped in MHRW. Regardless, the shipping bag was slowly opened to allow a small amount of laboratory MHRW to mix with the shipping water. This procedure was repeated several times throughout the course of one day until laboratory MHRW and shipping water were homogenized. Test organisms were 7 to 10-days old at the time of testing.

2.5 Test Food Preparation

Organisms were fed a YCT mixture daily that contained 2.6-2.9 grams of solids per liter (see **Table 2.5-1**). YCT was prepared by adding 5 g of Trout Chow® to 1 L of deionized water, followed by homogenization in a blender (EPA, 2000). The homogenized mixture was poured into a 2-L separatory funnel, aerated, and allowed to digest for one week at room temperature. The aeration apparatus was removed after the digestion period. The solid material settled out for one hour, after which the supernatant was collected using a 110 mesh Nitex screen. Yeast solution was prepared by adding 5 g of dry yeast to 1 L deionized water, followed by mixing. Cerophyl® was prepared by adding 5 g of alfalfa pellets to 1 L of deionized water, followed by homogenization in a blender. Equal parts of yeast, Trout Chow (supernatant), and Cerophyl® solutions were then added to a beaker and homogenized in a blender. The YCT mixture was stored in a freezer or refrigerator until use. Refrigerated YCT was used within two weeks of preparation.

2.6 Test Procedures

The following sections describe the procedures used for the site sediment and reference toxicity tests.

2.6.1 Site Sediment Toxicity Test

Sediment samples were collected from fourteen locations along the Animas River (A55, A56, A60, A68, A72, A73, A75CC, A75D, A75EC, Baker Bridge [Bbridge], James Ranch [Jranch], 32nd St, Lightener Creek [Lcreek] and Purple Cliffs [Pcliffs]). A duplicate was collected at location A68. Location A75CC was designated as the upstream reference location but it was later determined that this location was potentially impacted by mining activity and no longer designated as the reference. Testing was also performed on negative and positive control sediment (i.e., Control N and Control P, respectively) for quality assurance purposes. The positive control was spiked with 1000 mg/kg zinc solution intended to substantially reduce survival and growth while the negative control was not spiked and was used to test the overall health of the organisms. The control sediment consisted of sediment collected from Horsecreek Reservoir, located 5 miles south of Hudson, Colorado.

Eight replicates were tested for each location and the laboratory control samples. Eighty test organisms were collected to be used to determine an initial dry weight per organism to verify that the control organisms showed measureable growth after 10 days of exposure (See **Table 2.6-1**). The test chambers, which consisted of 300-mL beakers filled with 100 mL of sediment and 175 mL of overlying MHRW, were placed in a water bath to maintain a constant temperature during the test.

The testing took place over a 10-day period. The quality of the overlying MHRW was measured daily for DO and temperature. Overlying water was measured for hardness, conductivity, ammonia and pH (**Appendix A**) at the start (Day 0) and end (Day 9) of the test. The amphipods were fed 1 mL of YCT per test chamber per day. The surviving organisms were removed (or "picked") from the sediment using pipettes, a sieve, and/or Nitex screen at the end of the 10-day test period. Personnel involved with picking organisms from the sediment were required to show proficiency by retrieving at least 90% of organisms placed into "practice" sediment.

2.6.2 Reference Toxicity Test

The 96-hour reference toxicity test followed procedures outlined in Section 9, Quality Assurance and Quality Control, of *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates* (EPA, 2000) and was carried out concurrently with the site sediment toxicity test. The test chambers consisted of 200-mL beakers, filled with 100 mL of MHRW, and contained Nitex screen at the bottom as an artificial substrate. A stock solution of MHRW with zinc sulfate heptahydrate ($ZnSO_4$) was prepared with resulting zinc concentration of 100 ppm. Using a serial dilution approach, $ZnSO_4$ concentrations were reduced by 50% starting with the highest concentration (referred to as 100%) until the lowest dilution (6.25%) was reached. The following values provide the dilutions and average zinc concentrations (calculated from the initial and final measured dissolved Zn results, Table 3.1-2): 100% concentration of $ZnSO_4$ was 927 µg/L, followed by 50% (464 µg/L), 25% (253.5 µg/L), 12.5% (133 µg/L), 6.25% (66.85 µg/L) and 0% (10.3 µg/L). The zinc concentration used for 0% is and average of one half the laboratory detection limit of 10

µg/L (i.e. 5 µg/L) and the final estimated concentration of 15.6 µg/L. Zinc concentrations were verified using EPA Method 200.7/200.8 and are included in **Table 3.1-2**. Survival was the endpoint for the reference test.

2.7 Pore Water Collection Procedures

Pore water was collected from each individual test chamber for analysis at the start and end of the test. These samples were collected by placing a push-point pore water sampling probe in each test chamber and extracting the water from within the bedded sediment using a 50 mL syringe. The syringe was then fit with a 0.45 micrometer filter, and the sample was transferred to a 10 mL sample container. The sample was labeled, preserved, and stored at 4°C in the Region 8 Laboratory. Initial and final pore water samples were analyzed for dissolved metals using EPA Method 200.7 (EPA 1994a) and 200.8 (EPA, 1994b).

2.8 Overlying Surface Water Collection Procedure

Samples for overlying water were collected using treatment group dedicated 60 mL syringes. Water was collected from just below the surface in each replicate for a sample location composite sample. Composite samples were collected for alkalinity, anions, total recoverable and dissolved metals samples and a discrete water sample was collected from each replicate for all ammonia samples. After approximately 40 mL (5 mL from each replicate) of water was pulled into the syringe a visual observation of the water was made to ensure that no organisms were inadvertently captured during this process.

3.0 RESULTS

This section presents the results for the site sediment and reference toxicity tests and addresses any issues or unforeseen conditions encountered during the test.

3.1 Site Sediment Toxicity Testing

Sediment, pore water, and overlying surface water samples were analyzed for total recoverable metals (sediment & overlying water) and dissolved metals (pore water & overlying water) using EPA Method 200.7/200.8. **Tables 3.1-1** through **3.1-4** provide the results of these analyses. The overlying water was tested for alkalinity, anions, and dissolved organic carbon using EPA Methods 310.1, 300.0, and 415.1, respectively. **Table 3.1-8** provides the results of these analyses.

The conditions in the test chambers generally met the performance criteria (see **Table 2.0-1**). Daily water chemistry is provided in **Appendix A**. The performance criterion for EPA Method 100.1 requires no more than 50% change for alkalinity, hardness and pH whereas DO must be maintained above 2.5 mg/L. The replicates' variability in hardness met performance criteria of 50% at all sample locations except Control N and Control P. Control N had an initial hardness of 356 and a final hardness of 138, making a 61% change. Control P had an initial hardness of 322 and a final hardness of 139, making a 57% change. The replicates' variability in alkalinity met performance criteria of 50% at all sample locations except location A72. A72 had an initial alkalinity of 40.5 and a final

alkalinity of 60.7, making a 50% difference. Location A55 and A73 were close to the 50% criteria at 46% and 48%, respectively. DO was generally maintained above the performance criterion of 2.5 mg/L throughout the test. The criterion was not fully met for location A55 (rep 4), location A56 (rep 5, rep 6, rep 7) or location A75-CC (rep 1 – rep 8). The overlying water temperatures deviated slightly more than ±2ºC from 23ºC, ranging between 20.0°C and 23.1°C during the 10-day test period. The only temperature deviations were observed on day 0 of the test when several replicates were slightly below the recommended minimum of 21°C.

A discrete sample of the overlying water was obtained from each replicate on Day 0 and Day 9 of the test for ammonia analysis using EPA Method 350.1 (EPA 1993). Ammonia (NH_3-N) concentrations on Day 0 (initial water chemistry) ranged from 0.02 mg/L NH_3-N in A75CC replicates 3, 4, 6 and 8 to 1.88 mg/L NH_3-N in A55-02 mg/L NH_3-N. On Day 9 (final water chemistry) concentrations ranged from 0.02 mg/L NH_3-N in several locations and replicates to 0.62 mg/L NH_3-N in A55-03 (see **Table 3.1-5**). The average Day 0 and Day 9 ammonia levels measured in the eight replicates of each of the sediment samples used in the toxicity test were compared to pH-dependent acute ammonia criteria. As shown in **Table 3.1-5,** all ammonia levels fell below their respective acute ammonia criteria. The ammonia criteria were calculated using the "salmonids present" equation, which is provided on p. 54 of the Colorado Department of Public Health and Environment Water Quality Control Commission (CDPHE): Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31) (CDPHE, 2013).

Surviving *H. azteca* were collected at the end of the 10 day test from each test chamber, counted, placed in aluminum weigh boats, and dried for at least 24 hrs at 80ºC. Every effort was made to ensure that sediment particles were not inadvertently added to the weigh boats with the organisms. Pans with dried *H. azteca* were then weighed. All information was recorded on laboratory bench sheets.

CETIS (Comprehensive Environmental Toxicity Information System) statistical software (2011) was used to establish the significance of differences between *H. azteca* survival and biomass between laboratory controls, upstream reference and site locations after 10 days of exposure in the sediment samples (see **Attachment 1**). **Figure 3.1-1** presents the results for survival and **Figure 3.1-2** presents the results for biomass.

Survival Results

Survival results for each replicate and average per location are included in the CETIS worksheets (**Attachment 1**). Control P and Control N showed an average of 92.5% survival and 91.3% survival, respectively. The survival results were almost indistinguishable from each other. Control N met the minimum performance criterion of ≥80% survival. Control P had unexpectedly high survival but did not influence the outcome of the toxicity test. Site sample results were only compared to Control N to determine significant survival and growth. The available analytical data for pore water,

overlying water, and sediment samples (see **Tables 3.1-1 to 3.1-4**) show that the Zn levels in Control P were consistently similar to those measured in Control N.

Control N had 92.5 ± 8.9% survival and Control P had 91.3 ± 13.6% survival. The following values represent the average survival results for the remaining sample locations: A55 (60 ± 16%), A56 (43.8 ± 26.2%), A60 (77.5 ± 18.3%), A68 (70 ± 28.3%), A72 (70 ± 13.1%), A73 (73.8 ± 22%), A75CC (73.8 ± 19.2%), A75D (78.6 ± 21.9%), A75EC (81.3 ± 24.8%), Bbridge (86.3 ± 10.6%), Jranch (66.3± 24.5%), 32nd St (87.5 ± 10.4%), Lcreek (73.8 ± 22%), Pcliffs (31.3 ± 27.5%), A68Dup (70 ± 20%).

Biomass Results

Biomass results for each replicate and average per location are included in the CETIS worksheets (**Attachment 1**). Average biomass for each location was calculated by dividing the total weight of all surviving *H. azteca* per sample location by the total number of *H. azteca* introduced per sample location on Day 0 of the test (i.e. [total weight of *H. azteca* from all eight replicates per sample location] / [8 replicates x 10 *H. azteca* introduced for each sample location]). The results show that Control N had an average biomass of 78.1 ± 11.8 µg/organism and Control P had an average biomass of 51.1 ± 13.1 µg/organism. The following values represent the average biomass results for the remaining sample locations: A55 (21.1 ± 6.8 µg/organism), A56 (14.3 ± 9.1 µg/organism), A60 (23.1 ± 5.5 µg/organism), A68 (23.2 ± 9.2 µg/organism), A72 (27.9 ± 6.9 µg/organism), A73 (21.8 ± 6.2 µg/organism), A75CC (36.6 ± 8.0 µg/organism) A75D (24.9 ± 8.3 µg/organism), A75EC (36.3 ± 11.2 µg/organism), Bbridge (30.8 ± 6.1 µg/organism), Jranch (24.4 ± 8.5 µg/organism), 32nd St (33.4 ± 7.9 µg/organism), Lcreek (24.4 ± 9.6 µg/organism), Pcliffs (11.3 ± 8.1 µg/organism) and A68Dup (23.9 ± 9.2 µg/organism).

Growth Results

Growth was calculated by comparing mean initial dry weight per organism (**Table 2.6-1**; 80 organisms used to determine initial dry weight) to the mean final dry weight per survivors at the end of the test (Day 10). The sample mean for each sample location (**Table 3.1-7**) was calculated by averaging the results of the mean dry weight (µg) per survivor for each replicate. Control N passed acceptability criterion (**Table 2.0-1**), which requires measureable increase in growth in control sediment between the start (Day 0) and the end of the test (Day 10). All Control N growth results, along with supplemental growth results for Control P and each sample location are included in **Table 3.1-7**. The mean weight per survivor in each replicate is presented in **Table 3.1-7**. The initial average organism weight was 22.5 µg/organism (**Table 2.6-1**), whereas the final average organism weight for Control N was 78.1 ± 11.8 µg/organism (269.8% growth increase).

3.2 Reference Toxicity Test

Overlying water quality parameters were consistent throughout the 96-hour reference toxicity test (see **Appendix B**). The performance criterion for EPA Method 100.1

requires no more than 50% change for alkalinity, hardness and pH whereas DO must be maintained above 2.5 mg/L. Test chamber temperatures ranged between 21.9°C and 22.8°C during the test period. The variability in hardness and alkalinity was less than 50% within each test chamber, and DO levels ranged between 3.2 mg/L and 6.01 mg/L.

CETIS used the Trimmed Spearman-Karber method to calculate the EC_{50} of 196.7 ug/L zinc with an UCL of 210.4 and an LCL of 183.8 ug/L zinc. These values correspond with historical EC50 values calculated from reference toxicity tests performed at the Region 8 Laboratory. *Note that CETIS uses the term "EC50" (Median Effective Concentration effecting 50% of the test organisms) instead of LC_{50}.*

Survival Results

The surviving organisms were collected at the end of the 96-hour reference toxicity test and counted. **Figure 3.2-1** provides the results. The control (10.3 µg/L Zn) passed the performance criterion of $\geq$ 80% survival, with average survival of 100%. The following values show the average zinc concentrations and % survivals from the reference toxicity test: 66.85 µg/L zinc = 97.5% survival, 133 µg/L zinc = 100% survival, 253.5 µg/L zinc = 12.5% survival, 464 µg/L zinc = 0% survival and 927 µg/L zinc = 0% survival. A 96-hour EC_{50} of 196.7 µg/L was calculated using the Trimmed Spearman-Karber Estimates (see **Attachment 2**).

A discrete sample of the overlying water was obtained from each replicate on Day 0 and Day 4 of the test for ammonia analysis using EPA Method 350.1 (EPA 1993). Ammonia (NH_3-N) levels on Day 0 (initial water chemistry) ranged from 0.02 mg/L in 10 replicates to 0.33 mg/L NH_3-N in the Control-04 replicate. On Day 4 (final water chemistry), the ammonia levels ranged from 0.04 mg/L NH_3-N in the 100%-01 replicate to 0.88 mg/L NH_3-N in the 25%-01 replicate. **Table 3.1-6** provides the ammonia data. The average Day 0 and Day 4 ammonia levels measured in the four replicates of each of the samples used in the reference toxicity test were compared to pH-dependent acute ammonia criteria. None of the measured ammonia levels exceeded their respective criteria. Note that the acute ammonia criteria were calculated using the "salmonids present" equation, provided on p. 54 of Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31) (CDPHE, 2012).

4.0 DISCUSSION

The survival and biomass results of the Animas River sediment toxicity test were compared to the negative laboratory control. Below is a discussion of the results.

Survival

The CETIS software was used to perform a Bonferroni Adjusted t Test, comparing Control N and Site samples, to determine the significance ($p \leq 0.05$) of the observed

survival after 10 days of exposure (**Attachment 1**). Control N had 92.5 % survival. Control N (together with Control P) had the highest survival of all samples in the test. The following sample locations were found not to be statistically different when compared to Control N: A75CC (73.8% survival), Control P (91.3% survival), A60 (77.5% survival), A68 (70% survival), A72 (70% survival), A73 (73.8% survival), A75D (78.6% survival), A75EC (81.3% survival), Bbridge (86.3% survival), 32nd St (87.5% survival), Lcreek (73.8% survival) and A68 Dup (70% survival). The survival of A55 (60%), A56 (43.8%), Jranch (66.3%) and Pcliffs (31.3%) were all statistically different when compared to Control N.

Biomass

CETIS was used to perform Bonferroni Adjusted t Test comparisons of the negative control against Site samples to determine significant ($p \leq 0.05$) difference in observed biomass after 10 days of exposure (**Attachment 1**). Control N had a mean biomass of 78.1 $\pm$ 11.8 µg. When Control N was compared to Site samples, all locations (i.e. A75CC, A55, A56, A60, A68, A72, A73, A75D, A75EC, Bbridge, Jranch, 32nd St, Lcreek, Pcliffs and A68 Dup) were significantly lower. Note that the A75D-01 pan was compromised. It was not possible to run biomass for this pan.

Growth

Control N passed TAC with measurable growth and had a final average weight per organism of 84.4µg. Organisms in Control N had a growth increase of about 61.8 µg/organism when compared to the initial average weight of *H. azteca* (22.5 µg/organism).

Results consistently show that survival and biomass at locations A55, A56, Jranch and Pcliffs are significantly impacted when compared to the negative control. The following sample locations were determined to be significantly impacted for biomass but not survival when compared to the negative control: A75CC, A60, A68, A72, A73, A75D, A75EC, Bbridge, 32nd St, Lcreek, and A68 Dup. A75CC was originally designated as an upstream reference location but later found to be potentially impacted by mining-related contaminants.

5.0 REFERENCES

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Tables

Table 2.0-1 Test Conditions and Acceptability Criteria for 10 Day Sediment Toxicity Testing Using *H. azteca*

Parameter	Conditions
Test Type	Whole sediment toxicity test with renewal of overlying water
Temperature	23 +/- 1°C
Light Quality	Wide spectrum flourescent lights
Illuminance	100 to 1000 lux
Photoperiod	16 light 8 dark
Test Chamber	300 mL beaker
Sediment Volume	100 mL
Overlying Water Volume	175 mL
Renewal of Overlying Water	2 volumes per day
Age of Organisms	7-14 day old at start of test
Number of Organisms/chamber	10
Number of Replicates	8 for whole sediment; 4 for reference test
Feeding	YCT food fed 1.0 mL per day to each test chamber
Aeration	None
Overlying Water	Moderately Hard Reconstituted Water
Test Chamber Cleaning	Clean screens if clogged
Overlying Water Quality	Hardness, Alkalinity, Conductivity, pH, monitored at beginning and end of test, Temperature and Dissolved Oxygen monitored daily
Test Duration	10 days
Endpoints	Survival and growth
Test Acceptability	Minimum mean control survival of 80% and measurable growth of test organisms in the control sediment

Prepared by: BB 2/27/15
Reviewed by:

Table 2.5-1

Initial Feed Weight Data Sheet

November 2014 Animas River Sediment Toxicity Test Using *H. azteca*

10-Day Static Renewal

Feed Dry Weight Rep #1		
Weigh boat	1.5561	g
Weigh boat + 1 mL wet feed	2.5158	g
1 mL wet feed	0.9597	g
Weight boat + dry feed	1.5583	g
Dry feed	0.0022	g/mL
Dry feed	2.2	g/L

Feed Dry Weight Rep#2		
Weigh boat	1.533	g
Weigh boat + 1 mL wet feed	2.4735	g
1 mL wet feed	0.9405	g
Weight boat + dry feed	1.5351	g
Dry feed	0.0021	g/mL
Dry feed	2.1	g/L

Table 2.6-1

Initial *H. azteca* Weight Data Sheet

2014 November Animas River Sediment Toxicity Test

10-Day Static Renewal

Initial Dry Weight: 80 Organisms		
Weigh Boat (empty)	1.3097	g
Weigh Boat with 80 organisms (dried)	1.3115	g
Average Organism	22.5	µg

Table 3.1-1
November 2014 Animas River Sediment Toxicity Test Using *H. azteca*
Pore Water Dissolved Metals Results (ug/L)

Initial

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Hardness	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
A55	101	0.502J	3.01	106	<2.00U	1.09	49800	15.3	1.32	28.4	156	<100U	8.81	7700	21200	0.658J	3150	1.40J	<0.500U	18600	530	<0.500U	3.95	63.1
A56	136	0.530J	1.50J	72.1	<2.00U	1.62	48800	1.11J	1.07	67.5	155	<100U	8.72	7960	12100	1.13	2940	1.17J	0.636J	17500	500	<0.500U	<2.00U	190
A60	32.4J	0.600J	<0.500U	46.7	<2.00U	6.69	56700	1.27J	0.409	14.7	174	<100U	2.41	7960	3520	1.05	2540	<1.00U	<0.500U	17200	599	<0.500U	<2.00U	588
A68	35.6J	<0.500U	<0.500U	34.8	<2.00U	1.62	56100	<1.00U	0.121J	5.31	170	<100U	0.527	7270	512	<0.500U	2130	<1.00U	<0.500U	15200	587	<0.500U	<2.00U	230
A68Dup	22.5J	<0.500U	<0.500U	27.9	<2.00U	0.812	46100	<1.00U	<0.100U	3.43	140	<100U	0.418	5950	77.4	<0.500U	1800	<1.00U	<0.500U	14600	489	<0.500U	<2.00U	196
A72	23.9J	<0.500U	<0.500U	29.1	<2.00U	2.46	44000	<1.00U	1.21	3.37	143	<100U	0.191J	8130	3430	1.49	2080	<1.00U	<0.500U	19600	438	<0.500U	<2.00U	182
A73	24.4J	<0.500U	<0.500U	35.8	<2.00U	0.634	37400	<1.00U	0.125J	12.8	120	<100U	0.799	6440	55.4	1.04	1730	<1.00U	<0.500U	17800	370	<0.500U	<2.00U	220
A75CC	42.9J	<0.500U	2.45	260	<2.00U	<0.100U	66600	2.69	2.52	1.24	231	<100U	0.116J	15800	3020	1.02	3560	1.43J	<0.500U	21000	421	<0.500U	<2.00U	15.7J
A75D	28.0J	<0.500U	<0.500U	40.9	<2.00U	1.62	39100	<1.00U	0.814	4.05	127	<100U	0.299	7100	2320	0.716J	2780	<1.00U	<0.500U	17300	365	<0.500U	<2.00U	157
A75EC	137	<0.500U	2.92	230	<2.00U	0.121J	26600	1.33J	12.0	1.68	117	<100U	0.196J	12300	11000	19.5	3790	1.87J	<0.500U	15500	191	0.756J	<2.00U	15.0J
Animas@32nd Bridge	56.9	<0.500U	0.964J	70.5	<2.00U	<0.100U	46000	1.21J	0.719	2.10	150	<100U	0.599	8680	3990	<0.500U	3710	<1.00U	<0.500U	20000	460	<0.500U	<2.00U	29.6
Animas@Lightner Creek	40.5J	<0.500U	0.608J	62.1	<2.00U	<0.100U	41000	<1.00U	0.585	1.11	144	<100U	0.207	10200	671	1.22	2700	<1.00U	<0.500U	23100	378	<0.500U	<2.00U	12.6J
Animas@Purple Cliffs	21.8J	<0.500U	0.616J	58.6	<2.00U	<0.100U	36600	1.13J	0.391	1.26	122	<100U	0.152J	7340	219	1.19	2440	<1.00U	<0.500U	19300	322	<0.500U	<2.00U	15.4J
Bbridge	138	<0.500U	0.665J	58.4	<2.00U	1.35	43200	<1.00U	1.19	7.82	145	<100U	0.632	9050	4280	1.16	4030	<1.00U	<0.500U	18500	357	<0.500U	<2.00U	67.8
James Ranch	154	<0.500U	0.965J	50.8	<2.00U	1.28	46900	<1.00U	1.25	7.94	157	141J	0.766	9630	4520	<0.500U	3100	<1.00U	<0.500U	19900	344	<0.500U	<2.00U	59.2
N-Control	83.6	<5.00U	5.01JD	<50.0U	<2.00U	<1.00U	322000	<10.0U	6.45D	16.9D	1240	<100U	<1.00U	105000	822	<5.00U	21000	10.5JD	<5.00U	357000	1730	<5.00U	<20.0U	21.0
P-Control	108	<5.00U	6.86JD	<50.0U	<2.00U	<1.00U	389000	<10.0U	9.65D	22.6D	1550	<100U	<1.00U	140000	1040	10.4D	27600	16.1JD	<5.00U	485000	2140	<5.00U	<20.0U	37.1

Final

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Hardness	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
A55	166	1.08	2.44	118	<2.00U	1.47	29400	2.27	0.536	59.4	99	<100U	33.3	6290	13300	<0.500U	3800	1.19J	<0.500U	24800	372	<0.500U	<2.00U	54.0
A56	64.5	0.552J	1.03J	52.9	<2.00U	1.08	33500	1.82J	0.466	45.5	114	<100U	8.78	7450	8210	<0.500U	3270	1.07J	<0.500U	20400	355	<0.500U	<2.00U	60.7
A60	37.4J	0.554J	1.03J	58.4	<2.00U	12.4	84200	3.11	0.574	11.7	263	<100U	2.51	12700	11700	<0.500U	3590	1.03J	<0.500U	26500	792	<0.500U	<2.00U	1100
A68	<20.0U	<0.500U	<0.500U	35.1	<2.00U	1.12	53600	1.77J	<0.100U	3.84	162	<100U	0.116J	6780	234	<0.500U	2420	<1.00U	<0.500U	23300	588	<0.500U	<2.00U	232
A68 Dup	23.0J	<0.500U	<0.500U	38.8	<2.00U	1.89	62000	1.81J	<0.100U	5.17	186	<100U	0.203	7530	806	<0.500U	2640	<1.00U	<0.500U	22900	658	<0.500U	<2.00U	253
A72	37.7J	<0.500U	<0.500U	40.5	<2.00U	2.58	70300	<1.00U	3.08	3.38	218	281	<0.100U	10400	13100	<0.500U	2940	<1.00U	<0.500U	26900	688	<0.500U	<2.00U	217
A73	21.1J	<0.500U	<0.500U	42.9	<2.00U	0.968	42400	<1.00U	0.125J	2.36	131	<100U	0.170J	6000	158	1.59	2040	<1.00U	<0.500U	23100	435	<0.500U	<2.00U	298
A75CC	45.0J	<2.50U	8.40JD	617D	<2.00U	<0.500U	129000	5.14JD	8.14D	<2.50U	438	8700	<0.500U	28300	9140	<2.50U	9280	<5.00U	<2.50U	27900	856	<2.50U	<10.0U	21.3
A75D	<20.0U	<0.500U	<0.500U	47.1	<2.00U	1.97	49900	<1.00U	0.777	4.26	155	<100U	0.137J	7430	3150	<0.500U	3390	<1.00U	<0.500U	20300	477	<0.500U	<2.00U	191
A75EC	70.9	<0.500U	3.98	334	<2.00U	<0.100U	29600	3.36	17.6	1.57	139	867	<0.100U	15700	21800	9.34	4510	2.48	<0.500U	27200	220	<0.500U	<2.00U	<10.0U
Animas@32nd Bridge	37.0J	<0.500U	0.616J	79.1	<2.00U	0.290	59500	<1.00U	0.685	2.24	192	<100U	0.309	10600	4090	<0.500U	3480	<1.00U	<0.500U	28400	548	<0.500U	<2.00U	33.4
Animas@Lightner Creek	35.8J	<0.500U	1.26J	101	<2.00U	<0.100U	62400	<1.00U	1.32	1.63	223	<100U	0.123J	16400	1760	<0.500U	3480	1.49J	<0.500U	34500	617	<0.500U	<2.00U	18.9J
Animas@Purple Cliffs	22.3J	0.715J	1.39J	131	<2.00U	<0.100U	62200	<1.00U	0.708	2.21	213	<100U	0.159J	14000	324	0.696J	4060	1.02J	<0.500U	32900	526	<0.500U	<2.00U	16.4J
Bbridge	72.4	<0.500U	1.01J	97.6	<2.00U	0.479	53800	<1.00U	1.18	8.89	182	<100U	1.31	11600	4970	<0.500U	6410	1.47J	<0.500U	27300	476	<0.500U	<2.00U	32.7
James Ranch	89.8	<0.500U	2.74	116	<2.00U	0.408	55500	<1.00U	1.73	18.2	187	<100U	0.991	11800	9300	<0.500U	5450	3.33	<0.500U	25400	467	<0.500U	<2.00U	36.4
N-Control	74.6	<5.00U	13.1JD	<50.0U	<2.00U	<1.00U	360000	<10.0U	15.5D	10.6D	1390	4050	1.38JD	120000	7940	19.3D	18600	12.6JD	<5.00U	369000	2040	<5.00U	<20.0U	28.0
P-Control	40.8J	<5.00U	9.72JD	<50.0U	<2.00U	<1.00U	233000	<10.0U	9.54D	6.70JD	857	1260	<1.00U	66600	4760	11.6D	9920	<10.0U	<5.00U	159000	1300	<5.00U	<20.0U	137

Note: Data Qualifier Definitions Listed Below:
D = The analyte was diluted prior to analysis.
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Prepared by: B. Belmonte 2/26/15
Reviewed by: E. Seiler 3/5/15

Table 3.1-2
November 2014 Animas River Sediment Toxicity Test Using *H. azteca*
Overlying Water Dissolved Metals-Analytical Results (ug/L)

Initial

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
A55	193	<0.500U	2.51	109	<2.00U	0.663	36700	2.85	1.05	17.9	<100U	8.69	8730	14400	0.736J	2820	1.28J	<0.500U	21700	380	<0.500U	<2.00U	83.4
A56	181	<0.500U	0.593J	58.1	<2.00U	1.96	31800	1.41J	0.693	21.0	<100U	5.48	8970	6640	0.827J	2470	<1.00U	<0.500U	22100	312	<0.500U	<2.00U	117
A60	47.5J	0.669J	<0.500U	27.7	<2.00U	4.35	34700	<1.00U	0.197J	17.9	<100U	2.34	8460	944	0.519J	2220	<1.00U	<0.500U	22100	346	<0.500U	<2.00U	211
A68	64.7	<0.500U	<0.500U	17.5	<2.00U	0.482	31400	1.21J	<0.100U	3.08	<100U	0.561	8750	104	<0.500U	1940	<1.00U	<0.500U	22200	300	<0.500U	<2.00U	47.0
A68 Dup	38.6J	<0.500U	<0.500U	11.2	<2.00U	0.205	22200	1.19J	<0.100U	1.43	<100U	0.292	9380	15.0	<0.500U	1880	<1.00U	<0.500U	23400	194	<0.500U	<2.00U	43.5
A72	26.2J	<0.500U	<0.500U	18.1	<2.00U	1.11	29000	<1.00U	0.543	3.42	<100U	0.192J	9250	1490	0.737J	2010	<1.00U	<0.500U	23400	267	<0.500U	<2.00U	61.3
A73	23.0J	<0.500U	<0.500U	17.3	<2.00U	0.303	24800	<1.00U	<0.100U	4.95	<100U	0.451	9000	13.2	0.560J	1870	<1.00U	<0.500U	23300	212	<0.500U	<2.00U	70.6
A75CC	50.2	<0.500U	1.23J	153	<2.00U	<0.100U	44800	1.09J	0.641	1.21	<100U	<0.100U	12500	43.2	0.759J	2900	<1.00U	<0.500U	22700	281	<0.500U	<2.00U	12.2J
A75D	44.4J	<0.500U	<0.500U	23.6	<2.00U	0.744	25400	<1.00U	0.364	2.55	<100U	0.215	8600	1020	<0.500U	2430	<1.00U	<0.500U	23000	220	<0.500U	<2.00U	40.1
A75EC	249	<0.500U	0.913J	124	<2.00U	0.108J	18700	<1.00U	4.51	1.79	<100U	0.157J	11100	4800	7.31	2770	<1.00U	<0.500U	23100	126	<0.500U	<2.00U	13.3J
Animas@32nd Bridge	58.0	<0.500U	<0.500U	43.5	<2.00U	0.115J	34800	<1.00U	0.138J	2.31	<100U	0.483	8880	247	0.696J	2940	<1.00U	<0.500U	22900	319	<0.500U	<2.00U	24.5
Animas@Lightner Creek	37.8J	<0.500U	0.509J	52.9	<2.00U	<0.100U	38700	1.52J	0.191J	1.09	<100U	<0.100U	10300	135	0.613J	2610	<1.00U	<0.500U	23200	339	<0.500U	<2.00U	<10.0U
Animas@Purple Cliffs	<20.0U	<0.500U	<0.500U	53.3	<2.00U	<0.100U	32700	1.02J	0.110J	0.945J	<100U	<0.100U	7120	12.8	<0.500U	2170	<1.00U	<0.500U	18800	277	<0.500U	<2.00U	11.5J
Bbridge	121	<0.500U	<0.500U	41.4	<2.00U	1.12	31900	<1.00U	0.744	6.58	<100U	0.279	8930	2130	<0.500U	3200	<1.00U	<0.500U	21600	260	<0.500U	<2.00U	43.7
James Ranch	133	<0.500U	0.644J	36.3	<2.00U	1.21	35900	1.08J	0.748	6.44	<100U	0.431	9370	2020	<0.500U	2940	<1.00U	<0.500U	22400	256	<0.500U	<2.00U	43.6
N-Control	29.7J	<2.50U	<2.50U	36.9JD	<2.00U	<0.500U	101000	<5.00U	1.03D	5.83D	<100U	<0.500U	25500	85.7	<2.50U	7670	<5.00U	<2.50U	84300	545	<2.50U	<10.0U	11.9J
P-Control	27.1J	<0.500U	1.35J	30.0	<2.00U	<0.100U	89200	1.03J	1.04	5.02	<100U	<0.100U	24100	94.7	<0.500U	7110	2.22	<0.500U	73700	493	<0.500U	<2.00U	13.1J
Ref 100%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	12700	1.20J	<0.100U	1.21	<100U	<0.100U	11600	<2.00U	<0.500U	2160	<1.00U	<0.500U	25500	79.4	<0.500U	<2.00U	1000
Ref. 12.5%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	12800	1.49J	<0.100U	1.08	<100U	<0.100U	11700	<2.00U	<0.500U	2160	<1.00U	<0.500U	25700	79.9	<0.500U	<2.00U	139
Ref. 25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	12800	1.38J	<0.100U	1.19	<100U	<0.100U	11700	<2.00U	<0.500U	2170	<1.00U	<0.500U	25800	79.6	<0.500U	<2.00U	256
Ref. 50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	12700	1.27J	<0.100U	1.32	<100U	<0.100U	11600	<2.00U	<0.500U	2130	<1.00U	<0.500U	26000	79.4	<0.500U	<2.00U	489
Ref. 6.25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	12800	1.60J	<0.100U	1.30	<100U	<0.100U	11700	<2.00U	<0.500U	2170	<1.00U	<0.500U	25700	79.7	<0.500U	<2.00U	77.5
Ref. control	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	13100	1.25J	<0.100U	0.957J	<100U	<0.100U	11700	<2.00U	<0.500U	2080	<1.00U	<0.500U	25400	79.1	<0.500U	<2.00U	<10.0U

Final

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
A55	<20.0U	<0.500U	0.572J	16.6	<2.00U	0.101J	18200	<1.00U	<0.100U	4.07	<100U	0.784	11000	434	<0.500U	2720	<1.00U	<0.500U	26600	150	<0.500U	<2.00U	17.7J
A56	<20.0U	<0.500U	<0.500U	14.7	<2.00U	0.126J	19600	1.32J	<0.100U	2.97	<100U	<0.100U	11800	38.7	<0.500U	2730	<1.00U	<0.500U	27500	151	<0.500U	<2.00U	13.5J
A60	<20.0U	<0.500U	<0.500U	12.1	<2.00U	0.186J	19700	1.43J	<0.100U	2.45	<100U	<0.100U	12100	10.8	<0.500U	2590	<1.00U	<0.500U	27600	153	<0.500U	<2.00U	34.4
A68	<20.0U	<0.500U	<0.500U	10.5	<2.00U	<0.100U	19600	<1.00U	<0.100U	2.20	<100U	<0.100U	12100	<2.00U	<0.500U	2510	<1.00U	<0.500U	27400	149	<0.500U	<2.00U	26.4
A68 Dup	<20.0U	<0.500U	<0.500U	9.83J	<2.00U	<0.100U	18200	2.23	<0.100U	3.01	<100U	<0.100U	11400	<2.00U	<0.500U	2420	<1.00U	<0.500U	25900	145	<0.500U	<2.00U	27.4
A72	<20.0U	<0.500U	<0.500U	9.92J	<2.00U	<0.100U	18500	<1.00U	<0.100U	1.50	<100U	<0.100U	11900	13.3	<0.500U	2430	<1.00U	<0.500U	26700	134	<0.500U	<2.00U	10.3J
A73	<20.0U	<0.500U	<0.500U	9.83J	<2.00U	<0.100U	17300	<1.00U	<0.100U	1.79	<100U	<0.100U	12200	3.43J	<0.500U	2510	<1.00U	<0.500U	28300	119	<0.500U	<2.00U	10.8J
A75CC	<20.0U	<0.500U	1.33J	48.4	<2.00U	<0.100U	24000	1.09J	<0.100U	0.560J	<100U	<0.100U	13000	85.2	<0.500U	3120	<1.00U	<0.500U	27300	147	<0.500U	<2.00U	<10.0U
A75D	<20.0U	<0.500U	<0.500U	11.6	<2.00U	<0.100U	17900	1.22J	<0.100U	1.91	<100U	<0.100U	12000	<2.00U	<0.500U	2660	<1.00U	<0.500U	27500	126	<0.500U	<2.00U	11.9J
A75EC	21.4J	<0.500U	<0.500U	36.9	<2.00U	<0.100U	16000	<1.00U	0.188J	1.36	<100U	<0.100U	12300	35.8	0.876J	2600	<1.00U	<0.500U	26700	96.7	<0.500U	<2.00U	<10.0U
Animas@32nd Bridge	<20.0U	<0.500U	<0.500U	21.0	<2.00U	<0.100U	21400	1.24J	<0.100U	1.33	<100U	<0.100U	12100	14.9	<0.500U	2760	<1.00U	<0.500U	28100	153	<0.500U	<2.00U	<10.0U
Animas@Lightner Creek	27.4J	<0.500U	<0.500U	37.8	<2.00U	<0.100U	27800	<1.00U	<0.100U	1.30	<100U	<0.100U	12100	2.01J	<0.500U	2560	<1.00U	<0.500U	27000	196	<0.500U	<2.00U	<10.0U
Animas@Purple Cliffs	<20.0U	<0.500U	0.700J	45.5	<2.00U	<0.100U	26600	<1.00U	<0.100U	1.32	<100U	<0.100U	10700	<2.00U	<0.500U	2310	<1.00U	<0.500U	24200	182	<0.500U	<2.00U	<10.0U
Bbridge	39.1J	<0.500U	<0.500U	19.4	<2.00U	<0.100U	19300	<1.00U	<0.100U	1.94	<100U	<0.100U	11200	<2.00U	<0.500U	2650	<1.00U	<0.500U	24700	135	<0.500U	<2.00U	15.1J
James Ranch	32.8J	<0.500U	<0.500U	17.9	<2.00U	<0.100U	21300	<1.00U	<0.100U	2.10	<100U	<0.100U	12000	<2.00U	<0.500U	2730	<1.00U	<0.500U	26600	140	<0.500U	<2.00U	13.6J
N-Control	<20.0U	<0.500U	0.560J	23.9	<2.00U	<0.100U	30900	<1.00U	0.124J	1.68	<100U	<0.100U	14800	<2.00U	<0.500U	3370	<1.00U	<0.500U	37500	185	<0.500U	<2.00U	<10.0U
P-Control	<20.0U	<0.500U	<0.500U	24.0	<2.00U	<0.100U	30900	<1.00U	0.140J	1.82	<100U	<0.100U	15000	7.71	0.500J	3390	<1.00U	<0.500U	38200	187	<0.500U	<2.00U	315
Ref. control	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	15400	1.42J	<0.100U	2.40	<100U	<0.100U	13000	<2.00U	10.7	3340	<1.00U	<0.500U	28800	92.4	<0.500U	<2.00U	15.6J
Ref. 6.25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	15900	1.55J	<0.100U	6.23	<100U	<0.100U	12900	<2.00U	2.41	3050	<1.00U	<0.500U	28500	92.8	<0.500U	<2.00U	56.2
Ref. 12.5%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	15600	1.13J	<0.100U	3.58	<100U	<0.100U	12600	<2.00U	1.19	2970	<1.00U	<0.500U	28100	93.0	<0.500U	<2.00U	127
Ref. 25%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	15900	1.14J	<0.100U	1.60	<100U	0.108J	13000	<2.00U	1.14	3010	<1.00U	<0.500U	28600	92.8	<0.500U	<2.00U	251
Ref. 50%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	15100	1.24J	<0.100U	1.86	<100U	<0.100U	12500	<2.00U	1.24	2970	<1.00U	<0.500U	28500	91.6	<0.500U	<2.00U	439
Ref 100%	<20.0U	<0.500U	<0.500U	<5.00U	<2.00U	<0.100U	15000	<1.00U	<0.100U	2.11	<100U	<0.100U	12200	<2.00U	1.13	2770	<1.00U	<0.500U	27700	90.9	<0.500U	<2.00U	854

Note: Data Qualifier Definitions Listed Below:
D = The analyte was diluted prior to analysis.
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Prepared by: B. Belmonte 2/26/15
Reviewed by: E. Seiler 3/5/15

Table 3.1-3
November 2014 Animas River Sediment Toxicity Test Using *H. azteca*
Overlying Water Total Metals-Analytical Results (ug/L)

Initial

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
A55	3440	<2.50U	4.41JD	125D	2.15J	3.99D	36100	<5.00U	2.04D	163D	2510	142D	9230	14800	<2.50U	3250	<5.00U	<2.50U	22300	389	10.5D	<10.0U	621
A56	2250	<2.50U	2.95JD	73.8D	<2.00U	3.26D	35400	<5.00U	1.59D	133D	2100	116D	9140	5440	4.11JD	3020	<5.00U	<2.50U	21600	359	<2.50U	<10.0U	582
A60	1510	<2.50U	<2.50U	42.6JD	<2.00U	5.72D	34400	<5.00U	0.723JD	76.3D	1790	117D	8740	1190	<2.50U	2630	<5.00U	<2.50U	22100	349	3.13JD	<10.0U	426
A68	1780	<2.50U	<2.50U	33.2JD	<2.00U	0.871JD	30800	<5.00U	0.610JD	28.0D	2210	48.4D	9010	350	<2.50U	2420	<5.00U	<2.50U	22000	304	<2.50U	<10.0U	269
A68 Dup	4670	<2.50U	7.95JD	59.0D	<2.00U	3.48D	22600	<5.00U	2.56D	85.4D	8420	215D	10400	2860	2.75JD	2950	<5.00U	<2.50U	23100	212	<2.50U	<10.0U	1250
A72	1810	<2.50U	3.14JD	29.4JD	<2.00U	1.45D	28300	<5.00U	1.29D	32.1D	4880	30.6D	9330	1540	<2.50U	2260	<5.00U	<2.50U	23100	268	<2.50U	<10.0U	147
A73	1160	<2.50U	<2.50U	29.7JD	<2.00U	<0.500U	24800	<5.00U	0.907JD	17.9D	3830	29.1D	8990	188	<2.50U	2080	<5.00U	<2.50U	23100	220	<2.50U	<10.0U	128
A75CC	1750	<2.50U	<2.50U	180D	<2.00U	<0.500U	44300	<5.00U	1.86D	4.22JD	1530	2.23D	12900	414	<2.50U	3320	<5.00U	<2.50U	22700	284	<2.50U	<10.0U	24.9
A75D	1440	<2.50U	4.45JD	33.5JD	<2.00U	1.32D	25200	<5.00U	1.18D	19.2D	3050	23.5D	8720	1210	<2.50U	2680	<5.00U	<2.50U	23000	223	<2.50U	<10.0U	172
A75EC	2680	<2.50U	2.65JD	135D	<2.00U	1.48D	18600	<5.00U	10.7D	8.05D	1170	2.42D	11200	4770	17.0D	2910	<5.00U	<2.50U	23100	127	<2.50U	<10.0U	60.3
Animas@32nd Bridge	1810	<2.50U	<2.50U	60.3D	<2.00U	1.84D	35200	7.02JBD	1.53D	31.6D	2400	38.6D	9250	846	<2.50U	3280	<5.00U	<2.50U	23000	327	<2.50U	<10.0U	216
Animas@Lightner Creek	1590	<2.50U	<2.50U	71.2D	<2.00U	<0.500U	40800	<5.00U	1.03D	7.07D	2110	8.58D	10400	267	3.08JD	3020	<5.00U	<2.50U	22400	344	<2.50U	<10.0U	78.3
Animas@Purple Cliffs	2150	<2.50U	<2.50U	87.1D	<2.00U	<0.500U	33800	6.03JBD	0.870JD	4.75JD	2360	5.95D	7650	87.3	<2.50U	2870	<5.00U	<2.50U	19100	289	<2.50U	<10.0U	36.6
Bbridge	5120	<2.50U	5.06JD	64.5D	<2.00U	2.93D	32500	<5.00U	2.40D	53.2D	9070	52.2D	9220	2510	2.54JD	3580	<5.00U	<2.50U	21500	271	10.1D	<10.0U	476
James Ranch	4350	<2.50U	3.31JD	56.7D	<2.00U	2.82D	36100	<5.00U	2.22D	45.8D	7330	46.9D	9800	2400	<2.50U	3170	<5.00U	<2.50U	22700	266	3.08JD	<10.0U	412
N-Control	432	<5.00U	<5.00U	<50.0U	<2.00U	<1.00U	99700	<10.0U	1.33JD	6.35JD	402	25.2D	25300	100	<5.00U	7720	<10.0U	<5.00U	83300	545	<5.00U	<20.0U	13.9J
P-Control	861	<5.00U	9.00JD	<50.0U	<2.00U	<1.00U	88800	<10.0U	1.52JD	6.90JD	986	1.64JD	23900	120	<5.00U	7140	<10.0U	<5.00U	74000	489	<5.00U	<20.0U	23.0
Ref. control	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12900	<5.00U	<0.500U	<2.50U	<100U	<0.500U	11600	<2.00U	<2.50U	2080	<5.00U	<2.50U	25300	79.1	<2.50U	<10.0U	<10.0U
Ref. 6.25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	13000	6.44JD	<0.500U	<2.50U	<100U	<0.500U	11700	<2.00U	<2.50U	2110	<5.00U	<2.50U	25500	79.6	<2.50U	<10.0U	71.8
Ref. 12.5%	<20.0U	<2.50U	2.88JD	<25.0U	<2.00U	<0.500U	12600	6.05JD	<0.500U	<2.50U	<100U	<0.500U	11300	<2.00U	<2.50U	2060	<5.00U	<2.50U	24900	78.7	<2.50U	<10.0U	134
Ref. 25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12800	5.75JD	<0.500U	<2.50U	<100U	0.954JD	11600	<2.00U	<2.50U	2110	<5.00U	<2.50U	25400	79.0	<2.50U	<10.0U	244
Ref. 50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12800	6.52JD	<0.500U	<2.50U	<100U	<0.500U	11600	<2.00U	<2.50U	2100	<5.00U	<2.50U	25600	79.3	<2.50U	<10.0U	468
Ref 100%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	12900	<5.00U	<0.500U	<2.50U	<100U	<0.500U	11500	<2.00U	<2.50U	2080	<5.00U	<2.50U	25200	78.8	<2.50U	<10.0U	946

Final

STATION_ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Vanadium	Zinc
A55	33.8J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	19600	7.41JD	<0.500U	8.47D	<100U	3.51D	11600	442	<2.50U	2910	<5.00U	<2.50U	28000	157	9.12D	<10.0U	16.2J
A56	223	<2.50U	<2.50U	32.9JD	<2.00U	<0.500U	21000	8.06JD	<0.500U	7.47D	941	83.8D	12300	133	<2.50U	2890	<5.00U	<2.50U	28000	160	2.81JD	<10.0U	34.5
A60	21.3J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	21000	7.74JD	<0.500U	3.58JD	<100U	<0.500U	12600	12.7	<2.50U	2730	<5.00U	<2.50U	28400	159	<2.50U	<10.0U	28.1
A68	29.4J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	20400	5.40JD	<0.500U	2.74JD	<100U	<0.500U	12400	2.41J	<2.50U	2670	<5.00U	<2.50U	27900	154	<2.50U	<10.0U	23.4
A68 Dup	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	19400	5.96JD	<0.500U	<2.50U	<100U	<0.500U	12100	2.46J	<2.50U	2560	<5.00U	<2.50U	27800	149	<2.50U	<10.0U	25.1
A72	30.3J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	19200	6.36JD	<0.500U	<2.50U	<100U	<0.500U	12100	13.6	<2.50U	2520	<5.00U	<2.50U	27300	137	<2.50U	<10.0U	<10.0U
A73	24.7J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	18300	6.96JD	<0.500U	<2.50U	<100U	<0.500U	12400	2.19J	<2.50U	2550	<5.00U	<2.50U	28500	123	<2.50U	<10.0U	<10.0U
A75CC	<20.0U	<2.50U	<2.50U	55.0D	<2.00U	<0.500U	25500	6.82JD	<0.500U	<2.50U	155J	<0.500U	13500	112	<2.50U	3220	<5.00U	<2.50U	27700	153	<2.50U	<10.0U	<10.0U
A75D	25.2J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	19200	7.42JD	<0.500U	2.70JD	<100U	<0.500U	12400	<2.00U	<2.50U	2730	<5.00U	<2.50U	28100	131	<2.50U	<10.0U	12.8J
A75EC	39.6J	<2.50U	<2.50U	36.7JD	<2.00U	<0.500U	17400	7.85JD	<0.500U	<2.50U	<100U	<0.500U	13200	39.3	<2.50U	2780	<5.00U	<2.50U	28500	103	<2.50U	<10.0U	<10.0U
Animas@32nd Bridge	21.7J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	22100	6.22JD	<0.500U	<2.50U	<100U	<0.500U	12800	29.3	<2.50U	3120	<5.00U	<2.50U	29400	158	<2.50U	<10.0U	<10.0U
Animas@Lightner Creek	63.5	<2.50U	<2.50U	32.3JD	<2.00U	<0.500U	28800	5.58JD	<0.500U	<2.50U	<100U	<0.500U	12200	6.24	<2.50U	2560	<5.00U	<2.50U	27000	198	<2.50U	<10.0U	<10.0U
Animas@Purple Cliffs	696	<2.50U	<2.50U	49.3JD	<2.00U	<0.500U	28900	7.43JD	<0.500U	2.78JD	587	1.35D	11500	14.0	<2.50U	2670	<5.00U	<2.50U	25800	194	<2.50U	<10.0U	10.3J
Bbridge	55.9	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	20200	7.55JD	<0.500U	<2.50U	<100U	<0.500U	11500	7.90	<2.50U	2740	<5.00U	<2.50U	25400	138	<2.50U	<10.0U	11.8J
James Ranch	38.9J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	21700	5.74JD	<0.500U	<2.50U	<100U	<0.500U	12000	3.01J	<2.50U	2730	<5.00U	<2.50U	26600	141	9.69D	<10.0U	<10.0U
N-Control	54.0	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	31800	7.02JD	<0.500U	<2.50U	<100U	<0.500U	14900	<2.00U	<2.50U	3340	<5.00U	<2.50U	37600	187	2.84JD	<10.0U	<10.0U
P-Control	63.2	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	31600	7.47JD	<0.500U	<2.50U	<100U	<0.500U	15100	9.26	<2.50U	3350	<5.00U	<2.50U	38600	188	<2.50U	<10.0U	299
Ref. control	<20.0U	<2.50U	3.58JD	<25.0U	<2.00U	<0.500U	15600	<5.00U	<0.500U	<2.50U	<100U	<0.500U	12300	2.36J	<2.50U	2860	<5.00U	<2.50U	28300	93.8	<2.50U	<10.0U	812
Ref. 6.25%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	16600	5.59JD	<0.500U	4.38JD	<100U	0.943JD	13100	<2.00U	<2.50U	3070	<5.00U	<2.50U	28700	95.5	<2.50U	<10.0U	126
Ref. 12.5%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	16500	6.32JD	<0.500U	<2.50U	<100U	<0.500U	13100	<2.00U	<2.50U	3020	<5.00U	<2.50U	28700	94.9	<2.50U	<10.0U	238
Ref. 25%	25.7J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	15800	7.10JD	<0.500U	<2.50U	<100U	<0.500U	12700	2.31J	<2.50U	2920	<5.00U	<2.50U	28800	94.2	<2.50U	<10.0U	413
Ref. 50%	<20.0U	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	16800	7.48JD	<0.500U	<2.50U	<100U	<0.500U	13300	2.11J	<2.50U	3130	<5.00U	<2.50U	29200	96.9	<2.50U	<10.0U	67.5
Ref 100%	22.2J	<2.50U	<2.50U	<25.0U	<2.00U	<0.500U	15900	7.24JD	<0.500U	<2.50U	<100U	<0.500U	13200	<2.00U	8.62D	3340	<5.00U	<2.50U	29400	94.7	<2.50U	<10.0U	<10.0U

Note: Data Qualifier Definitions Listed Below:
D = The analyte was diluted prior to analysis.
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Prepared by: B. Belmonte 2/26/15
Reviewed by: E. Seiler 3/5/15

Table 3.1-4
November 2014 Animas River Sediment Toxicity Test Using *H. azteca*
Initial Total Recoverable Metals Results

Station ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thalium	Vanadium	Zinc
	mg/kg dry wt	ug/kg dry wt	ug/kg dry wt	ug/kg dry wt	mg/kg dry wt	ug/kg dry wt	mg/kg dry wt	ug/kg dry wt	ug/kg dry wt	ug/kg dry wt	mg/kg dry wt	ug/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	ug/kg dry wt	mg/kg dry wt	ug/kg dry wt	ug/kg dry wt	mg/kg dry wt	mg/kg dry wt	ug/kg dry wt	ug/kg dry wt	mg/kg dry wt
A55	7790D	1670D	18000D	102000D	<1.98U	7660D	2900D	3520D	10800D	203000D	20900D	1230000D	4440D	6660D	0.04D	5650D	432JD	<992U	2990D	<248U	37.6D	<496U	13700D	1920D
A56	9310D	1640D	20200D	129000D	2.94JD	11600D	3550D	3600D	13200D	244000D	21700D	1180000D	4450D	9250D	0.06D	7130D	422JD	<1000U	3620D	<251U	37.5D	1110D	13400D	3220D
A60	7730D	2190D	20400D	91700D	<2.03U	9550D	2730D	3880D	11000D	262000D	23400D	1610000D	4690D	7460D	0.07D	6260D	423JD	<1020U	5960D	<254U	27.2D	<508U	14300D	2130D
A68	7700D	1760D	17500D	128000D	<1.97U	10800D	3040D	3730D	12100D	216000D	24000D	1240000D	4590D	9430D	0.02JD	6560D	423JD	<985U	2900D	<246U	30.5D	<492U	14800D	2480D
A72	9960D	1390D	26800D	93200D	<2.03U	3030D	1970D	3010D	13600D	133000D	42000D	499000D	3580D	3400D	0.05D	5330D	521JD	<1020U	1830D	<254U	40.6D	<508U	16400D	858D
A73	6770D	1510D	20500D	92800D	<2.04U	2700D	1870D	3500D	10800D	113000D	36800D	435000D	3610D	2780D	0.02JD	5500D	522JD	<1020U	1240D	<255U	32.9D	<509U	16300D	749D
A75CC	4740D	<500U	3080D	93000D	<2.00U	164JD	5150D	6690D	5670D	7890D	9700D	5210D	3880D	376D	<0.01U	7310BD	834JD	<1000U	<500U	<250U	17.8D	<500U	11200D	45.3D
A75D	7660D	1220D	17500D	107000D	<2.03U	3730D	2150D	3720D	17200D	103000D	30800D	339000D	3580D	3750D	<0.02U	8200BD	638JD	<1020U	948JD	<254U	35.0D	1140D	14500D	1080D
A75EC	6560D	<508U	6550D	50700D	<2.03U	714D	952D	7290D	24000D	13000D	14400D	5290D	2460D	708D	<0.02U	37900BD	632JD	<1020U	<508U	<254U	4.73JD	552JD	7780D	142D
Animas @32nd Bridge	5210D	644JD	8710D	78500D	<2.03U	2100D	2740D	4440D	8730D	55000D	15300D	186000D	2970D	2220D	<0.02U	9770BD	523JD	<1020U	1210D	<254U	23.8D	<508U	11300D	810D
Animas @Lightner Creek	4710D	772JD	10300D	153000D	<2.01U	3200D	71200D	5380D	7440D	41300D	17800D	92400D	6550D	1150D	0.04D	19500BD	708JD	1180JD	569JD	<252U	260D	<504U	19900D	529D
Animas @Purple Cliffs	4470D	<494U	6840D	163000D	<1.98U	1100D	32700D	4190D	5150D	19000D	14600D	35500D	6250D	399D	0.04D	10700BD	723JD	<989U	<494U	<247U	121D	<494U	13300D	157D
Bbridge	8040D	863JD	16200D	119000D	<1.99U	4630D	4070D	4740D	17200D	92000D	27200D	244000D	3640D	3970D	0.02JD	12100BD	741JD	<997U	1020D	<249U	39.6D	<499U	15000D	1700D
JamesRanch	10600D	927JD	18900D	128000D	<2.02U	4970D	3830D	4830D	17800D	108000D	29900D	290000D	3840D	4250D	0.04D	11900BD	839JD	<1010U	1260D	<252U	39.1D	<504U	15500D	1730D

Note: Data Qualifier Definitions Listed Below:
D = The analyte was diluted prior to analysis.
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Prepared by: B. Belmonte 3/4/15
Reviewed by: E. Seiler 3/5/15

Table 3.1-5
Initial and Final Average Ammonia Results
November 2014 Animas River Sediment Toxicity Test Using *H. azteca*

Site/ Replicate ID	Initial Measured Ammonia Conc. (mg N/L)	Initial Measured pH	Initial Average Measured Ammonia Conc. ± SD (mg N/L)	Initial Average Measured pH	Initial Ammonia Criterion (mg N/L)[a]	Final Measured Ammonia Conc. (mg N/L)[b]	Final Measured pH[b]	Final Average Measured Ammonia Conc. ± SD (mg N/L)	Final Average Measured pH	Final Ammonia Criterion (mg N/L)[a]
Control-N-01	1.11	7.06	1.19 ± 0.22	7.24	18.95	0.48	7.16	0.36 ± 0.07	7.24	18.86
Control-N-02	0.962	7.2				0.443	7.14			
Control-N-03	1.36	7.21				0.392	7.19			
Control-N-04	1.19	7.25				0.305	7.23			
Control-N-05	1.12	7.21				0.34	7.27			
Control-N-06	0.982	7.31				0.262	7.3			
Control-N-07	1.63	7.31				0.36	7.31			
Control-N-08	1.18	7.33				0.299	7.31			
A75CC-01	0.0505	6.99	0.03 ± 0.01	6.78	28.36	0.256	6.97	0.26 ± 0.05	7.06	22.87
A75CC-02	0.0384	7.04				0.308	7.01			
A75CC-03	**0.015**	7.09				0.239	7.04			
A75CC-04	**0.015**	7.12				0.326	7.05			
A75CC-05	0.0305	4.33				0.333	7.1			
A75CC-06	**0.015**	7.21				0.238	7.08			
A75CC-07	0.0333	7.23				0.226	7.11			
A75CC-08	**0.015**	7.25				0.179	7.1			
Control P-01	1.52	7.21	1.17 ± 0.19	7.37	15.95	0.271	7	0.33 ± 0.05	7.37	15.95
Control P-02	1.11	7.33				0.312	7.06			
Control P-03	1.1	7.37				0.299	7.1			
Control P-04	1.1	7.37				0.315	7.11			
Control P-05	1.23	7.42				0.386	7.14			
Control P-06	1.26	7.41				0.268	7.14			
Control P-07	0.865	7.43				0.378	7.14			
Control P-08	1.18	7.43				0.394	7.17			
A55-01	1.71	6.99	1.38 ± 0.45	7.12	21.53	0.496	7.14	0.33 ± 0.23	7.09	22.27
A55-02	1.88	6.99				0.565	7.13			
A55-03	1.39	7.04				0.621	7.1			
A55-04	1.78	7.08				0.318	7.08			
A55-05	0.747	7.18				0.105	7.08			
A55-06	0.696	7.19				0.0597	7.05			
A55-07	1.28	7.25				0.0699	7.05			
A55-08	1.59	7.23				0.367	7.05			
A56-01	0.956	7.32	0.93 ± 0.06	7.31	17.26	**0.015**	7.05	0.02 ± 0.00	7.04	23.25
A56-02	0.95	7.32				**0.015**	7.04			
A56-03	0.898	7.31				**0.015**	7.05			
A56-04	0.975	7.31				**0.015**	7.05			
A56-05	1.02	7.3				**0.015**	7.04			
A56-06	0.874	7.31				**0.015**	7.03			
A56-07	0.899	7.31				**0.015**	7.03			
A56-08	0.841	7.31				**0.015**	7.03			

Table 3.1-5
Initial and Final Average Ammonia Results
November 2014 Animas River Sediment Toxicity Test Using *H. azteca*

Site/ Replicate ID	Initial Measured Ammonia Conc. (mg N/L)	Initial Measured pH	Initial Average Measured Ammonia Conc. ± SD (mg N/L)	Initial Average Measured pH	Initial Ammonia Criterion (mg N/L)[a]	Final Measured Ammonia Conc. (mg N/L)[b]	Final Measured pH[b]	Final Average Measured Ammonia Conc. ± SD (mg N/L)	Final Average Measured pH	Final Ammonia Criterion (mg N/L)[a]
A60-01	0.193	7.49	0.18 ± 0.03	7.31	17.29	0.0338	7.26	0.02 ± 0.01	7.18	20.14
A60-02	0.148	7.4				**0.015**	7.22			
A60-03	0.176	7.33				0.0308	7.2			
A60-04	0.181	7.29				**0.015**	7.19			
A60-05	0.224	7.26				**0.015**	7.18			
A60-06	0.132	7.24				**0.015**	7.17			
A60-07	0.216	7.24				0.0324	7.1			
A60-08	0.182	7.23				**0.015**	7.13			
A68-01	0.142	7.28	0.14 ± 0.04	7.30	17.45	**0.015**	7.14	0.02 ± 0.01	7.15	20.84
A68-02	0.103	7.29				0.033	7.14			
A68-03	0.154	7.31				**0.015**	7.15			
A68-04	0.115	7.32				0.0305	7.16			
A68-05	0.125	7.32				**0.015**	7.16			
A68-06	0.236	7.3				**0.015**	7.16			
A68-07	0.138	7.3				**0.015**	7.15			
A68-08	0.146	7.3				**0.015**	7.14			
A72-01	0.0521	7.23	0.07 ± 0.02	7.10	21.86	0.0538	7.15	0.06 ± 0.01	7.10	21.94
A72-02	0.0768	7.17				0.0414	7.09			
A72-03	0.0948	7.09				0.0448	7.13			
A72-04	0.0885	7.12				0.0547	7.08			
A72-05	0.0864	7.08				0.0633	7.09			
A72-06	0.0585	7.05				0.0761	7.09			
A72-07	0.06	7.04				0.0676	7.08			
A72-08	0.076	7.05				0.0561	7.09			
A73-01	0.0318	7.24	0.05 ± 0.01	7.16	20.73	0.101	7.19	0.10 ± 0.07	7.15	20.76
A73-02	0.0352	7.19				0.0914	7.18			
A73-03	0.0543	7.18				0.264	7.17			
A73-04	0.0593	7.16				0.0732	7.15			
A73-05	0.0535	7.15				0.0777	7.15			
A73-06	0.0653	7.11				0.0507	7.14			
A73-07	0.0521	7.12				0.0799	7.12			
A73-08	0.0618	7.09				0.087	7.13			
A75D-01	0.0456	7.24	0.05 ± 0.02	7.21	19.42	0.0667	6.99	0.07 ± 0.03	7.13	21.39
A75D-02	0.0544	7.21				0.0441	7.08			
A75D-03	0.0556	7.2				0.0503	7.15			
A75D-04	0.0935	7.17				0.0645	7.13			
A75D-05	0.0387	7.23				0.0867	7.21			
A75D-06	0.0435	7.23				0.134	7.15			
A75D-07	0.0406	7.21				0.0489	7.14			
A75D-08	0.0398	7.22				0.0756	7.15			

Table 3.1-5
Initial and Final Average Ammonia Results
November 2014 Animas River Sediment Toxicity Test Using *H. azteca*

Site/ Replicate ID	Initial Measured Ammonia Conc. (mg N/L)	Initial Measured pH	Initial Average Measured Ammonia Conc. ± SD (mg N/L)	Initial Average Measured pH	Initial Ammonia Criterion (mg N/L)[a]	Final Measured Ammonia Conc. (mg N/L)[b]	Final Measured pH[b]	Final Average Measured Ammonia Conc. ± SD (mg N/L)	Final Average Measured pH	Final Ammonia Criterion (mg N/L)[a]
A75EC-01	0.263	7.31	0.44 ± 0.27	7.25	18.70	0.0611	7.09	0.08 ± 0.02	7.14	21.03
A75EC-02	0.316	7.26				0.0736	7.12			
A75EC-03	0.303	7.25				0.0894	7.16			
A75EC-04	0.314	7.25				0.0521	7.14			
A75EC-05	0.308	7.24				0.0655	7.16			
A75EC-06	0.315	7.24				0.113	7.15			
A75EC-07	0.76	7.22				0.0995	7.16			
A75EC-08	0.979	7.2				0.0726	7.15			
Bbridge-01	0.739	7.04	0.72 ± 0.41	7.01	23.97	0.0334	7.22	0.02 ± 0.01	7.17	20.45
Bbridge-02	0.55	6.98				0.0378	7.2			
Bbridge-03	0.488	6.96				**0.015**	7.17			
Bbridge-04	0.545	6.97				0.033	7.16			
Bbridge-05	0.614	7				0.0301	7.16			
Bbridge-06	1.73	7.01				**0.015**	7.15			
Bbridge-07	0.561	7.04				**0.015**	7.14			
Bbridge-08	0.563	7.05				**0.015**	7.14			
Jranch-01	0.345	7.08	0.67 ± 0.18	7.13	21.23	**0.015**	7.13	0.03 ± 0.02	7.13	21.28
Jranch-02	0.634	7.1				**0.015**	7.12			
Jranch-03	0.694	7.14				**0.015**	7.11			
Jranch-04	0.608	7.14				**0.015**	7.13			
Jranch-05	0.587	7.14				**0.015**	7.14			
Jranch-06	0.652	7.16				**0.015**	7.13			
Jranch-07	0.933	7.15				0.071	7.16			
Jranch-08	0.868	7.15				0.0427	7.12			
32nd St-01	0.987	6.54	0.96 ± 0.13	6.69	29.90	**0.015**	5.82	0.04 ± 0.02	6.15	35.89
32nd St-02	1.03	6.56				0.0777	5.93			
32nd St-03	0.712	6.63				**0.015**	5.97			
32nd St-04	1.06	6.71				0.0424	6.1			
32nd St-05	0.96	6.76				0.0618	6.25			
32nd St-06	0.85	6.76				0.0302	6.32			
32nd St-07	1.09	6.77				**0.015**	6.39			
32nd St-08	1.02	6.8				0.0326	6.38			
Lcreek-01	0.345	6.84	0.25 ± 0.05	6.90	26.08	0.0359	6.47	0.04 ± 0.01	6.70	29.84
Lcreek-02	0.285	6.86				0.0408	6.13			
Lcreek-03	0.262	6.87				0.0408	6.69			
Lcreek-04	0.161	7.01				0.0605	6.76			
Lcreek-05	0.207	6.88				0.0342	6.8			
Lcreek-06	0.267	6.9				0.0506	6.87			
Lcreek-07	0.266	6.92				0.0346	6.89			
Lcreek-08	0.231	6.95				0.0361	6.95			

Table 3.1-5
Initial and Final Average Ammonia Results
November 2014 Animas River Sediment Toxicity Test Using *H. azteca*

Site/ Replicate ID	Initial Measured Ammonia Conc. (mg N/L)	Initial Measured pH	Initial Average Measured Ammonia Conc. ± SD (mg N/L)	Initial Average Measured pH	Initial Ammonia Criterion (mg N/L)[a]	Final Measured Ammonia Conc. (mg N/L)[b]	Final Measured pH[b]	Final Average Measured Ammonia Conc. ± SD (mg N/L)	Final Average Measured pH	Final Ammonia Criterion (mg N/L)[a]
Pcliffs-01	0.189	7.01	0.15 ± 0.03	7.05	23.06	0.061	6.98	0.06 ± 0.01	7.10	21.97
Pcliffs-02	0.164	6.99				0.0607	7.04			
Pcliffs-03	0.178	7.03				0.0662	7.08			
Pcliffs-04	0.123	7.12				0.061	7.11			
Pcliffs-05	0.111	7.06				0.0529	7.13			
Pcliffs-06	0.148	7.05				0.0701	7.13			
Pcliffs-07	0.152	7.07				0.0691	7.16			
Pcliffs-08	0.13	7.06				0.0602	7.16			
A68Dup-01	0.0778	7.1	0.07 ± 0.01	7.00	24.13	**0.015**	7.12	0.02 ± 0.00	7.13	21.26
A68Dup-02	0.0698	7.01				**0.015**	7.11			
A68Dup-03	0.0753	6.95				**0.015**	7.14			
A68Dup-04	0.059	6.97				**0.015**	7.12			
A68Dup-05	0.0764	6.99				**0.015**	7.17			
A68Dup-06	0.0598	6.98				**0.015**	7.14			
A68Dup-07	0.071	6.98				**0.015**	7.14			
A68Dup-08	0.0816	7.01				**0.015**	7.11			

a The sample-specific acute ammonia criterion was calculated using the "salmon present" formula on p. 54 of the Colorado Department of Public Health and Environment, Water Quality Control Commission, Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31).

[b]Values shown are either the measurements made at the end of the test (day 10) or earlier if all test organisms died before the 10-day exposure period was completed.

Bolded values were <0.0300U (less than 0.03 non-detect). The reporting limit was divided in half to create an average numerical value.

Prepared by: B. Belmonte (3/2/15)
Reviewed by: E. Czerepak (3/2/15)

Table 3.1-6
Initial and Final Average Ammonia Results
November 2014 Animas River Sediment Toxicity Test Using *H. azteca*

Site/ Replicate ID	Initial Measured Ammonia Conc. (mg N/L)	Initial Measured pH	Initial Average Measured Ammonia Conc. ± SD (mg N/L)	Initial Average Measured pH	Initial Ammonia Criterion (mg N/L)[a]	Final Measured Ammonia Conc. (mg N/L)[b]	Final Measured pH[b]	Final Average Measured Ammonia Conc. ± SD (mg N/L)	Final Average Measured pH	Final Ammonia Criterion (mg N/L)[a]
Ref Control-01	0.172	6.78	0.213 ± 0.07	6.82	27.63	0.752	6.76	0.772 ± 0.09	6.73	29.31
Ref Control-02	0.17	6.75				0.797	6.71			
Ref Control-03	0.185	6.84				0.662	6.68			
Ref Control-04	0.325	6.92				0.876	6.76			
6.25%-01	0.323	6.96	0.202 ± 0.08	7.05	23.14	0.667	6.87	0.728 ± 0.12	6.93	25.55
6.25%-02	0.14	7.05				0.583	6.89			
6.25%-03	0.161	7.07				0.824	6.95			
6.25%-04	0.184	7.10				0.836	7.01			
12.5%-01	0.17	7.16	0.167 ± 0.00	7.17	20.40	0.7	7.05	0.658 ± 0.05	7.09	22.22
12.5%-02	0.162	7.15				0.692	7.08			
12.5%-03	0.166	7.19				0.631	7.1			
12.5%-04	0.17	7.18				0.608	7.12			
25%-01	0.169	7.24	0.091 ± 0.09	7.25	18.67	0.879	7.12	0.691 ± 0.13	7.13	21.28
25%-02	0.163	7.26				0.65	--			
25%-03	**0.015**	7.24				0.627	7.15			
25%-04	**0.015**	7.25				0.609	7.12			
50%-01	**0.015**	7.23	0.015 ± 0.00	7.25	18.67	0.419	--	0.394 ± 0.06	NC	NA
50%-02	**0.015**	7.25				0.319	--			
50%-03	**0.015**	7.25				0.367	--			
50%-04	**0.015**	7.26				0.469	--			
100%-01	**0.015**	7.26	0.015 ± 0.00	7.25	18.61	0.0426	--	0.073 ± 0.02	NC	NA
100%-02	**0.015**	7.25				0.0747	--			
100%-03	**0.015**	7.25				0.0833	--			
100%-04	**0.015**	7.24				0.0926	--			

NA = Not available
NC = Not calculated

[a] The sample-specific acute ammonia criterion was calculated using the "salmon present" formula on p. 54 of the Colorado Department of Public Health and Environment, Water Quality Control Commission, Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31).

[b]Values shown are either the measurements made at the end of the test (day 4) or earlier if all test organisms died before the 4-day exposure period was completed.
Bolded values were <0.0300U (less than 0.03 non-detect). The reporting limit was divided in half to create an average numerical value.

Prepared by: B. Belmonte (3/2/15)
Reviewed by: E. Czerepak (3/2/15)

Table 3.1-7 Upper Animas November 2014
Sediment Toxicity Test
Weight Data Sheets: 10-Day Static Renewal

Start Date	11/10/14	Drying Time	24 hours
End Date	11/20/14	Oven Temp (C)	70°C
Weighing Date	11/24/14	Organism	*H. azteca*
No. of Replicates	8	Initial Weight (µg)	22.5
Feed Rate/Type	YCT/Daily	Analysts	SA,LC, CL

Site I.D.	Weight of Oven Dried Pan (µg)	Pan + Dried Organisms (µg)	Dry Organisms (µg)	Number of Survivors	Mean Weight per Survivor (µg)	Sample Mean (µg)	Growth (ug)	increase in growth (ug)	% increase in growth
Control-P-01	205204.0	205911.9	707.9	10	70.79	54.80	55.99	32.30	140.81
Control-P-02	205998.1	206278.7	280.6	9	31.18				
Control-P-03	206580.9	207127.4	546.5	10	54.65				
Control-P-04	208732.0	209310.6	578.6	9	64.29				
Control-P-05	206416.7	207022.2	605.5	10	60.55				
Control-P-06	206133.4	206595.0	461.6	10	46.16				
Control-P-07	206977.9	207481.9	504.0	9	56.00				
Control-P-08	209186.5	209589.3	402.8	6	67.13				
Control-N-01	207611.3	208342.6	731.3	9	81.26	84.38	84.43	61.88	269.76
Control-N-02	206723.9	207590.8	866.9	9	96.32				
Control-N-03	205511.0	206381.4	870.4	10	87.04				
Control-N-04	205135.5	205828.8	693.3	10	69.33				
Control-N-05	206769.2	207643.2	874.0	10	87.40				
Control-N-06	206171.4	206743.5	572.1	8	71.51				
Control-N-07	204986.0	205895.1	909.1	10	90.91				
Control-N-08	206227.3	206957.7	730.4	8	91.30				
A55-01	207818.7	208074.0	255.3	7	36.47	35.54	35.21	13.04	56.83
A55-02	209379.6	209565.6	186.0	5	37.20				
A55-03	209005.9	209135.4	129.5	5	25.90				
A55-04	208339.0	208532.7	193.7	7	27.67				
A55-05	204645.1	204922.9	277.8	9	30.87				
A55-06	206386.2	206558.3	172.1	5	34.42				
A55-07	208028.5	208354.2	325.7	6	54.28				
A55-08	207144.0	207293.9	149.9	4	37.47				
A56-01	207086.0	207109.1	23.1	1	23.10	31.91	32.72	9.41	41.01
A56-02	208273.0	208454.5	181.5	5	36.30				
A56-03	208368.7	208551.9	183.2	7	26.17				
A56-04	207430.5	N/A	N/A	0	N/A				
A56-05	205378.5	205618.6	240.1	6	40.02				
A56-06	206155.2	206343.8	188.6	7	26.94				
A56-07	208613.0	208715.1	102.1	4	25.53				
A56-08	207257.2	207483.7	226.5	5	45.30				
A60-01	206790.0	207013.2	223.2	8	27.90	30.70	29.86	8.20	35.74
A60-02	206414.0	206651.9	237.9	9	26.43				
A60-03	208917.2	209172.5	255.3	10	25.53				
A60-04	206806.4	206956.8	150.4	7	21.49				
A60-05	205542.7	205828.6	285.9	9	31.77				
A60-06	206630.8	206944.9	314.1	8	39.26				
A60-07	207783.8	207997.6	213.8	7	30.54				
A60-08	209932.7	210103.4	170.7	4	42.67				
A68-01	208094.6	208364.3	269.7	8	33.71	35.14	33.19	12.64	55.10
A68-02	205439.1	205743.5	304.4	9	33.82				
A68-03	208751.2	208801.6	50.4	1	50.40				
A68-04	208901.3	209231.7	330.4	8	41.30				
A68-05	206252.8	206521.7	268.9	8	33.61				
A68-06	208955.4	209124.2	168.8	5	33.76				
A68-07	210559.4	210743.5	184.1	7	26.30				
A68-08	208212.8	208494.9	282.1	10	28.21				

Table 3.1-7 Upper Animas November 2014
Sediment Toxicity Test
Weight Data Sheets: 10-Day Static Renewal

Start Date	11/10/14	Drying Time	24 hours
End Date	11/20/14	Oven Temp (C)	70°C
Weighing Date	11/24/14	Organism	*H. azteca*
No. of Replicates	8	Initial Weight (µg)	22.5
Feed Rate/Type	YCT/Daily	Analysts	SA,LC, CL

Site I.D.	Weight of Oven Dried Pan (µg)	Pan + Dried Organisms (µg)	Dry Organisms (µg)	Number of Survivors	Mean Weight per Survivor (µg)	Sample Mean (µg)	Growth (ug)	increase in growth (ug)	% increase in growth
A72-01	206938.1	207215.4	277.3	6	46.22	40.13	39.89	17.63	76.84
A72-02	209312.9	209655.6	342.7	8	42.84				
A72-03	207023.3	207228.7	205.4	5	41.08				
A72-04	207516.5	207797.2	280.7	7	40.10				
A72-05	207816.7	208105.0	288.3	9	32.03				
A72-06	208817.1	209217.4	400.3	8	50.04				
A72-07	209231.6	209420.3	188.7	7	26.96				
A72-08	207371.2	207621.7	250.5	6	41.75				
A73-01	206998.6	207218.9	220.3	7	31.47	29.97	29.58	7.47	32.56
A73-02	208585.2	208695.1	109.9	4	27.47				
A73-03	206461.8	206742.7	280.9	9	31.21				
A73-04	206770.0	207086.4	316.4	10	31.64				
A73-05	206847.5	207050.9	203.4	6	33.90				
A73-06	205836.1	206013.9	177.8	5	35.56				
A73-07	207168.0	207378.5	210.5	9	23.39				
A73-08	209547.5	209773.4	225.9	9	25.10				
A75D-01	203883.2	N/A	N/A	6	N/A	29.00	28.54	6.50	28.33
A75D-02	208984.3	209241.7	257.4	6	42.90				
A75D-03	204984.3	205278.1	293.8	10	29.38				
A75D-04	207544.2	207687.3	143.1	5	28.62				
A75D-05	205343.0	205629.4	286.4	10	28.64				
A75D-06	207958.4	208118.3	159.9	6	26.65				
A75D-07	206649.4	207032.8	383.4	10	38.34				
A75D-08	206888.1	207105.2	217.1	8	27.14				
A75CC-01	207680.0	208156.8	476.8	8	59.60	50.60	49.62	28.10	122.48
A75CC-02	208567.8	209029.2	461.4	10	46.14				
A75CC-03	207815.8	208164.1	348.3	6	58.05				
A75CC-04	208172.9	208486.6	313.7	6	52.28				
A75CC-05	209923.1	210269.6	346.5	8	43.31				
A75CC-06	206960.1	207340.2	380.1	8	47.51				
A75CC-07	207264.9	207489.0	224.1	4	56.03				
A75CC-08	208633.2	209009.8	376.6	9	41.84				
A75EC-01	206708.9	207063.5	354.6	8	44.33	44.81	44.63	22.31	97.25
A75EC-02	209294.0	209651.4	357.4	7	51.06				
A75EC-03	207678.2	208201.6	523.4	10	52.34				
A75EC-04	207992.1	208383.2	391.1	10	39.11				
A75EC-05	208756.1	209079.2	323.1	7	46.16				
A75EC-06	206331.9	206765.3	433.4	10	43.34				
A75EC-07	207720.1	208107.6	387.5	10	38.75				
A75EC-08	207513.1	207643.3	130.2	3	43.40				
BBRIDGE-01	205181.5	205590.2	408.7	10	40.87	35.68	35.71	13.18	57.46
BBRIDGE-02	206946.6	207246.3	299.7	8	37.46				
BBRIDGE-03	207747.3	208015.9	268.6	9	29.84				
BBRIDGE-04	205770.2	206119.1	348.9	8	43.61				
BBRIDGE-05	206331.8	206599.3	267.5	8	33.44				
BBRIDGE-06	206634.1	206988.3	354.2	9	39.36				
BBRIDGE-07	206511.5	206812.7	301.2	10	30.12				
BBRIDGE-08	209996.5	210211.7	215.2	7	30.74				

Table 3.1-7 Upper Animas November 2014
Sediment Toxicity Test
Weight Data Sheets: 10-Day Static Renewal

Start Date	11/10/14	Drying Time	24 hours
End Date	11/20/14	Oven Temp (C)	70°C
Weighing Date	11/24/14	Organism	*H. azteca*
No. of Replicates	8	Initial Weight (µg)	22.5
Feed Rate/Type	YCT/Daily	Analysts	SA,LC, CL

Site I.D.	Weight of Oven Dried Pan (µg)	Pan + Dried Organisms (µg)	Dry Organisms (µg)	Number of Survivors	Mean Weight per Survivor (µg)	Sample Mean (µg)	Growth (ug)	increase in growth (ug)	% increase in growth
James Ranch-01	207671.3	207895.0	223.7	6	37.28	40.41	36.83	17.91	78.08
James Ranch-02	207839.2	208097.9	258.7	8	32.34				
James Ranch-03	207552.2	207897.2	345.0	9	38.33				
James Ranch-04	205818.6	206136.6	318.0	7	45.43				
James Ranch-05	206494.4	206695.7	201.3	7	28.76				
James Ranch-06	206697.1	206766.9	69.8	1	69.80				
James Ranch-07	206135.2	206381.9	246.7	7	35.24				
James Ranch-08	207520.6	207809.5	288.9	8	36.11				
32nd St-01	206502.5	206965.2	462.7	10	46.27	37.99	38.18	15.49	67.54
32nd St-02	208956.8	209321.4	364.6	10	36.46				
32nd St-03	207666.3	207867.6	201.3	7	28.76				
32nd St-04	206970.0	207325.9	355.9	9	39.54				
32nd St-05	204937.5	205220.5	283.0	9	31.44				
32nd St-06	206236.8	206631.4	394.6	8	49.33				
32nd St-07	204458.0	204768.7	310.7	8	38.84				
32nd St-08	206669.2	206969.0	299.8	9	33.31				
Lightner Creek-01	206090.8	206295.8	205.0	6	34.17	32.87	33.05	10.37	45.19
Lightner Creek-02	207667.8	208046.0	378.2	9	42.02				
Lightner Creek-03	206066.8	206462.9	396.1	10	39.61				
Lightner Creek-04	205190.0	205362.1	172.1	5	34.42				
Lightner Creek-05	206873.7	207135.0	261.3	9	29.03				
Lightner Creek-06	205595.9	205722.0	126.1	4	31.53				
Lightner Creek-07	206112.8	206316.3	203.5	7	29.07				
Lightner Creek-08	204713.6	204921.4	207.8	9	23.09				
Purple Cliffs-01	204240.6	204339.6	99.0	4	24.75	44.87	36.18	22.37	97.52
Purple Cliffs-02	205728.0	205787.7	59.7	1	59.70				
Purple Cliffs-03	207264.9	207458.1	193.2	6	32.20				
Purple Cliffs-04	209212.6	209292.1	79.5	2	39.75				
Purple Cliffs-05	208278.1	208410.6	132.5	3	44.17				
Purple Cliffs-06	205909.4	NA	NA	0	N/A				
Purple Cliffs-07	207631.9	207891.4	259.5	8	32.44				
Purple Cliffs-08	208878.5	208959.6	81.1	1	81.10				
A68 Dup-01	206981.7	207368.9	387.2	10	38.72	33.77	34.15	11.27	49.15
A68 Dup-02	204634.3	204831.4	197.1	6	32.85				
A68 Dup-03	206802.6	207052.2	249.6	7	35.66				
A68 Dup-04	206061.9	206230.5	168.6	7	24.09				
A68 Dup-05	204876.6	204978.7	102.1	3	34.03				
A68 Dup-06	204651.7	204993.6	341.9	8	42.74				
A68 Dup-07	207523.7	207740.1	216.4	7	30.91				
A68 Dup-08	208473.8	208723.4	249.6	8	31.20				

Notes:
A55-02 had 5 living organisms and 2 dead
A55-04 had 7 living organisms and 1 dead
A55-07 had 6 living organisms and 2 dead
A55-08 had 4 living organisms and 1 dead
A56-06 had 7 living organisms and 1 dead
A60-08 had 4 living organisms and 3 dead
A72-06 had 8 living organisms and 1 dead
A72-07 had 7 living organisms and 1 dead
A73-06 had 5 living organisms and 1 dead
Purple Cliffs-05 had 3 living organisms and 1 dead
A68 Dup-03 had 7 living organisms and 1 dead
A75D-01 reported a droped sample

Table 3.1-8

November 2014 Animas River Sediment Toxicity Test Using *H. azteca*

Initial and Final Wet Chemistry Results (mg/L)

Initial

STATION_ID	Chloride	Dissolved Organic Carbon	Fluoride	Nitrate/Nitrite as N	Sulfate as SO4	Total Alkalinity
A55	1.9J	10.5	0.9	<1.0U	64.1	145
A56	1.8J	2.9	0.6	<1.0U	74.1	106
A60	2.1	1.5	0.7	<1.0U	82.7	86.5
A68	1.8J	<1.0U	0.4	<1.0U	80.6	80.4
A68 Dup	1.7J	<1.0U	0.2	<1.0U	75.8	69.8
A72	1.8J	<1.0U	0.5	<1.0U	118	40.5
A73	1.8J	<1.0U	0.4	<1.0U	104	42.6
A75CC	2.2	10.5	0.9	<1.0U	66.9	146
A75D	1.8J	<1.0U	0.4	<1.0U	87.4	61.9
A75EC	1.8J	2.4	0.1J	<1.0U	68.5	83.3
Animas@32nd Bridge	3.3	1.4	0.4	<1.0U	69.3	109
Animas@Lightner Creek	3.7	1.5	0.2	<1.0U	71.1	140
Animas@Purple Cliffs	1.9J	1.3	0.2	<1.0U	64.8	89.8
Bbridge	2.1	1.4	0.3	<1.0U	79.7	92.6
James Ranch	2.1	1.7	0.3	<1.0U	84.1	100
N-Control	45.2D	5.5	<1.0U	<10.0U	360D	73.3
P-Control	37.3D	5.9	<1.0U	<10.0U	301D	74.5
Ref 100%	1.7J	<1.0U	<0.1U	<1.0U	74.4	61.4
Ref. 12.5%	1.7J	<1.0U	<0.1U	<1.0U	73.8	60.7
Ref. 25%	1.7J	<1.0U	<0.1U	<1.0U	73.9	61.5
Ref. 50%	1.7J	<1.0U	<0.1U	<1.0U	74.1	60.6
Ref. 6.25%	1.7J	<1.0U	<0.1U	<1.0U	73.8	60.6
Ref. control	1.7J	<1.0U	<0.1U	<1.0U	73.5	61.4

Final

STATION_ID	Chloride	Dissolved Organic Carbon	Fluoride	Nitrate/Nitrite as N	Sulfate as SO4	Total Alkalinity
A55	2.1	1.2	0.6	<1.0U	75.6	78.5
A56	2.1	<1.0U	0.3	<1.0U	82.3	75.6
A60	2.1	<1.0U	0.3	<1.0U	84.3	75.8
A68	2.1	<1.0U	0.2	<1.0U	83.9	75.1
A68 Dup	2.1	<1.0U	0.1J	<1.0U	82.8	72.6
A72	2.1	<1.0U	0.3	<1.0U	93.3	60.7
A73	2.1	<1.0U	0.3	<1.0U	88.5	63.2
A75CC	2.1	1.4	<0.1U	<1.0U	73.3	109
A75D	2.1	<1.0U	0.2	<1.0U	84.9	70.2
A75EC	2.1	1.1	<0.1U	<1.0U	79.0	73.5
Animas@32nd Bridge	2.2	1.0	0.2	<1.0U	84.3	81.8
Animas@Lightner Creek	2.3	<1.0U	0.1J	<1.0U	79.8	103
Animas@Purple Cliffs	2.0	<1.0U	<0.1U	<1.0U	77.0	90.8
Bbridge	2.1	<1.0U	0.1J	<1.0U	78.0	72.2
James Ranch	2.1	<1.0U	0.2	<1.0U	84.6	78.6
N-Control	7.8	1.8	<0.1U	<1.0U	134	89.2
P-Control	8.4	1.6	<0.1U	<1.0U	137	87.3
Ref 100%	2.8	2.3	<0.1U	2.1J	81.4	64.6
Ref. 12.5%	2.4	2.5	<0.1U	<1.0U	86.2	74.4
Ref. 25%	2.3	2.6	<0.1U	<1.0U	86.6	75.2
Ref. 50%	2.5	2.4	<0.1U	1.2J	83.2	68.4
Ref. 6.25%	2.4	2.8	<0.1U	<1.0U	87.2	75.6
Ref. control	2.6	3.1	<0.1U	<1.0U	86.7	73.2

Prepared by: B. Belmonte (2/26/15)

Reviewed by: E. Seiler (3/5/15)

Figures

Figure 3.1-1
2014 Upper Animas River Sediment Toxicity Test Using *H. azteca*
Average Percent Survival + 1 SD per Sampling Location

N =Average biomass is statistically different when compared to Control N

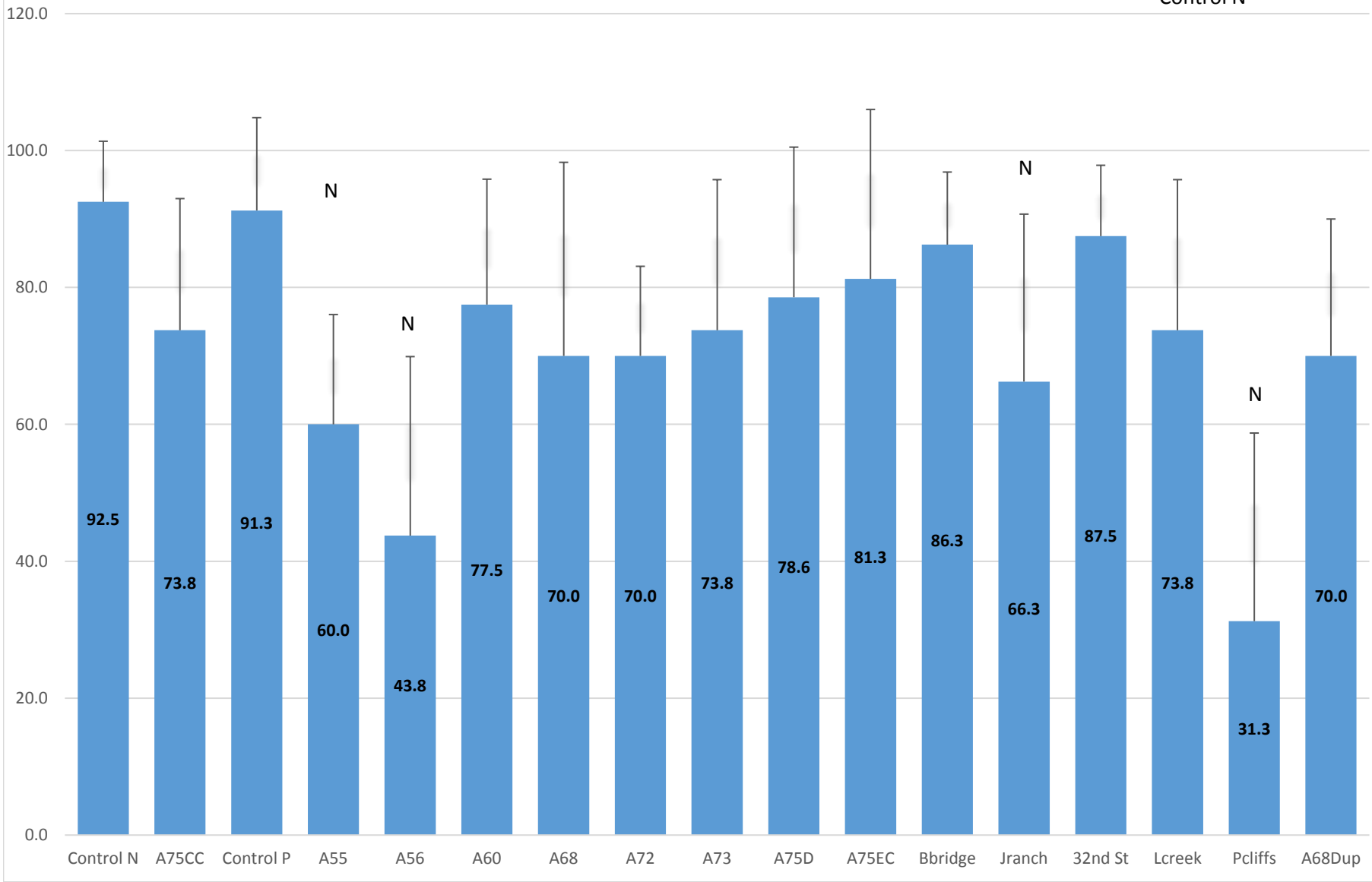


Figure 3.1-2
2014 Upper Animas River Sediment Toxicity Test Using *H. azteca*
Average Biomass + 1 SD per Sampling Location (ug/organism)

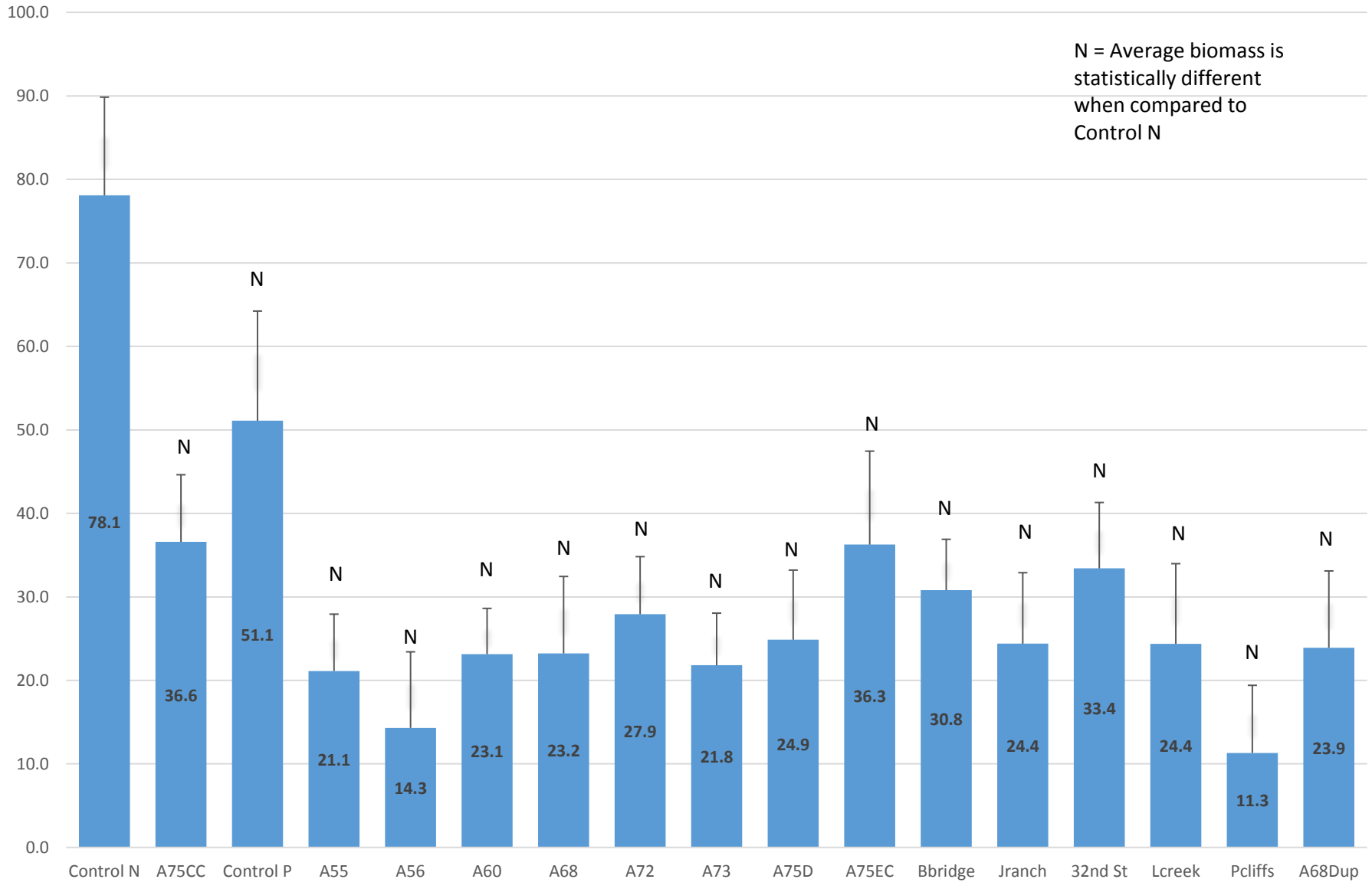
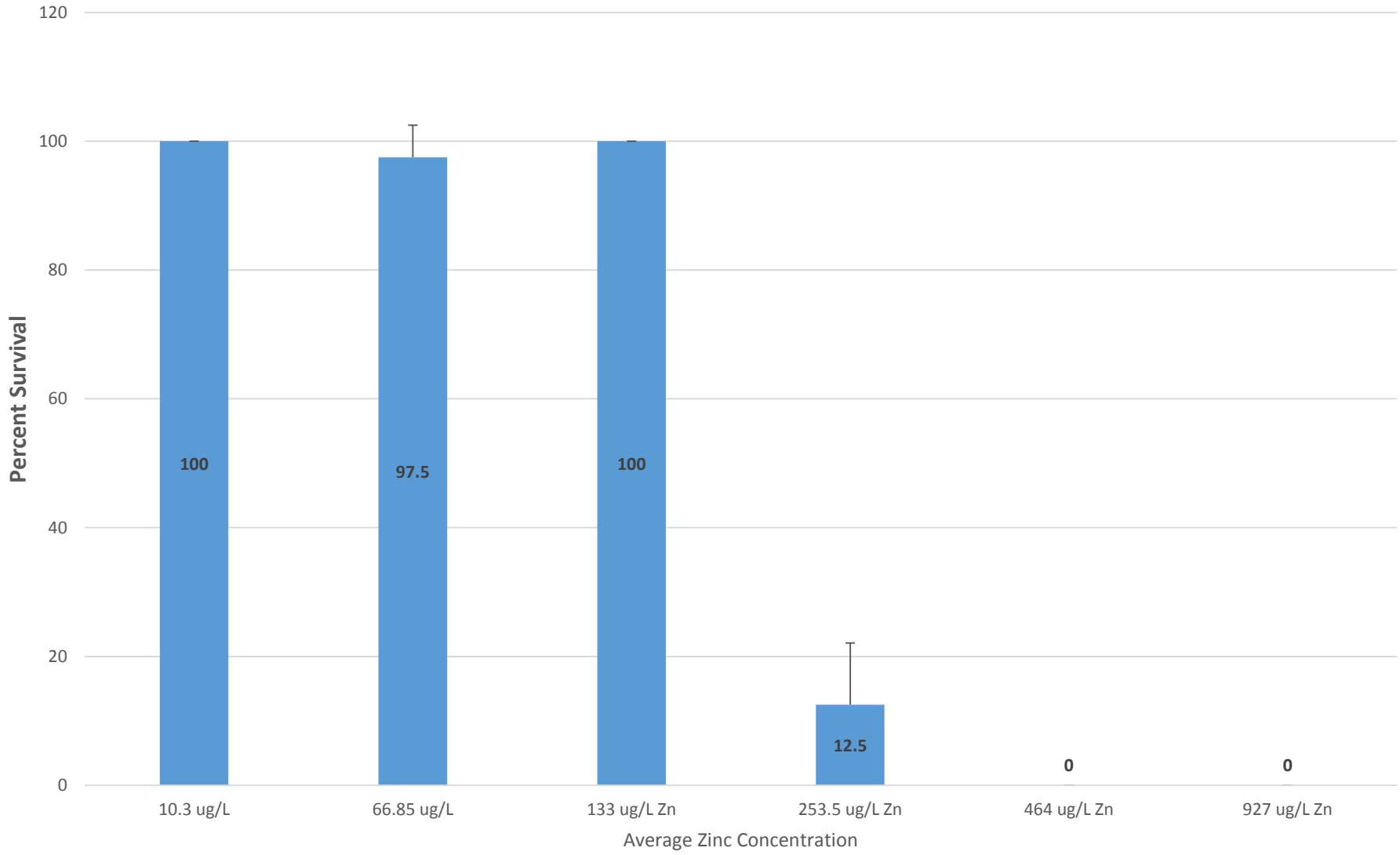


Figure 3.2-1
2014 Upper Animas River Concurrent Acute Reference Toxicity Test using H.azteca and Zinc Sulfate (ZnSO4)
***H. azteca* Percent Survival + 1 SD per Zinc Concentration**



November 2014 10-day Upper Animas River Sediment Toxicity Test Using *H. azteca*

Location	CETIS avg survival	% survival	CETIS SD	survival %SD	CETIS Avg biomass (mg)	CETIS biomass SD (mg)	Avg biomass (ug)	biomass SD (ug)
Control N	0.925	92.5	0.0886	8.9	0.07809	0.0118	78.1	11.8
A75CC	0.7375	73.8	0.1923	19.2	0.03659	0.0080	36.6	8.0
Control P	0.9125	91.3	0.1356	13.6	0.05109	0.0131	51.1	13.1
A55	0.6	60.0	0.1604	16.0	0.02113	0.0068	21.1	6.8
A56	0.4375	43.8	0.2615	26.2	0.01431	0.0091	14.3	9.1
A60	0.775	77.5	0.1832	18.3	0.02314	0.0055	23.1	5.5
A68	0.7	70.0	0.2828	28.3	0.02323	0.0092	23.2	9.2
A72	0.7	70.0	0.1309	13.1	0.02792	0.0069	27.9	6.9
A73	0.7375	73.8	0.22	22.0	0.02181	0.0062	21.8	6.2
A75D	0.7857	78.6	0.2193	21.9	0.02487	0.0083	24.9	8.3
A75EC	0.8125	81.3	0.2475	24.8	0.03626	0.0112	36.3	11.2
Bbridge	0.8625	86.3	0.1061	10.6	0.0308	0.0061	30.8	6.1
Jranch	0.6625	66.3	0.2446	24.5	0.0244	0.0085	24.4	8.5
32nd St	0.875	87.5	0.1035	10.4	0.03341	0.0079	33.4	7.9
Lcreek	0.7375	73.8	0.22	22.0	0.02438	0.0096	24.4	9.6
Pcliffs	0.3125	31.3	0.2748	27.5	0.01131	0.0081	11.3	8.1
A68Dup	0.7	70.0	0.2	20.0	0.02391	0.0092	23.9	9.2

%Zn (ug/L)	Zn (Dis ug/L)	CETIS survival	% survival	CETIS Surv. SD	%SD
10.3 ug/L	10.3	1	100	0	0
66.85 ug/L	66.85	0.975	97.5	0.05	5
133 ug/L Zn	133	1	100	0	0
253.5 ug/L Zn	253.5	0.125	12.5	0.09574	9.574
464 ug/L Zn	464	0	0	0	0
927 ug/L Zn	927	0	0	0	0

Prepared by: B. Belmonte (2/27/15)
Reviewed by: E. Seiler (3/4/15)

Appendices

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14
End Date	11/20/14
Water Type	MHRW
Analysts	SA, LC, CL

No. of Replicates	8
Organism	*H. azteca*
No. of Organisms	80

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Control-P-01	pH	7.21									7.00	
Control-P-01	Conductivity (us/cm)	1068									427	
Control-P-01	D.O. (mg/L)	6.10	5.13	3.93	3.63	3.76	3.90	3.11	3.68	3.65	5.03	4.16
Control-P-01	Temp (C)	21.13	22.1	22.6	22.5	22.7	22.6	22.7	22.4	22.4	22.67	22.6
Control-P-01	Hardness	322										139
Control-P-01	Alkalinity	74.5										87.3
Control-P-02	pH	7.33									7.06	
Control-P-02	Conductivity (us/cm)	979									448	
Control-P-02	D.O. (mg/L)	5.34	4.71	3.80	3.84	3.64	4.07	4.23	3.91	3.88	5.14	4.40
Control-P-02	Temp (C)	21.01	22.1	22.5	22.3	22.7	22.4	22.8	22.4	22.4	22.64	22.6
Control-P-02	Hardness	322										139
Control-P-02	Alkalinity	74.5										87.3
Control-P-03	pH	7.37									7.10	
Control-P-03	Conductivity (us/cm)	1024									471	
Control-P-03	D.O. (mg/L)	4.72	5.16	3.98	3.86	3.85	4.10	3.76	3.85	3.70	5.22	4.43
Control-P-03	Temp (C)	20.99	22.2	22.3	22.1	22.6	22.4	22.8	22.2	22.4	22.63	22.6
Control-P-03	Hardness	322										139
Control-P-03	Alkalinity	74.5										87.3
Control-P-04	pH	7.37									7.11	
Control-P-04	Conductivity (us/cm)	936									477	
Control-P-04	D.O. (mg/L)	4.64	4.91	3.80	4.11	4.01	3.89	3.89	3.67	3.54	5.23	4.32
Control-P-04	Temp (C)	20.91	22.1	22.3	22.0	22.7	22.4	22.7	22.0	22.3	22.63	22.5
Control-P-04	Hardness	322										139
Control-P-04	Alkalinity	74.5										87.3

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Control-P-05	pH	7.42									7.14	
Control-P-05	Conductivity (us/cm)	920									475	
Control-P-05	D.O. (mg/L)	5.16	4.61	4.05	3.83	4.00	3.89	4.15	3.73	3.47	5.21	4.07
Control-P-05	Temp (C)	20.97	22.1	22.3	22.1	22.6	22.5	22.7	22.0	22.3	22.61	22.5
Control-P-05	Hardness	322										139
Control-P-05	Alkalinity	74.5										87.3
Control-P-06	pH	7.41									7.14	
Control-P-06	Conductivity (us/cm)	985									467	
Control-P-06	D.O. (mg/L)	5.39	4.61	4.05	3.83	4.00	3.89	4.07	3.67	3.44	5.10	4.32
Control-P-06	Temp (C)	20.98	21.9	22.2	22.1	22.6	22.5	22.7	22.0	22.3	22.60	22.4
Control-P-06	Hardness	322										139
Control-P-06	Alkalinity	74.5										87.3
Control-P-07	pH	7.43									7.14	
Control-P-07	Conductivity (us/cm)	835									482	
Control-P-07	D.O. (mg/L)	4.73	4.85	4.02	3.96	3.93	3.78	4.32	4.20	3.26	5.16	4.25
Control-P-07	Temp (C)	20.62	22.0	22.5	22.2	22.6	22.5	22.6	22.0	22.3	22.69	22.4
Control-P-07	Hardness	322										139
Control-P-07	Alkalinity	74.5										87.3
Control-P-08	pH	7.43									7.17	
Control-P-08	Conductivity (us/cm)	968									496	
Control-P-08	D.O. (mg/L)	5.48	4.55	4.20	3.98	3.95	4.09	4.09	4.01	3.33	5.19	3.96
Control-P-08	Temp (C)	20.71	22.1	22.4	22.1	22.6	22.5	22.7	22.0	22.4	22.62	22.6
Control-P-08	Hardness	322										139
Control-P-08	Alkalinity	74.5										87.3

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Control-N-01	pH	7.06									7.16	
Control-N-01	Conductivity (us/cm)	995									460	
Control-N-01	D.O. (mg/L)	5.67	4.33	4.05	3.69	3.73	3.63	3.62	3.39	3.28	5.03	3.58
Control-N-01	Temp (C)	21.57	22.2	22.4	22.8	22.5	22.4	22.6	21.9	22.4	22.76	21.8
Control-N-01	Hardness	356										138
Control-N-01	Alkalinity	73.3										89.2
Control-N-02	pH	7.20									7.14	
Control-N-02	Conductivity (us/cm)	933									472	
Control-N-02	D.O. (mg/L)	5.68	4.49	4.17	3.88	3.59	3.56	3.76	3.81	3.22	4.92	3.96
Control-N-02	Temp (C)	21.56	22.5	22.5	22.6	22.5	22.4	22.6	21.9	22.4	22.75	22.4
Control-N-02	Hardness	356										138
Control-N-02	Alkalinity	73.3										89.2
Control-N-03	pH	7.21									7.19	
Control-N-03	Conductivity (us/cm)	997									464	
Control-N-03	D.O. (mg/L)	5.78	4.63	4.38	3.91	3.81	3.25	3.87	3.50	3.31	4.91	3.87
Control-N-03	Temp (C)	21.42	22.2	22.2	22.6	22.4	22.4	22.6	21.9	22.4	22.67	22.5
Control-N-03	Hardness	356										138
Control-N-03	Alkalinity	73.3										89.2
Control-N-04	pH	7.25									7.23	
Control-N-04	Conductivity (us/cm)	1002									455	
Control-N-04	D.O. (mg/L)	5.86	4.34	4.52	3.96	3.76	3.76	3.87	3.47	3.23	4.99	3.72
Control-N-04	Temp (C)	21.45	22.5	22.3	22.7	22.2	22.3	22.5	21.8	22.4	22.71	22.5
Control-N-04	Hardness	356										138
Control-N-04	Alkalinity	73.3										89.2

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Control-N-05	pH	7.21									7.27	
Control-N-05	Conductivity (us/cm)	1127									476	
Control-N-05	D.O. (mg/L)	6.20	4.35	3.30	3.88	3.91	3.83	3.96	3.41	3.21	4.94	3.25
Control-N-05	Temp (C)	21.26	22.0	22.4	22.6	22.5	22.4	22.5	21.8	22.3	22.61	22.5
Control-N-05	Hardness	356										138
Control-N-05	Alkalinity	73.3										89.2
Control-N-06	pH	7.31									7.30	
Control-N-06	Conductivity (us/cm)	1002									460	
Control-N-06	D.O. (mg/L)	5.92	4.67	4.51	4.04	3.80	3.63	3.56	3.32	3.29	4.95	3.88
Control-N-06	Temp (C)	21.38	22.5	22.2	22.6	22.5	22.4	22.5	21.8	22.3	22.69	22.5
Control-N-06	Hardness	356										138
Control-N-06	Alkalinity	73.3										89.2
Control-N-07	pH	7.31									7.31	
Control-N-07	Conductivity (us/cm)	1221									458	
Control-N-07	D.O. (mg/L)	5.17	4.35	5.20	4.02	3.91	3.80	3.62	3.47	3.21	4.95	4.22
Control-N-07	Temp (C)	21.41	22.4	22.5	22.8	22.7	22.5	22.6	21.8	22.3	22.75	22.5
Control-N-07	Hardness	356										138
Control-N-07	Alkalinity	73.3										89.2
Control-N-08	pH	7.33									7.31	
Control-N-08	Conductivity (us/cm)	1165									464	
Control-N-08	D.O. (mg/L)	5.08	4.51	4.47	3.94	3.75	3.63	3.79	3.28	3.20	4.93	3.96
Control-N-08	Temp (C)	21.36	22.5	22.5	22.7	22.5	22.5	22.5	21.8	22.4	22.68	22.5
Control-N-08	Hardness	356										138
Control-N-08	Alkalinity	73.3										89.2

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A55-01	pH	6.99									7.14	
A55-01	Conductivity (us/cm)	348									325	
A55-01	D.O. (mg/L)	5.04	3.82	3.25	3.47	3.13	3.68	2.69	3.31	2.99	4.78	3.29
A55-01	Temp (C)	21.18	21.7	22.3	22.4	22.7	22.2	22.7	22.2	22.0	22.64	22.4
A55-01	Hardness	128										91
A55-01	Alkalinity	145										78.5
A55-02	pH	6.99									7.13	
A55-02	Conductivity (us/cm)	418									326	
A55-02	D.O. (mg/L)	3.90	3.64	3.46	3.18	3.34	3.61	3.55	3.17	3.09	4.40	3.21
A55-02	Temp (C)	21.23	22	22.5	22.4	22.6	22.2	22.6	22.2	22.3	22.62	22.5
A55-02	Hardness	128										91
A55-02	Alkalinity	145										78.5
A55-03	pH	7.04									7.10	
A55-03	Conductivity (us/cm)	416									326	
A55-03	D.O. (mg/L)	2.38	3.65	3.50	3.14	3.58	2.78	2.62	3.19	2.62	4.09	2.92
A55-03	Temp (C)	21.24	22.2	22.2	22.2	22.5	22.1	22.6	22.0	22.3	22.58	22.6
A55-03	Hardness	128										91
A55-03	Alkalinity	145										78.5
A55-04	pH	7.08									7.08	
A55-04	Conductivity (us/cm)	425									326	
A55-04	D.O. (mg/L)	2.05	3.76	4.00	3.15	3.34	3.55	3.11	3.10	3.08	4.00	3.13
A55-04	Temp (C)	21.15	22.1	22.1	22.0	22.2	22.0	22.6	22.0	22.3	22.54	22.5
A55-04	Hardness	128										91
A55-04	Alkalinity	145										78.5

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A55-05	pH	7.18									7.08	
A55-05	Conductivity (us/cm)	403									330	
A55-05	D.O. (mg/L)	2.79	3.83	3.53	3.21	3.34	3.61	3.46	3.32	2.81	3.45	2.99
A55-05	Temp (C)	21.24	22.1	22.1	22.2	22.2	22.2	22.5	21.9	22.3	22.53	22.4
A55-05	Hardness	128										91
A55-05	Alkalinity	145										78.5
A55-06	pH	7.19									7.05	
A55-06	Conductivity (us/cm)	400									328	
A55-06	D.O. (mg/L)	2.28	3.35	3.86	3.28	3.54	3.83	3.66	3.18	2.90	2.74	2.45
A55-06	Temp (C)	21.20	21.8	22.2	22.0	22.2	22.2	22.5	21.9	22.3	22.57	22.3
A55-06	Hardness	128										91
A55-06	Alkalinity	145										78.5
A55-07	pH	7.25									7.05	
A55-07	Conductivity (us/cm)	401									322	
A55-07	D.O. (mg/L)	2.98	3.94	3.55	3.25	3.15	3.79	3.56	3.15	2.97	3.05	2.74
A55-07	Temp (C)	21.19	21.8	22.2	22.1	22.4	22.3	22.6	21.9	22.3	22.64	22.3
A55-07	Hardness	128										91
A55-07	Alkalinity	145										78.5
A55-08	pH	7.23									7.05	
A55-08	Conductivity (us/cm)	414									329	
A55-08	D.O. (mg/L)	2.93	3.83	3.36	3.18	3.26	4.32	3.34	3.08	3.05	3.25	2.87
A55-08	Temp (C)	21.24	22.2	22.3	22.1	22.2	22.3	22.7	21.9	22.3	22.64	22.5
A55-08	Hardness	128										91
A55-08	Alkalinity	145										78.5

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A56-01	pH	7.32									7.05	
A56-01	Conductivity (us/cm)	368									316	
A56-01	D.O. (mg/L)	4.84	4.36	3.35	3.42	3.54	3.84	3.06	3.01	2.90	4.22	2.44
A56-01	Temp (C)	21.23	21.8	22.1	22.3	22.8	22.4	22.8	22.1	22.2	22.71	22.7
A56-01	Hardness	116										97
A56-01	Alkalinity	106										75.6
A56-02	pH	7.32									7.04	
A56-02	Conductivity (us/cm)	376									328	
A56-02	D.O. (mg/L)	5.12	4.49	3.47	3.19	3.34	3.54	3.03	3.16	2.92	4.15	3.13
A56-02	Temp (C)	21.21	22.1	22.3	22.3	22.8	22.3	22.8	22.1	22.4	22.68	22.7
A56-02	Hardness	116										97
A56-02	Alkalinity	106										75.6
A56-03	pH	7.31									7.05	
A56-03	Conductivity (us/cm)	377									337	
A56-03	D.O. (mg/L)	4.48	4.18	3.48	3.52	3.55	3.52	3.30	3.14	3.03	3.18	3.42
A56-03	Temp (C)	21.15	21.8	22.0	22.1	22.5	22.2	22.7	22.2	22.4	22.57	22.6
A56-03	Hardness	116										97
A56-03	Alkalinity	106										75.6
A56-04	pH	7.31									7.05	
A56-04	Conductivity (us/cm)	366									334	
A56-04	D.O. (mg/L)	4.88	4.37	3.96	3.43	3.48	3.51	3.48	3.21	2.88	30.9	2.98
A56-04	Temp (C)	20.21	21.8	22.2	22.1	22.6	22.2	22.6	21.9	22.5	22.58	22.5
A56-04	Hardness	116										97
A56-04	Alkalinity	106										75.6

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A56-05	pH	7.30									7.04	
A56-05	Conductivity (us/cm)	377									338	
A56-05	D.O. (mg/L)	4.54	4.36	4.23	3.17	3.35	3.83	3.44	3.51	2.79	2.17	3.24
A56-05	Temp (C)	21.03	22.2	22.2	22.1	22.7	22.2	22.6	21.9	22.3	22.65	22.4
A56-05	Hardness	116										97
A56-05	Alkalinity	106										75.6
A56-06	pH	7.31									7.03	
A56-06	Conductivity (us/cm)	364									336	
A56-06	D.O. (mg/L)	2.94	4.74	4.43	3.35	3.43	3.79	3.29	3.36	2.94	2.13	3.15
A56-06	Temp (C)	20.87	22.1	22.2	22.1	22.7	22.2	22.6	22.0	22.3	22.59	22.5
A56-06	Hardness	116										97
A56-06	Alkalinity	106										75.6
A56-07	pH	7.31									7.03	
A56-07	Conductivity (us/cm)	370									341	
A56-07	D.O. (mg/L)	3.99	4.35	3.46	3.29	3.37	3.55	3.48	3.25	2.91	2.37	3.09
A56-07	Temp (C)	21.27	22.2	22.4	22.1	22.8	22.3	22.6	22.0	22.3	22.70	22.4
A56-07	Hardness	116										97
A56-07	Alkalinity	106										75.6
A56-08	pH	7.31									7.03	
A56-08	Conductivity (us/cm)	349									335	
A56-08	D.O. (mg/L)	4.98	4.76	3.45	3.53	3.24	3.91	3.52	3.44	2.87	3.36	3.2
A56-08	Temp (C)	21.35	21.9	22.3	22.2	22.8	22.4	22.7	23.0	22.5	22.68	22.5
A56-08	Hardness	116										97
A56-08	Alkalinity	106										75.6

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A60-01	pH	7.49									7.26	
A60-01	Conductivity (us/cm)	359									325	
A60-01	D.O. (mg/L)	6.18	4.34	3.41	3.58	3.24	4.21	3.25	3.31	3.10	5.29	2.64
A60-01	Temp (C)	20.84	21.9	22.5	22.5	22.6	22.4	22.6	21.9	22.1	22.55	22.5
A60-01	Hardness	122										99
A60-01	Alkalinity	86.5										75.8
A60-02	pH	7.40									7.22	
A60-02	Conductivity (us/cm)	350									335	
A60-02	D.O. (mg/L)	5.23	4.06	3.47	3.96	3.36	4.13	3.53	2.80	3.44	4.96	3.26
A60-02	Temp (C)	21.21	22.1	22.3	22.3	22.5	22.3	22.7	22.2	22.2	22.63	22.5
A60-02	Hardness	122										99
A60-02	Alkalinity	86.5										75.8
A60-03	pH	7.33									7.20	
A60-03	Conductivity (us/cm)	359									348	
A60-03	D.O. (mg/L)	4.05	4.24	3.37	3.64	3.27	3.54	3.35	2.97	3.17	4.65	2.80
A60-03	Temp (C)	21.17	21.8	22.3	22.3	22.6	22.4	22.7	22.0	22.3	22.53	22.5
A60-03	Hardness	122										99
A60-03	Alkalinity	86.5										75.8
A60-04	pH	7.29									7.19	
A60-04	Conductivity (us/cm)	363									340	
A60-04	D.O. (mg/L)	4.73	4.12	3.45	3.56	3.04	3.71	3.57	2.99	3.13	4.58	3.21
A60-04	Temp (C)	21.17	22.1	22.3	22.3	22.6	22.5	22.6	21.9	22.3	22.58	22.5
A60-04	Hardness	122										99
A60-04	Alkalinity	86.5										75.8

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A60-05	pH	7.26									7.18	
A60-05	Conductivity (us/cm)	364									338	
A60-05	D.O. (mg/L)	4.94	4.09	3.69	3.42	3.24	3.38	3.84	3.15	3.10	4.47	3.24
A60-05	Temp (C)	21.27	22.1	22.4	22.5	22.6	22.4	22.6	22.0	22.4	22.68	22.5
A60-05	Hardness	122										99
A60-05	Alkalinity	86.5										75.8
A60-06	pH	7.24									7.17	
A60-06	Conductivity (us/cm)	355									337	
A60-06	D.O. (mg/L)	4.10	4.12	3.52	3.80	3.21	3.35	3.56	3.09	2.98	4.38	2.78
A60-06	Temp (C)	21.16	22.1	22.2	22.4	22.5	22.3	22.6	22.0	22.4	22.61	22.6
A60-06	Hardness	122										99
A60-06	Alkalinity	86.5										75.8
A60-07	pH	7.24									7.10	
A60-07	Conductivity (us/cm)	362									336	
A60-07	D.O. (mg/L)	4.63	4.06	3.54	3.59	3.41	3.50	3.68	3.22	2.94	4.30	3.09
A60-07	Temp (C)	21.37	22.1	22.5	22.5	22.6	22.2	22.6	22.0	22.4	22.71	22.6
A60-07	Hardness	122										99
A60-07	Alkalinity	86.5										75.8
A60-08	pH	7.23									7.13	
A60-08	Conductivity (us/cm)	360									335	
A60-08	D.O. (mg/L)	4.92	4.23	3.73	3.53	3.48	3.43	3.79	3.34	3.03	4.11	3.05
A60-08	Temp (C)	21.26	22.3	22.3	22.4	22.5	22	22.7	22.1	22.4	22.67	22.6
A60-08	Hardness	122										99
A60-08	Alkalinity	86.5										75.8

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A68-01	pH	7.28									7.14	
A68-01	Conductivity (us/cm)	339									320	
A68-01	D.O. (mg/L)	5.17	4.68	3.78	3.68	3.53	3.87	3.44	3.25	3.06	4.48	2.85
A68-01	Temp (C)	21.46	22.1	22.3	22.3	22.5	22.20	22.7	22.0	22.4	22.77	22.7
A68-01	Hardness	114										99
A68-01	Alkalinity	80.4										75.1
A68-02	pH	7.29									7.14	
A68-02	Conductivity (us/cm)	338									329	
A68-02	D.O. (mg/L)	5.60	4.56	4.20	3.88	3.40	3.78	3.60	3.34	3.11	4.60	3.45
A68-02	Temp (C)	20.71	22.0	22.5	22.3	22.5	22.4	22.8	22.1	22.4	22.76	22.7
A68-02	Hardness	114										99
A68-02	Alkalinity	80.4										75.1
A68-03	pH	7.31									7.15	
A68-03	Conductivity (us/cm)	345									335	
A68-03	D.O. (mg/L)	5.92	4.67	4.09	3.46	3.45	3.68	3.99	3.30	3.24	4.68	3.51
A68-03	Temp (C)	21.28	21.9	22.4	22.4	22.2	22.4	22.8	22.0	22.4	22.68	22.7
A68-03	Hardness	114										99
A68-03	Alkalinity	80.4										75.1
A68-04	pH	7.32									7.16	
A68-04	Conductivity (us/cm)	339									335	
A68-04	D.O. (mg/L)	6.11	4.63	3.83	3.52	3.49	3.71	4.23	3.37	3.04	4.76	3.67
A68-04	Temp (C)	20.84	21.8	22.3	22.4	22.3	22.4	22.7	21.9	22.4	22.65	22.6
A68-04	Hardness	114										99
A68-04	Alkalinity	80.4										75.1

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A68-05	pH	7.32									7.16	
A68-05	Conductivity (us/cm)	344									334	
A68-05	D.O. (mg/L)	5.75	4.28	4.18	3.64	3.44	3.59	3.80	3.31	3.12	4.76	3.48
A68-05	Temp (C)	21.26	22.1	22.3	22.4	22.2	22.3	22.7	21.9	22.3	22.67	22.5
A68-05	Hardness	114										99
A68-05	Alkalinity	80.4										75.1
A68-06	pH	7.30									7.16	
A68-06	Conductivity (us/cm)	351									337	
A68-06	D.O. (mg/L)	5.74	4.18	4.04	3.83	3.31	3.49	3.56	3.25	3.07	4.59	3.35
A68-06	Temp (C)	20.90	21.9	22.2	22.3	22.3	22.3	22.6	21.9	22.3	22.61	22.6
A68-06	Hardness	114										99
A68-06	Alkalinity	80.4										75.1
A68-07	pH	7.30									7.15	
A68-07	Conductivity (us/cm)	344									332	
A68-07	D.O. (mg/L)	5.60	4.71	4.07	3.65	3.41	3.51	3.57	3.24	2.97	4.54	3.27
A68-07	Temp (C)	21.32	22.0	22.4	22.3	22.3	22.4	22.6	22.0	22.4	22.71	22.2
A68-07	Hardness	114										99
A68-07	Alkalinity	80.4										75.1
A68-08	pH	7.30									7.14	
A68-08	Conductivity (us/cm)	345									334	
A68-08	D.O. (mg/L)	5.54	4.37	3.96	3.88	3.38	3.72	3.55	3.13	3.08	4.61	3.55
A68-08	Temp (C)	21.02	22.0	22.3	22.3	22.3	22.4	22.6	21.9	22.4	22.68	22.4
A68-08	Hardness	114										99
A68-08	Alkalinity	80.4										75.1

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A72-01	pH	7.23									7.15	
A72-01	Conductivity (us/cm)	342									318	
A72-01	D.O. (mg/L)	6.57	4.46	4.00	3.70	3.62	3.67	3.55	3.64	3.08	5.40	3.20
A72-01	Temp (C)	20.67	22.1	22.4	22.3	22.5	22.4	22.6	21.5	22.4	22.68	22.5
A72-01	Hardness	111										95
A72-01	Alkalinity	40.5										60.7
A72-02	pH	7.17									7.09	
A72-02	Conductivity (us/cm)	351									324	
A72-02	D.O. (mg/L)	6.60	4.44	4.51	3.88	3.58	3.64	3.96	3.61	3.24	5.09	3.63
A72-02	Temp (C)	20.70	22.1	22.2	22.2	22.5	22.4	22.6	21.9	22.4	22.67	22.6
A72-02	Hardness	111										95
A72-02	Alkalinity	40.5										60.7
A72-03	pH	7.09									7.13	
A72-03	Conductivity (us/cm)	359									334	
A72-03	D.O. (mg/L)	6.42	4.61	3.99	3.80	3.61	3.66	3.83	3.77	3.19	4.96	3.58
A72-03	Temp (C)	20.94	22.0	22.2	22.2	22.5	22.4	22.6	22.0	22.4	22.66	22.6
A72-03	Hardness	111										95
A72-03	Alkalinity	40.5										60.7
A72-04	pH	7.12									7.08	
A72-04	Conductivity (us/cm)	350									335	
A72-04	D.O. (mg/L)	6.43	4.43	4.08	3.93	3.63	3.79	3.67	3.52	3.12	4.92	3.64
A72-04	Temp (C)	20.50	22.0	22.1	22.1	22.3	22.3	22.6	21.7	22.3	22.57	22.5
A72-04	Hardness	111										95
A72-04	Alkalinity	40.5										60.7

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14
End Date	11/20/14
Water Type	MHRW
Analysts	SA, LC, CL

No. of Replicates	8
Organism	*H. azteca*
No. of Organisms	80

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A72-05	pH	7.08									7.09	
A72-05	Conductivity (us/cm)	363									335	
A72-05	D.O. (mg/L)	6.47	4.63	4.18	3.62	3.71	3.87	3.80	3.82	3.10	4.92	3.55
A72-05	Temp (C)	20.90	21.9	22.2	22.2	22.3	22.4	22.5	21.7	22.3	22.58	22.5
A72-05	Hardness	111										95
A72-05	Alkalinity	40.5										60.7
A72-06	pH	7.05									7.09	
A72-06	Conductivity (us/cm)	352									335	
A72-06	D.O. (mg/L)	6.37	4.58	3.93	3.80	3.57	3.50	3.65	3.81	3.04	4.96	3.61
A72-06	Temp (C)	21.15	21.9	22.2	22.4	22.3	22.4	22.5	21.7	22.4	22.59	22.5
A72-06	Hardness	111										95
A72-06	Alkalinity	40.5										60.7
A72-07	pH	7.04									7.08	
A72-07	Conductivity (us/cm)	345									330	
A72-07	D.O. (mg/L)	6.09	4.61	3.99	4.03	3.68	3.76	3.70	3.76	3.31	4.80	3.74
A72-07	Temp (C)	21.43	22.2	22.5	22.5	22.5	22.4	22.6	21.7	22.4	22.75	22.4
A72-07	Hardness	111										95
A72-07	Alkalinity	40.5										60.7
A72-08	pH	7.05									7.09	
A72-08	Conductivity (us/cm)	356									334	
A72-08	D.O. (mg/L)	6.44	4.56	4.15	3.97	3.82	3.75	3.78	3.75	3.29	4.85	3.40
A72-08	Temp (C)	20.58	22.2	22.2	22.6	22.3	22.3	22.6	21.8	22.4	22.68	22.6
A72-08	Hardness	111										95
A72-08	Alkalinity	40.5										60.7

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A73-01	pH	7.24									7.19	
A73-01	Conductivity (us/cm)	315									323	
A73-01	D.O. (mg/L)	7.00	5.70	4.28	4.18	3.79	3.72	4.20	3.70	3.49	5.13	3.38
A73-01	Temp (C)	20.95	21.8	22.3	22.1	22.6	22.1	22.6	21.9	22.2	22.66	22.3
A73-01	Hardness	99										93
A73-01	Alkalinity	42.6										63.2
A73-02	pH	7.19									7.18	
A73-02	Conductivity (us/cm)	325									323	
A73-02	D.O. (mg/L)	7.20	5.74	4.20	4.32	4.19	3.93	4.21	4.17	3.72	4.98	3.57
A73-02	Temp (C)	20.10	21.8	22.5	22.4	22.5	22.3	22.7	22.0	22.4	22.74	22.4
A73-02	Hardness	99										93
A73-02	Alkalinity	42.6										63.2
A73-03	pH	7.18									7.17	
A73-03	Conductivity (us/cm)	328									326	
A73-03	D.O. (mg/L)	7.01	4.90	4.34	4.32	3.80	3.67	4.23	3.78	3.57	5.05	3.63
A73-03	Temp (C)	20.40	21.9	22.2	22.2	22.3	22.2	22.7	22.0	22.4	22.63	22.5
A73-03	Hardness	99										93
A73-03	Alkalinity	42.6										63.2
A73-04	pH	7.16									7.15	
A73-04	Conductivity (us/cm)	316									324	
A73-04	D.O. (mg/L)	7.02	5.03	4.28	4.19	3.72	4.17	4.34	3.79	3.52	4.87	3.74
A73-04	Temp (C)	21.07	21.9	22.1	22.1	22.2	22.2	22.7	22.0	22.4	22.59	22.5
A73-04	Hardness	99										93
A73-04	Alkalinity	42.6										63.2

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14
End Date	11/20/14
Water Type	MHRW
Analysts	SA, LC, CL

No. of Replicates	8
Organism	*H. azteca*
No. of Organisms	80

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A73-05	pH	7.15									7.15	
A73-05	Conductivity (us/cm)	328									326	
A73-05	D.O. (mg/L)	7.06	5.24	4.49	3.76	3.92	4.15	4.44	3.74	3.50	5.02	3.32
A73-05	Temp (C)	21.13	21.8	22.3	22.0	22.3	22.2	22.6	22.0	22.4	22.62	22.4
A73-05	Hardness	99										93
A73-05	Alkalinity	42.6										63.2
A73-06	pH	7.11									7.14	
A73-06	Conductivity (us/cm)	325									328	
A73-06	D.O. (mg/L)	7.04	4.41	4.43	3.87	3.90	4.08	4.37	4.18	3.82	5.07	3.18
A73-06	Temp (C)	21.14	21.8	22.3	22.1	22.2	22.2	22.6	22.0	22.4	22.65	22.5
A73-06	Hardness	99										93
A73-06	Alkalinity	42.6										63.2
A73-07	pH	7.12									7.12	
A73-07	Conductivity (us/cm)	331									324	
A73-07	D.O. (mg/L)	6.99	5.24	4.41	4.03	3.84	3.98	4.23	4.01	3.69	4.74	3.66
A73-07	Temp (C)	21.19	22.1	22.4	22.3	22.4	22.6	22.6	22.0	22.4	22.69	22.6
A73-07	Hardness	99										93
A73-07	Alkalinity	42.6										63.2
A73-08	pH	7.09									7.13	
A73-08	Conductivity (us/cm)	328									329	
A73-08	D.O. (mg/L)	6.92	5.28	4.38	4.41	3.75	3.93	4.17	4.12	3.79	4.83	3.81
A73-08	Temp (C)	21.24	22.1	22.4	22.3	22.3	22.3	22.7	22.1	22.4	22.74	22.6
A73-08	Hardness	99										93
A73-08	Alkalinity	42.6										63.2

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A75D-01	pH	7.24									6.99	
A75D-01	Conductivity (us/cm)	318									315	
A75D-01	D.O. (mg/L)	5.67	4.67	4.07	3.66	3.45	3.59	3.50	3.14	2.73	4.80	3.15
A75D-01	Temp (C)	21.42	22.1	22.3	22.5	22.4	22.4	22.7	21.8	22.4	22.73	22.6
A75D-01	Hardness	99										94
A75D-01	Alkalinity	61.9										70.2
A75D-02	pH	7.21									7.08	
A75D-02	Conductivity (us/cm)	330									325	
A75D-02	D.O. (mg/L)	5.19	4.26	4.07	3.51	3.66	3.63	3.44	3.27	2.94	4.70	3.29
A75D-02	Temp (C)	21.45	22.3	22.4	22.5	22.5	22.5	22.8	22.0	22.5	22.77	22.7
A75D-02	Hardness	99										94
A75D-02	Alkalinity	61.9										70.2
A75D-03	pH	7.20									7.15	
A75D-03	Conductivity (us/cm)	331									330	
A75D-03	D.O. (mg/L)	5.34	4.52	4.13	3.50	3.48	3.83	3.35	3.19	2.97	4.73	3.98
A75D-03	Temp (C)	21.31	22.3	22.2	22.4	22.5	22.3	22.7	21.9	22.4	22.67	22.7
A75D-03	Hardness	99										94
A75D-03	Alkalinity	61.9										70.2
A75D-04	pH	7.17									7.13	
A75D-04	Conductivity (us/cm)	333									332	
A75D-04	D.O. (mg/L)	6.97	4.26	3.94	3.50	3.56	3.93	3.28	3.35	3.04	4.73	3.14
A75D-04	Temp (C)	20.24	22.2	22.3	22.5	22.3	22.3	22.7	21.8	22.4	22.65	22.6
A75D-04	Hardness	99										94
A75D-04	Alkalinity	61.9										70.2

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A75D-05	pH	7.23									7.21	
A75D-05	Conductivity (us/cm)	319									329	
A75D-05	D.O. (mg/L)	6.22	4.36	3.97	3.55	3.27	3.65	3.56	3.40	2.92	4.96	3.02
A75D-05	Temp (C)	21.14	22.2	22.2	22.7	22.5	22.3	22.6	21.8	22.4	22.64	22.6
A75D-05	Hardness	99										94
A75D-05	Alkalinity	61.9										70.2
A75B-06	pH	7.23									7.15	
A75D-06	Conductivity (us/cm)	321									342	
A75D-06	D.O. (mg/L)	5.74	4.56	4.05	3.82	3.22	3.82	3.66	3.43	3.06	4.72	3.39
A75D-06	Temp (C)	21.18	22.2	22.3	22.7	22.4	22.3	22.6	21.6	22.4	22.65	22.6
A75D-06	Hardness	99										94
A75D-06	Alkalinity	61.9										70.2
A75D-07	pH	7.21									7.14	
A75D-07	Conductivity (us/cm)	331									329	
A75D-07	D.O. (mg/L)	5.88	4.51	3.95	3.71	3.46	3.31	3.72	3.28	3.06	4.70	3.64
A75D-07	Temp (C)	21.34	22.1	22.3	22.7	22.6	22.4	22.6	21.9	22.4	22.71	22.6
A75D-07	Hardness	99										94
A75D-07	Alkalinity	61.9										70.2
A75D-08	pH	7.22									7.15	
A75D-08	Conductivity (us/cm)	322									329	
A75D-08	D.O. (mg/L)	5.74	4.41	3.94	3.64	3.70	3.91	3.92	3.29	3.13	4.77	3.44
A75D-08	Temp (C)	21.38	22.2	22.4	22.6	22.6	22.4	22.6	21.9	22.4	22.74	22.6
A75D-08	Hardness	99										94
A75D-08	Alkalinity	61.9										70.2

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A75CC-01	pH	6.99									6.97	
A75CC-01	Conductivity (us/cm)	444									358	
A75CC-01	D.O. (mg/L)	5.57	3.41	3.16	2.81	2.84	2.88	2.75	2.32	2.40	4.04	2.64
A75CC-01	Temp (C)	21.55	22.4	22.4	22.5	22.6	22.5	22.5	21.7	22.4	22.69	22.6
A75CC-01	Hardness	163										114
A75CC-01	Alkalinity	146										109
A75CC-02	pH	7.04									7.01	
A75CC-02	Conductivity (us/cm)	431									351	
A75CC-02	D.O. (mg/L)	5.14	2.91	2.75	2.78	2.93	2.73	2.83	2.77	2.47	3.09	2.24
A75CC-02	Temp (C)	20.92	22.4	22.5	22.6	22.4	22.5	22.6	21.8	22.4	22.68	22.7
A75CC-02	Hardness	163										114
A75CC-02	Alkalinity	146										109
A75CC-03	pH	7.09									7.04	
A75CC-03	Conductivity (us/cm)	426									359	
A75CC-03	D.O. (mg/L)	4.68	3.43	2.52	3.03	3.18	2.31	3.07	2.56	2.23	3.03	2.69
A75CC-03	Temp (C)	21.49	22.4	22.2	22.5	22.5	22.5	22.6	21.8	22.4	22.67	22.6
A75CC-03	Hardness	163										114
A75CC-03	Alkalinity	146										109
A75CC-04	pH	7.12									7.05	
A75CC-04	Conductivity (us/cm)	419									366	
A75CC-04	D.O. (mg/L)	4.37	3.67	3.34	2.91	3.03	3.14	2.74	2.44	2.49	3.16	2.84
A75CC-04	Temp (C)	21.45	22.3	22.3	22.2	22.3	22.5	22.6	21.8	22.4	22.63	22.6
A75CC-04	Hardness	163										114
A75CC-04	Alkalinity	146										109

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A75CC-05	pH	7.15									7.10	
A75CC-05	Conductivity (us/cm)	431									360	
A75CC-05	D.O. (mg/L)	4.33	3.60	3.22	3.10	2.91	3.07	2.93	2.61	2.37	3.46	2.57
A75CC-05	Temp (C)	21.43	22.3	22.3	22.5	22.5	22.4	22.5	21.8	22.3	22.61	22.6
A75CC-05	Hardness	163										114
A75CC-05	Alkalinity	146										109
A75CC-06	pH	7.21									7.08	
A75CC-06	Conductivity (us/cm)	422									364	
A75CC-06	D.O. (mg/L)	3.80	3.81	3.36	3.01	2.93	2.93	2.81	2.55	2.31	3.51	2.56
A75CC-06	Temp (C)	21.27	22.3	22.3	22.3	22.1	22.2	22.4	21.7	22.3	22.60	22.4
A75CC-06	Hardness	163										114
A75CC-06	Alkalinity	146										109
A75CC-07	pH	7.23									7.11	
A75CC-07	Conductivity (us/cm)	400									353	
A75CC-07	D.O. (mg/L)	4.15	4.04	3.67	3.23	3.2	2.88	2.98	2.51	2.34	3.46	2.66
A75CC-07	Temp (C)	21.46	22.1	22.3	22.6	22.5	22.3	22.6	22.0	22.4	22.77	22.5
A75CC-07	Hardness	163										114
A75CC-07	Alkalinity	146										109
A75CC-08	pH	7.25									7.10	
A75CC-08	Conductivity (us/cm)	385									353	
A75CC-08	D.O. (mg/L)	4.44	3.85	3.58	3.19	3.21	3.31	3.15	2.59	2.41	3.55	2.84
A75CC-08	Temp (C)	21.44	22.1	22.3	22.5	22.4	22.3	22.6	22.0	22.4	22.70	22.6
A75CC-08	Hardness	163										114
A75CC-08	Alkalinity	146										109

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A75EC-01	pH	7.31									7.09	
A75EC-01	Conductivity (us/cm)	316									312	
A75EC-01	D.O. (mg/L)	6.03	4.26	3.76	3.62	3.43	3.59	3.84	3.31	3.03	4.89	3.08
A75EC-01	Temp (C)	21.17	22.1	22.4	22.5	22.5	22.5	22.6	21.9	22.3	22.80	22.6
A75EC-01	Hardness	93										91
A75EC-01	Alkalinity	83.3										73.5
A75EC-02	pH	7.26									7.12	
A75EC-02	Conductivity (us/cm)	322									326	
A75EC-02	D.O. (mg/L)	5.93	4.33	3.98	3.46	3.45	3.60	3.73	3.10	2.99	4.73	3.49
A75EC-02	Temp (C)	21.41	22.1	22.4	22.4	22.4	22.4	22.7	22.0	22.4	22.77	22.7
A75EC-02	Hardness	93										91
A75EC-02	Alkalinity	83.3										73.5
A75EC-03	pH	7.25									7.16	
A75EC-03	Conductivity (us/cm)	319									325	
A75EC-03	D.O. (mg/L)	5.85	4.30	4.02	3.81	3.50	3.82	3.46	3.13	3.04	4.62	3.20
A75EC-03	Temp (C)	21.15	22.0	22.3	22.3	22.5	22.4	22.4	21.9	22.4	22.68	22.6
A75EC-03	Hardness	93										91
A75EC-03	Alkalinity	83.3										73.5
A75EC-04	pH	7.25									7.14	
A75EC-04	Conductivity (us/cm)	317									325	
A75EC-04	D.O. (mg/L)	5.53	4.28	3.91	3.74	3.73	3.76	3.41	3.37	3.08	4.57	3.02
A75EC-04	Temp (C)	21.4	22.2	22.4	22.5	22.3	22.4	22.5	21.9	22.4	22.69	22.6
A75EC-04	Hardness	93										91
A75EC-04	Alkalinity	83.3										73.5

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
A75EC-05	pH	7.24									7.16	
A75EC-05	Conductivity (us/cm)	317									316	
A75EC-05	D.O. (mg/L)	5.09	4.44	3.77	3.55	3.55	3.81	3.87	3.14	3.02	4.64	3.10
A75EC-05	Temp (C)	21.46	22.2	22.4	22.4	22.3	22.3	22.7	22.1	22.4	22.71	22.5
A75EC-05	Hardness	93										91
A75EC-05	Alkalinity	83.3										73.5
A75EC-06	pH	7.24									7.15	
A75EC-06	Conductivity (us/cm)	319									316	
A75EC-06	D.O. (mg/L)	5.32	4.16	3.85	4.02	3.34	3.78	3.75	3.43	3.20	4.62	3.27
A75EC-06	Temp (C)	21.47	22.2	22.3	22.5	22.4	22.5	22.7	22.0	22.4	22.76	22.6
A75EC-06	Hardness	93										91
A75EC-06	Alkalinity	83.3										73.5
A75EC-07	pH	7.22									7.16	
A75EC-07	Conductivity (us/cm)	325									320	
A75EC-07	D.O. (mg/L)	5.41	4.14	3.96	3.51	3.13	3.30	3.54	3.17	2.96	4.59	2.88
A75EC-07	Temp (C)	21.53	22.2	22.5	22.5	22.4	22.5	22.7	22.0	22.5	22.83	22.5
A75EC-07	Hardness	93										91
A75EC-07	Alkalinity	83.3										73.5
A75EC-08	pH	7.2									7.15	
A75EC-08	Conductivity (us/cm)	325									319	
A75EC-08	D.O. (mg/L)	5.46	4.15	4.03	3.79	3.25	3.57	3.64	3.19	3.14	4.30	3.15
A75EC-08	Temp (C)	21.31	22.3	22.5	22.3	22.3	22.4	22.7	22.0	22.5	22.84	22.6
A75EC-08	Hardness	93										91
A75EC-08	Alkalinity	83.3										73.5

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Bbridge-01	pH	7.04									7.22	
Bbridge-01	Conductivity (us/cm)	316									317	
Bbridge-01	D.O. (mg/L)	6.64	4.47	3.66	3.89	3.43	4.68	4.21	3.22	3.43	5.00	3.14
Bbridge-01	Temp (C)	20.84	22.1	22.7	22.5	22.6	22.2	22.8	23.1	22.5	22.76	22.5
Bbridge-01	Hardness	117										94
Bbridge-01	Alkalinity	92.6										72.2
Bbridge-02	pH	6.98									7.20	
Bbridge-02	Conductivity (us/cm)	335									317	
Bbridge-02	D.O. (mg/L)	6.21	4.83	3.81	3.60	3.71	4.47	3.95	3.25	3.52	4.74	3.75
Bbridge-02	Temp (C)	21.17	22.1	22.8	22.5	22.6	22.4	22.8	23.1	22.5	22.32	22.3
Bbridge-02	Hardness	117										94
Bbridge-02	Alkalinity	92.6										72.2
Bbridge-03	pH	6.96									7.17	
Bbridge-03	Conductivity (us/cm)	353									329	
Bbridge-03	D.O. (mg/L)	5.96	4.65	4.76	3.28	3.08	3.81	4.13	3.05	3.47	4.54	3.01
Bbridge-03	Temp (C)	21.19	21.9	22.6	22.3	22.4	22.2	22.9	23.0	22.5	22.80	22.6
Bbridge-03	Hardness	117										94
Bbridge-03	Alkalinity	92.6										72.2
Bbridge-04	pH	6.97									7.16	
Bbridge-04	Conductivity (us/cm)	359									328	
Bbridge-04	D.O. (mg/L)	5.85	4.56	4.73	3.56	3.63	4.26	3.96	3.42	3.36	4.48	3.14
Bbridge-04	Temp (C)	21.17	21.8	22.4	22.2	22.3	22.1	22.9	23.0	22.5	22.75	22.6
Bbridge-04	Hardness	117										94
Bbridge-04	Alkalinity	92.6										72.2

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Bbridge-05	pH	7.00									7.16	
Bbridge-05	Conductivity (us/cm)	369									315	
Bbridge-05	D.O. (mg/L)	5.73	4.54	4.57	3.95	3.68	3.67	3.53	3.23	3.51	4.42	2.98
Bbridge-05	Temp (C)	21.22	21.7	22.5	22.2	22.5	22.2	22.8	22.9	22.5	22.74	22.6
Bbridge-05	Hardness	117										94
Bbridge-05	Alkalinity	92.6										72.2
Bbridge-06	pH	7.01									7.15	
Bbridge-06	Conductivity (us/cm)	365									314	
Bbridge-06	D.O. (mg/L)	5.68	4.41	3.72	3.55	3.59	4.09	3.83	3.30	3.43	4.31	3.16
Bbridge-06	Temp (C)	21.24	21.8	22.5	22.3	22.4	22.3	22.8	22.9	22.4	22.76	22.6
Bbridge-06	Hardness	117										94
Bbridge-06	Alkalinity	92.6										72.2
Bbrigde-07	pH	7.04									7.14	
Bbrigde-07	Conductivity (us/cm)	368									320	
Bbrigde-07	D.O. (mg/L)	5.72	4.32	4.46	3.76	3.48	3.97	4.05	3.29	3.53	4.14	3.10
Bbrigde-07	Temp (C)	21.32	22.0	22.5	22.3	22.4	22.4	22.8	22.9	22.5	22.81	22.6
Bbrigde-07	Hardness	117										94
Bbrigde-07	Alkalinity	92.6										72.2
Bbridge-08	pH	7.05									7.14	
Bbridge-08	Conductivity (us/cm)	369									328	
Bbridge-08	D.O. (mg/L)	5.73	4.62	4.29	3.90	3.73	3.79	4.02	3.25	3.35	4.36	3.40
Bbridge-08	Temp (C)	21.32	22.0	22.6	22.3	22.4	22.4	22.8	22.9	22.5	22.81	22.7
Bbridge-08	Hardness	117										94
Bbridge-08	Alkalinity	92.6										72.2

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
JamesRanch-01	pH	7.08									7.13	
JamesRanch-01	Conductivity (us/cm)	354									329	
JamesRanch-01	D.O. (mg/L)	5.71	4.47	3.74	3.41	3.40	3.96	3.65	3.36	3.27	5.09	3.46
JamesRanch-01	Temp (C)	21.47	22.0	22.7	22.6	22.7	22.4	22.8	23.1	22.4	22.87	22.4
JamesRanch-01	Hardness	128										103
JamesRanch-01	Alkalinity	100										78.6
JamesRanch-02	pH	7.10									7.12	
JamesRanch-02	Conductivity (us/cm)	377									347	
JamesRanch-02	D.O. (mg/L)	5.69	4.31	3.62	3.27	3.55	4.01	3.71	3.63	2.71	4.68	3.44
JamesRanch-02	Temp (C)	21.35	22.0	22.6	22.6	22.6	22.4	22.8	23.1	22.5	22.85	22.6
JamesRanch-02	Hardness	128										103
JamesRanch-02	Alkalinity	100										78.6
JamesRanch-03	pH	7.14									7.11	
JamesRanch-03	Conductivity (us/cm)	378									348	
JamesRanch-03	D.O. (mg/L)	6.50	4.36	3.84	3.44	3.43	3.79	4.03	3.77	3.58	4.52	3.30
JamesRanch-03	Temp (C)	21.24	21.9	22.5	22.5	22.6	22.4	22.9	23.1	22.5	22.78	22.7
JamesRanch-03	Hardness	128										103
JamesRanch-03	Alkalinity	100										78.6
James Ranch-04	pH	7.14									7.13	
James Ranch-04	Conductivity (us/cm)	377									346	
James Ranch-04	D.O. (mg/L)	5.98	4.39	3.61	3.69	3.53	3.86	4.10	3.46	3.45	4.53	3.27
James Ranch-04	Temp (C)	21.31	21.9	22.5	22.4	22.6	22.5	22.9	23.0	22.5	22.80	22.7
James Ranch-04	Hardness	128										103
James Ranch-04	Alkalinity	100										78.6

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
James Ranch-05	pH	7.14									7.14	
James Ranch-05	Conductivity (us/cm)	377									344	
James Ranch-05	D.O. (mg/L)	5.09	4.48	3.85	3.17	3.50	4.10	3.86	3.46	3.43	4.47	3.23
James Ranch-05	Temp (C)	21.25	22.0	22.5	22.3	22.5	22.3	22.9	23.0	22.4	22.71	22.7
James Ranch-05	Hardness	128										103
James Ranch-05	Alkalinity	100										78.6
James Ranch-06	pH	7.16									7.13	
James Ranch-06	Conductivity (us/cm)	377									348	
James Ranch-06	D.O. (mg/L)	5.22	4.35	3.91	3.71	4.04	4.15	4.14	3.44	3.24	4.44	3.36
James Ranch-06	Temp (C)	21.27	21.8	22.5	22.3	22.5	22.3	22.8	22.9	22.4	22.73	22.6
James Ranch-06	Hardness	128										103
James Ranch-06	Alkalinity	100										78.6
JamesRanch-07	pH	7.15									7.16	
JamesRanch-07	Conductivity (us/cm)	388									326	
JamesRanch-07	D.O. (mg/L)	5.13	4.42	3.84	3.36	4.01	4.12	4.20	3.17	3.35	4.42	3.17
JamesRanch-07	Temp (C)	21.23	22.0	22.4	22.3	22.5	22.4	22.8	22.8	22.4	22.78	22.6
JamesRanch-07	Hardness	128										103
JamesRanch-07	Alkalinity	100										78.6
JamesRanch-08	pH	7.15									7.12	
JamesRanch-08	Conductivity (us/cm)	391									338	
JamesRanch-08	D.O. (mg/L)	4.48	4.31	3.73	3.47	3.28	3.78	3.98	3.56	3.32	4.27	3.12
JamesRanch-08	Temp (C)	21.22	22.0	22.5	22.3	22.4	22.3	22.8	22.9	22.4	22.72	22.7
JamesRanch-08	Hardness	128										103
JamesRanch-08	Alkalinity	100										78.6

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
32nd Bridge-01	pH	6.54									5.82	
32nd Bridge-01	Conductivity (us/cm)	365									341	
32nd Bridge-01	D.O. (mg/L)	4.86	4.86	4.70	4.02	4.03	4.25	4.25	3.79	3.58	5.01	3.64
32nd Bridge-01	Temp (C)	20.96	21.84	22.1	22.0	22.1	22.4	22.5	22.5	22.2	22.53	22.7
32nd Bridge-01	Hardness	123										103
32nd Bridge-01	Alkalinity	109										81.8
32nd Bridge-02	pH	6.56									5.93	
32nd Bridge-02	Conductivity (us/cm)	353									342	
32nd Bridge-02	D.O. (mg/L)	3.87	5.05	4.98	4.16	4.01	4.22	3.64	3.76	3.8	5.13	3.17
32nd Bridge-02	Temp (C)	21.04	22.0	22.2	22.0	22.2	22.4	22.6	22.6	22.3	22.14	22.4
32nd Bridge-02	Hardness	123										103
32nd Bridge-02	Alkalinity	109										81.8
32nd Bridge-03	pH	6.63									5.97	
32nd Bridge-03	Conductivity (us/cm)	353									348	
32nd Bridge-03	D.O. (mg/L)	4.28	4.97	5.10	3.65	3.89	4.04	3.67	3.69	3.38	5.28	3.52
32nd Bridge-03	Temp (C)	21.05	21.8	22.3	21.8	22.1	22.4	22.6	22.7	22.4	22.57	22.4
32nd Bridge-03	Hardness	123										103
32nd Bridge-03	Alkalinity	109										81.8
32nd Bridge-04	pH	6.71									6.10	
32nd Bridge-04	Conductivity (us/cm)	366									346	
32nd Bridge-04	D.O. (mg/L)	4.91	4.86	5.01	3.53	4.02	4.16	3.41	3.72	3.74	4.88	3.59
32nd Bridge-04	Temp (C)	21.13	21.8	22.2	22.0	22.2	22.2	22.5	22.5	22.3	22.68	22.5
32nd Bridge-04	Hardness	123										103
32nd Bridge-04	Alkalinity	109										81.8

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
32nd Bridge-05	pH	6.76									6.25	
32nd Bridge-05	Conductivity (us/cm)	370									344	
32nd Bridge-05	D.O. (mg/L)	4.44	4.92	5.02	3.41	3.95	4.15	3.82	3.74	3.63	5.24	3.60
32nd Bridge-05	Temp (C)	21.18	22.0	22.2	22.0	22.1	22.4	22.6	22.6	22.3	22.63	22.6
32nd Bridge-05	Hardness	123										103
32nd Bridge-05	Alkalinity	109										81.8
32nd Bridge-06	pH	6.76									6.32	
32nd Bridge-06	Conductivity (us/cm)	367									346	
32nd Bridge-06	D.O. (mg/L)	3.43	4.68	4.85	3.42	3.75	4.24	3.74	3.60	3.56	4.63	3.37
32nd Bridge-06	Temp (C)	21.22	21.8	22.3	22.2	22.3	22.3	22.6	22.6	22.4	22.71	22.6
32nd Bridge-06	Hardness	123										103
32nd Bridge-06	Alkalinity	109										81.8
32nd Bridge-07	pH	6.77									6.39	
32nd Bridge-07	Conductivity (us/cm)	366									342	
32nd Bridge-07	D.O. (mg/L)	3.19	4.78	4.98	3.46	4.03	4.14	3.94	3.54	3.49	4.57	3.56
32nd Bridge-07	Temp (C)	21.14	21.8	22.3	22.2	22.3	22.3	22.6	22.8	22.4	22.73	22.6
32nd Bridge-07	Hardness	123										103
32nd Bridge-07	Alkalinity	109										81.8
32nd Bridge-08	pH	6.8									6.38	
32nd Bridge-08	Conductivity (us/cm)	369									349	
32nd Bridge-08	D.O. (mg/L)	3.06	4.49	5.05	3.39	3.77	3.88	4.10	3.35	3.54	4.54	3.47
32nd Bridge-08	Temp (C)	21.16	21.8	22.4	22.3	22.3	22.3	22.6	22.8	22.4	22.73	22.7
32nd Bridge-08	Hardness	123										103
32nd Bridge-08	Alkalinity	109										81.8

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Lightner Creek-01	pH	6.84									6.47	
Lightner Creek-01	Conductivity (us/cm)	409									374	
Lightner Creek-01	D.O. (mg/L)	3.81	4.79	4.82	3.63	4.32	4.21	4.01	3.76	3.41	4.74	2.73
Lightner Creek-01	Temp (C)	21.19	22.0	22.6	22.5	22.5	22.0	22.6	22.8	22.4	22.86	22.7
Lightner Creek-01	Hardness	139										119
Lightner Creek-01	Alkalinity	140										103
Lightner Creek-02	pH	6.86									6.13	
Lightner Creek-02	Conductivity (us/cm)	399									364	
Lightner Creek-02	D.O. (mg/L)	4.59	4.94	5.08	3.76	4.03	4.18	4.24	3.71	3.55	4.64	3.35
Lightner Creek-02	Temp (C)	21.37	22.0	22.8	22.7	22.6	22.1	22.8	22.9	22.5	22.92	22.7
Lightner Creek-02	Hardness	139										119
Lightner Creek-02	Alkalinity	140										103
Lightner Creek-03	pH	6.87									6.69	
Lightner Creek-03	Conductivity (us/cm)	397									376	
Lightner Creek-03	D.O. (mg/L)	4.98	4.85	4.99	3.64	4.16	3.96	3.75	3.35	3.46	4.60	3.56
Lightner Creek-03	Temp (C)	21.34	22.0	22.7	22.2	22.3	22.2	22.9	23.1	22.5	22.89	22.8
Lightner Creek-03	Hardness	139										119
Lightner Creek-03	Alkalinity	140										103
Lightner Creek-04	pH	7.01									6.76	
Lightner Creek-04	Conductivity (us/cm)	214									351	
Lightner Creek-04	D.O. (mg/L)	4.67	4.76	5.38	3.59	3.70	4.11	4.24	3.62	3.51	4.42	3.42
Lightner Creek-04	Temp (C)	21.32	21.8	22.6	22.3	22.5	22.2	22.4	23.0	22.5	22.84	22.8
Lightner Creek-04	Hardness	139										119
Lightner Creek-04	Alkalinity	140										103

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Lightner Creek-05	pH	6.88									6.8	
Lightner Creek-05	Conductivity (us/cm)	369									374	
Lightner Creek-05	D.O. (mg/L)	5.29	4.89	5.04	3.72	3.85	4.09	4.00	4.05	3.47	4.61	3.62
Lightner Creek-05	Temp (C)	21.22	21.8	22.4	22.1	22.3	22	22.8	22.9	22.5	22.75	22.8
Lightner Creek-05	Hardness	139										119
Lightner Creek-05	Alkalinity	140										103
Lightner Creek-06	pH	6.90									6.87	
Lightner Creek-06	Conductivity (us/cm)	402									376	
Lightner Creek-06	D.O. (mg/L)	5.36	4.79	4.64	3.53	3.88	3.85	4.26	3.57	3.72	4.65	3.66
Lightner Creek-06	Temp (C)	21.27	21.9	22.5	22.2	22.4	22.0	22.8	22.8	22.4	22.79	22.7
Lightner Creek-06	Hardness	139										119
Lightner Creek-06	Alkalinity	140										103
Lightner Creek-07	pH	6.92									6.89	
Lightner Creek-07	Conductivity (us/cm)	405									373	
Lightner Creek-07	D.O. (mg/L)	5.02	4.88	4.87	3.62	3.90	3.81	4.21	3.73	3.60	4.62	3.48
Lightner Creek-07	Temp (C)	21.25	21.7	22.3	22.2	22.3	22.1	22.7	22.8	22.4	22.67	22.7
Lightner Creek-07	Hardness	139										119
Lightner Creek-07	Alkalinity	140										103
Lightner Creek-08	pH	6.95									6.95	
Lightner Creek-08	Conductivity (us/cm)	404									366	
Lightner Creek-08	D.O. (mg/L)	5.32	4.40	4.86	3.46	4.02	4.17	4.00	3.67	3.44	4.61	3.69
Lightner Creek-08	Temp (C)	21.27	21.8	22.5	22.3	22.4	21.9	22.6	22.8	22.4	22.77	22.6
Lightner Creek-08	Hardness	139										119
Lightner Creek-08	Alkalinity	140										103

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Purple Cliffs-01	pH	7.01									6.98	
Purple Cliffs-01	Conductivity (us/cm)	372									348	
Purple Cliffs-01	D.O. (mg/L)	6.46	4.70	4.09	3.35	3.91	4.11	4.43	3.66	3.63	4.94	3.06
Purple Cliffs-01	Temp (C)	21.20	22.1	22.8	22.6	22.7	22.1	22.7	23.1	22.5	22.66	22.7
Purple Cliffs-01	Hardness	111										111
Purple Cliffs-01	Alkalinity	89.8										90.8
Purple Cliffs-02	pH	6.99									7.04	
Purple Cliffs-02	Conductivity (us/cm)	369									354	
Purple Cliffs-02	D.O. (mg/L)	6.26	4.58	4.26	3.45	3.88	3.91	4.10	3.83	3.72	4.73	3.32
Purple Cliffs-02	Temp (C)	21.35	22.1	22.8	22.6	22.7	22.1	22.8	23.1	22.5	22.88	22.8
Purple Cliffs-02	Hardness	111										111
Purple Cliffs-02	Alkalinity	89.8										90.8
Purple Cliffs-03	pH	7.03									7.08	
Purple Cliffs-03	Conductivity (us/cm)	351									341	
Purple Cliffs-03	D.O. (mg/L)	6.16	4.69	4.16	4.09	3.74	4.18	4.04	3.72	3.56	4.75	2.49
Purple Cliffs-03	Temp (C)	21.32	22.0	22.6	22.4	22.6	22.1	22.4	23.1	22.5	22.83	22.7
Purple Cliffs-03	Hardness	111										111
Purple Cliffs-03	Alkalinity	89.8										90.8
Purple Cliffs-04	pH	7.12									7.11	
Purple Cliffs-04	Conductivity (us/cm)	211									343	
Purple Cliffs-04	D.O. (mg/L)	6.08	4.46	4.35	3.66	3.92	4.13	4.18	3.91	3.52	4.77	3.63
Purple Cliffs-04	Temp (C)	21.35	22.1	22.6	22.3	22.5	22.1	22.9	23.1	22.5	22.84	22.7
Purple Cliffs-04	Hardness	111										111
Purple Cliffs-04	Alkalinity	89.8										90.8

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014

Sediment Toxicity Test

10-Day Static Renewal Data Sheets

Start Date	11/10/14	No. of Replicates	8
End Date	11/20/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	80
Analysts	SA, LC, CL		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Purple Cliffs-05	pH	7.06									7.13	
Purple Cliffs-05	Conductivity (us/cm)	295									348	
Purple Cliffs-05	D.O. (mg/L)	6.19	4.62	4.49	3.54	3.87	3.93	4.11	3.68	3.49	4.84	3.38
Purple Cliffs-05	Temp (C)	21.26	21.9	22.5	22.3	22.4	21.9	22.9	23	22.5	22.76	22.6
Purple Cliffs-05	Hardness	111										111
Purple Cliffs-05	Alkalinity	89.8										90.8
Purple Cliffs-06	pH	7.05									7.13	
Purple Cliffs-06	Conductivity (us/cm)	321									351	
Purple Cliffs-06	D.O. (mg/L)	6.19	4.49	4.03	3.59	4.05	4.02	4.26	3.50	3.61	4.80	3.44
Purple Cliffs-06	Temp (C)	21.29	22.0	22.5	22.3	22.4	22.0	22.8	23.0	22.4	22.82	22.6
Purple Cliffs-06	Hardness	111										111
Purple Cliffs-06	Alkalinity	89.8										90.8
Purple Cliffs-07	pH	7.07									7.16	
Purple Cliffs-07	Conductivity (us/cm)	325									343	
Purple Cliffs-07	D.O. (mg/L)	6.16	4.75	3.95	3.53	4.14	4.12	4.30	3.59	3.67	4.72	3.42
Purple Cliffs-07	Temp (C)	21.26	21.9	22.5	22.2	22.4	22.0	22.7	23.0	22.5	22.82	22.6
Purple Cliffs-07	Hardness	111										111
Purple Cliffs-07	Alkalinity	89.8										90.8
Purple Cliffs-08	pH	7.06									7.16	
Purple Cliffs-08	Conductivity (us/cm)	286									335	
Purple Cliffs-08	D.O. (mg/L)	6.12	4.6	4.39	3.44	3.74	4.03	4.25	3.67	3.57	4.67	3.67
Purple Cliffs-08	Temp (C)	21.28	21.9	22.6	22.3	22.5	22.1	22.7	23.0	22.5	22.81	22.7
Purple Cliffs-08	Hardness	111										111
Purple Cliffs-08	Alkalinity	89.8										90.8

Note: All final parameter data is collected on Day 9, but reported on Day 10 per the test method.

Upper Animas 11/2014
Sediment Reference Toxicity Test
4-Day Static Renewal Data Sheets

Start Date	11/17/14	No. of Replicates	4
End Date	11/21/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
Control-01	No. Alive	10	10	10	10	10	
Control-01	pH	6.78				6.76	
Control-01	Conductivity (us/cm)	321				343	Diff
Control-01	D.O. (mg/L)	5.68	4.19	4.13	3.48	4.74	min
Control-01	Temp (C)	22.53	22.4	22.5	21.9	21.88	min
Control-01	Hardness	81				92	Diff
Control-01	Alkalinity	61.4				73.2	Diff
Control-02	No. Alive	10	10	10	10	10	
Control-02	pH	6.75				6.71	
Control-02	Conductivity (us/cm)	328				346	Diff
Control-02	D.O. (mg/L)	5.86	4.33	4.17	4.03	5.23	min
Control-02	Temp (C)	22.62	22.5	22.6	22.2	22.28	min
Control-02	Hardness	81				92	Diff
Control-02	Alkalinity	61.4				73.2	Diff
Control-03	No. Alive	10	10	10	10	10	
Control-03	pH	6.84				6.68	
Control-03	Conductivity (us/cm)	343				347	Diff
Control-03	D.O. (mg/L)	5.63	4.26	4.03	3.29	5.48	min
Control-03	Temp (C)	22.61	22.4	22.7	22.4	22.24	min
Control-03	Hardness	81				92	Diff
Control-03	Alkalinity	61.4				73.2	Diff
Control-04	No. Alive	10	10	10	10	10	
Control-04	pH	6.92				6.76	
Control-04	Conductivity (us/cm)	349				347	Diff
Control-04	D.O. (mg/L)	5.08	4.12	3.95	3.81	5.58	min
Control-04	Temp (C)	22.36	22.4	22.7	22.6	22.2	min
Control-04	Hardness	81				92	Diff
Control-04	Alkalinity	61.4				73.2	Diff

Upper Animas 11/2014
Sediment Reference Toxicity Test
4-Day Static Renewal Data Sheets

Start Date	11/17/14	No. of Replicates	4
End Date	11/21/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
6.25%%-01	No. Alive	10	10	9	9	9	
6.25%%-01	pH	6.96				6.87	
6.25%%-01	Conductivity (us/cm)	341				342	Diff
6.25%%-01	D.O. (mg/L)	5.65	4.11	3.57	3.79	5.38	min
6.25%%-01	Temp (C)	22.57	22.4	22.7	22.7	22.21	min
6.25%%-01	Hardness	80				93	Diff
6.25%%-01	Alkalinity	60.6				75.6	Diff
6.25%%-02	No. Alive	10	10	10	10	10	
6.25%%-02	pH	7.05				6.89	
6.25%%-02	Conductivity (us/cm)	328				341	Diff
6.25%%-02	D.O. (mg/L)	5.47	4.33	3.83	3.6	5.45	min
6.25%%-02	Temp (C)	22.43	22.4	22.7	22.7	22.14	min
6.25%%-02	Hardness	80				93	Diff
6.25%%-02	Alkalinity	60.6				75.6	Diff
6.25%%-03	No. Alive	10	10	10	10	10	
6.25%%-03	pH	7.07				6.95	
6.25%%-03	Conductivity (us/cm)	315				347	Diff
6.25%%-03	D.O. (mg/L)	5.84	4.00	3.31	3.71	5.52	min
6.25%%-03	Temp (C)	22.42	22.5	22.8	22.8	22.23	min
6.25%%-03	Hardness	80				93	Diff
6.25%%-03	Alkalinity	60.6				75.6	Diff
6.25%%-04	No. Alive	10	10	10	10	10	
6.25%%-04	pH	7.1				7.01	
6.25%%-04	Conductivity (us/cm)	336				346	Diff
6.25%%-04	D.O. (mg/L)	5.76	4.07	3.81	3.67	5.57	min
6.25%%-04	Temp (C)	22.59	22.4	22.8	22.8	22.26	min
6.25%%-04	Hardness	80				93	Diff
6.25%%-04	Alkalinity	60.6				75.6	Diff

Upper Animas 11/2014
Sediment Reference Toxicity Test
4-Day Static Renewal Data Sheets

Start Date	11/17/14	No. of Replicates	4
End Date	11/21/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
12.5%-01	No. Alive	10	10	10	10	10	
12.5%-01	pH	7.16				7.05	
12.5%-01	Conductivity (us/cm)	325				342	Diff
12.5%-01	D.O. (mg/L)	5.89	4.23	3.22	3.48	5.59	min
12.5%-01	Temp (C)	22.54	22.4	22.8	22.7	22.3	min
12.5%-01	Hardness	80				91	Diff
12.5%-01	Alkalinity	60.7				74.4	Diff
12.5%-02	No. Alive	10	10	10	10	10	
12.5%-02	pH	7.15				7.08	
12.5%-02	Conductivity (us/cm)	318				346	Diff
12.5%-02	D.O. (mg/L)	5.78	4.13	3.36	3.57	5.48	min
12.5%-02	Temp (C)	22.57	22.4	22.8	22.8	22.2	min
12.5%-02	Hardness	80				91	Diff
12.5%-02	Alkalinity	60.7				74.4	Diff
12.5%-03	No. Alive	10	10	10	10	10	
12.5%-03	pH	7.19				7.10	
12.5%-03	Conductivity (us/cm)	326				347	Diff
12.5%-03	D.O. (mg/L)	5.55	4.02	3.29	3.55	5.43	min
12.5%-03	Temp (C)	22.45	22.4	22.8	22.8	22.17	min
12.5%-03	Hardness	80				91	Diff
12.5%-03	Alkalinity	60.7				74.4	Diff
12.5%-04	No. Alive	10	10	10	10	10	
12.5%-04	pH	7.18				7.12	
12.5%-04	Conductivity (us/cm)	321				338	Diff
12.5%-04	D.O. (mg/L)	5.66	4.11	3.44	3.66	5.52	min
12.5%-04	Temp (C)	22.52	22.4	22.8	22.8	22.25	min
12.5%-04	Hardness	80				91	Diff
12.5%-04	Alkalinity	60.7				74.4	Diff

Upper Animas 11/2014
Sediment Reference Toxicity Test
4-Day Static Renewal Data Sheets

Start Date	11/17/14	No. of Replicates	4
End Date	11/21/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
25%-01	No. Alive	10	7	2	1	1	
25%-01	pH	7.24				7.12	Diff
25%-01	Conductivity (us/cm)	319				344	Diff
25%-01	D.O. (mg/L)	6.01	4.01	3.52	3.77	5.62	min
25%-01	Temp (C)	22.39	22.4	22.7	22.8	22.18	min
25%-01	Hardness	80				93	Diff
25%-01	Alkalinity	61.5				75.2	Diff
25%-02	No. Alive	10	9	3	0		
25%-02	pH	7.26					
25%-02	Conductivity (us/cm)	315					Diff
25%-02	D.O. (mg/L)	5.89	4.07	3.69	3.62		min
25%-02	Temp (C)	22.52	22.4	22.7	22.8		min
25%-02	Hardness	80			93		Diff
25%-02	Alkalinity	61.5			75.2		Diff
25%-03	No. Alive	10	7	2	2	2	
25%-03	pH	7.24				7.15	Diff
25%-03	Conductivity (us/cm)	329				338	Diff
25%-03	D.O. (mg/L)	5.67	4.13	3.63	3.68	5.62	min
25%-03	Temp (C)	22.51	22.4	22.7	22.8	22.2	min
25%-03	Hardness	80				93	Diff
25%-03	Alkalinity	61.5				75.2	Diff
25%-04	No. Alive	10	10	2	2	2	
25%-04	pH	7.25				7.12	Diff
25%-04	Conductivity (us/cm)	316				341	Diff
25%-04	D.O. (mg/L)	5.83	4.19	3.60	3.22	5.62	min
25%-04	Temp (C)	22.50	22.5	22.7	22.8	22.15	min
25%-04	Hardness	80				93	Diff
25%-04	Alkalinity	61.5				75.2	Diff

Upper Animas 11/2014
Sediment Reference Toxicity Test
4-Day Static Renewal Data Sheets

Start Date	11/17/14	No. of Replicates	4
End Date	11/21/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
50%-01	No. Alive	10	2	0			
50%-01	pH	7.23					
50%-01	Conductivity (us/cm)	331					Diff
50%-01	D.O. (mg/L)	6.00	3.94	3.40			min
50%-01	Temp (C)	22.51	22.5	22.8			min
50%-01	Hardness	79	89				Diff
50%-01	Alkalinity	60.6	68.4				Diff
50%-02	No. Alive	10	3	0			
50%-02	pH	7.25					
50%-02	Conductivity (us/cm)	330					Diff
50%-02	D.O. (mg/L)	5.96	3.96	3.61			min
50%-02	Temp (C)	22.54	22.4	22.7			min
50%-02	Hardness	79		89			Diff
50%-02	Alkalinity	60.6		68.4			Diff
50%-03	No. Alive	10	5	0			
50%-03	pH	7.25					
50%-03	Conductivity (us/cm)	320					Diff
50%-03	D.O. (mg/L)	5.72	4.04	3.54			min
50%-03	Temp (C)	22.56	22.4	22.7			min
50%-03	Hardness	79		89			Diff
50%-03	Alkalinity	60.6		68.4			Diff
50%-04	No. Alive	10	3	0			
50%-04	pH	7.26					
50%-04	Conductivity (us/cm)	334					Diff
50%-04	D.O. (mg/L)	5.77	3.82	3.58			min
50%-04	Temp (C)	22.59	22.4	22.6			min
50%-04	Hardness	79		89			Diff
50%-04	Alkalinity	60.6		68.4			Diff

Upper Animas 11/2014
Sediment Reference Toxicity Test
4-Day Static Renewal Data Sheets

Start Date	11/17/14	No. of Replicates	4
End Date	11/21/14	Organism	*H. azteca*
Water Type	MHRW	No. of Organisms	40
Analysts	SA, CL, LC		

Site I.D.	Parameter	Day 0	Day 1	Day 2	Day 3	Day 4	
100%-01	No. Alive	10	0				
100%-01	pH	7.26					
100%-01	Conductivity (us/cm)	315					Diff
100%-01	D.O. (mg/L)	5.53	4.40				min
100%-01	Temp (C)	22.56	22.7				min
100%-01	Hardness	80	88				Diff
100%-01	Alkalinity	61.4	64.6				Diff
100%-02	No. Alive	10	0				
100%-02	pH	7.25					
100%-02	Conductivity (us/cm)	322					Diff
100%-02	D.O. (mg/L)	5.79	4.21				min
100%-02	Temp (C)	22.57	22.7				min
100%-02	Hardness	80	88				Diff
100%-02	Alkalinity	61.4	64.6				Diff
100%-03	No. Alive	10	0				
100%-03	pH	7.25					
100%-03	Conductivity (us/cm)	330					Diff
100%-03	D.O. (mg/L)	5.61	4.37				min
100%-03	Temp (C)	22.64	22.7				min
100%-03	Hardness	80	88				Diff
100%-03	Alkalinity	61.4	64.6				Diff
100%-04	No. Alive	10	0				
100%-04	pH	7.24					
100%-04	Conductivity (us/cm)	338					Diff
100%-04	D.O. (mg/L)	5.74	4.23				min
100%-04	Temp (C)	22.55	22.7				min
100%-04	Hardness	80	88				Diff
100%-04	Alkalinity	61.4	64.6				Diff

DO
Temp(C)

Finalized by: B. Belmonte (2/26/15)

Reviewed by: E. Czerepak (3/2/15)

Hyalella 10-d Survival and Growth Sediment Test — U.S. EPA Region I Lab

Start Date:	10 Nov-14	**Species:**	Hyalella azteca	**Sample Code:**	Control-N
End Date:	20 Nov-14	**Protocol:**	EPA/600/R-99/064 (2000)	**Sample Source:**	Upper Animas River
Sample Date:	10 Nov-14	**Material:**	Lab Control	**Sample Station:**	Control-N

Batch Note: Region 8 Upper Animas H. azteca 10-day Sed Tox Test

Sample Code	Rep	Pos	# Exposed	# Survived	Total Weight-mg	Tare Weight-mg	Pan Count	Mean Length-mm	Notes
Control-N	1	23	10	9	208.3426	207.6113	9		
Control-N	2	56	10	9	207.5908	206.7239	9		
Control-N	3	118	10	10	206.3814	205.511	10		
Control-N	4	81	10	10	205.8288	205.1355	10		
Control-N	5	77	10	10	207.6432	206.7692	10		
Control-N	6	94	10	8	206.7435	206.1714	8		
Control-N	7	67	10	10	205.8951	204.986	10		
Control-N	8	5	10	8	206.9577	206.2273	8		
A75CC	1	134	10	8	208.1568	207.68	8		
A75CC	2	4	10	10	209.0292	208.5678	10		
A75CC	3	25	10	6	208.1641	207.8158	6		
A75CC	4	73	10	6	208.4866	208.1729	6		
A75CC	5	68	10	8	210.2696	209.9231	8		
A75CC	6	49	10	8	207.3402	206.9601	8		
A75CC	7	40	10	4	207.489	207.2649	4		
A75CC	8	60	10	9	209.0098	208.6332	9		
Control P	1	15	10	10	205.9119	205.204	10		
Control P	2	50	10	9	206.2787	205.9981	9		
Control P	3	6	10	10	207.1274	206.5809	10		
Control P	4	98	10	9	209.3106	208.732	9		
Control P	5	26	10	10	207.0222	206.4167	10		
Control P	6	8	10	10	206.595	206.1334	10		
Control P	7	130	10	9	207.4819	206.9779	9		
Control P	8	120	10	6	209.5893	209.1865	6		
A55	1	110	10	7	208.074	207.8187	7		
A55	2	37	10	5	209.5656	209.3796	5		
A55	3	74	10	5	209.1354	209.0059	5		
A55	4	9	10	7	208.5327	208.339	7		
A55	5	11	10	9	204.9229	204.6451	9		
A55	6	47	10	5	206.5583	206.3862	5		
A55	7	72	10	6	208.3542	208.0285	6		
A55	8	52	10	4	207.2939	207.144	4		
A56	1	119	10	1	207.1091	207.086	1		
A56	2	79	10	5	208.4545	208.273	5		
A56	3	18	10	7	208.5519	208.3687	7		
A56	4	33	10	0	0	0	0		
A56	5	70	10	6	205.6186	205.3785	6		
A56	6	41	10	7	206.3438	206.1552	7		
A56	7	2	10	4	208.7151	208.613	4		
A56	8	38	10	5	207.4837	207.2572	5		
A60	1	34	10	8	207.0132	206.79	8		
A60	2	114	10	9	206.6519	206.414	9		
A60	3	61	10	10	209.1725	208.9172	10		
A60	4	16	10	7	206.9568	206.8064	7		
A60	5	30	10	9	205.8286	205.5427	9		
A60	6	136	10	8	206.9449	206.6308	8		

CETIS Test Data Worksheet

Sample Code	Rep	Pos	# Exposed	# Survived	Total Weight-mg	Tare Weight-mg	Pan Count	Mean Length-mm	Notes
A60	7	45	10	7	207.9976	207.7838	7		
A60	8	32	10	4	210.1034	209.9327	4		
A68	1	76	10	8	208.3643	208.0946	8		
A68	2	135	10	9	205.7435	205.4391	9		
A68	3	29	10	1	208.8016	208.7512	1		
A68	4	115	10	8	209.2317	208.9013	8		
A68	5	80	10	8	206.5217	206.2528	8		
A68	6	128	10	5	209.1242	208.9554	5		
A68	7	117	10	7	210.7435	210.5594	7		
A68	8	69	10	10	208.4949	208.2128	10		
A72	1	104	10	6	207.2154	206.9381	6		
A72	2	62	10	8	209.6556	209.3129	8		
A72	3	39	10	5	207.2287	207.0233	5		
A72	4	106	10	7	207.7972	207.5165	7		
A72	5	59	10	9	208.105	207.8167	9		
A72	6	131	10	8	209.2174	208.8171	8		
A72	7	126	10	7	209.4203	209.2316	7		
A72	8	103	10	6	207.6217	207.3712	6		
A73	1	51	10	7	207.2189	206.9986	7		
A73	2	78	10	4	208.6951	208.5852	4		
A73	3	92	10	9	206.7427	206.4618	9		
A73	4	66	10	10	207.0864	206.77	10		
A73	5	88	10	6	207.0509	206.8475	6		
A73	6	43	10	5	206.0139	205.8361	5		
A73	7	123	10	9	207.3785	207.168	9		
A73	8	133	10	9	209.7734	209.5475	9		
A75D	1	3	10	6	0	0	6		Pan compromised.
A75D	2	12	10	6	209.2417	208.9843	6		
A75D	3	99	10	10	205.2781	204.9843	10		
A75D	4	1	10	5	207.6873	207.5442	5		
A75D	5	13	10	10	205.6294	205.343	10		
A75D	6	75	10	6	208.1183	207.9584	6		
A75D	7	112	10	10	207.0328	206.6494	10		
A75D	8	24	10	8	207.1052	206.8881	8		
A75EC	1	122	10	8	207.0635	206.7089	8		
A75EC	2	44	10	7	209.6514	209.294	7		
A75EC	3	95	10	10	208.2016	207.6782	10		
A75EC	4	97	10	10	208.3832	207.9921	10		
A75EC	5	85	10	7	209.0792	208.7561	7		
A75EC	6	91	10	10	206.7653	206.3319	10		
A75EC	7	101	10	10	208.1076	207.7201	10		
A75EC	8	19	10	3	207.6433	207.5131	3		
Bbridge	1	89	10	10	205.5902	205.1815	10		
Bbridge	2	35	10	8	207.2463	206.9466	8		
Bbridge	3	10	10	9	208.0159	207.7473	9		
Bbridge	4	27	10	8	206.1191	205.7702	8		
Bbridge	5	22	10	8	206.5993	206.3318	8		
Bbridge	6	111	10	9	206.9883	206.6341	9		
Bbridge	7	113	10	10	206.8127	206.5115	10		
Bbridge	8	83	10	7	210.2117	209.9965	7		
Jranch	1	107	10	6	207.895	207.6713	6		
Jranch	2	63	10	8	208.0979	207.8392	8		

CETIS Test Data Worksheet

Sample Code	Rep	Pos	# Exposed	# Survived	Total Weight-mg	Tare Weight-mg	Pan Count	Mean Length-mm	Notes
Jranch	3	108	10	9	207.8972	207.5522	9		
Jranch	4	58	10	7	206.1366	205.8186	7		
Jranch	5	84	10	7	206.6957	206.4944	7		
Jranch	6	48	10	1	206.7669	206.6971	1		
Jranch	7	87	10	7	206.3819	206.1352	7		
Jranch	8	116	10	8	207.8095	207.5206	8		
32nd St	1	46	10	10	206.9652	206.5025	10		
32nd St	2	53	10	10	209.3214	208.9568	10		
32nd St	3	100	10	7	207.8676	207.6663	7		
32nd St	4	93	10	9	207.3259	206.97	9		
32nd St	5	28	10	9	205.2205	204.9375	9		
32nd St	6	65	10	8	206.6314	206.2368	8		
32nd St	7	17	10	8	204.7687	204.458	8		
32nd St	8	125	10	9	206.969	206.6692	9		
Lcreek	1	86	10	6	206.2958	206.0908	6		
Lcreek	2	129	10	9	208.046	207.6678	9		
Lcreek	3	31	10	10	206.4629	206.0668	10		
Lcreek	4	124	10	5	205.3621	205.19	5		
Lcreek	5	64	10	9	207.135	206.8737	9		
Lcreek	6	121	10	4	205.722	205.5959	4		
Lcreek	7	57	10	7	206.3163	206.1128	7		
Lcreek	8	127	10	9	204.9214	204.7136	9		
Pcliffs	1	7	10	4	204.3396	204.2406	4		
Pcliffs	2	82	10	1	205.7877	205.728	1		
Pcliffs	3	71	10	6	207.4581	207.2649	6		
Pcliffs	4	55	10	2	209.2921	209.2126	2		
Pcliffs	5	109	10	3	208.4106	208.2781	3		
Pcliffs	6	102	10	0	0	0	0		
Pcliffs	7	54	10	8	207.8914	207.6319	8		
Pcliffs	8	20	10	1	208.9596	208.8785	1		
A68 Dup	1	90	10	10	207.3689	206.9817	10		
A68 Dup	2	96	10	6	204.8314	204.6343	6		
A68 Dup	3	42	10	7	207.0522	206.8026	7		
A68 Dup	4	14	10	7	206.2305	206.0619	7		
A68 Dup	5	21	10	3	204.9787	204.8766	3		
A68 Dup	6	105	10	8	204.9936	204.6517	8		
A68 Dup	7	36	10	7	207.7401	207.5237	7		
A68 Dup	8	132	10	8	208.7234	208.4738	8		

Hyalella 10-d Survival and Growth Sediment Test — **U.S. EPA Region I Lab**

Analysis ID:	19-5339-8603	**Endpoint:**	Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	04 Mar-15 14:56	**Analysis:**	Parametric-Multiple Comparison	**Official Results:**	Yes

Batch Note: Region 8 Upper Animas H. azteca 10-day Sed Tox Test

Sample Code	Sample Notes
Control-N	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A75CC	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Control P	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A55	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A56	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A60	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A68	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A72	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A73	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A75D	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A75EC	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Bbridge	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Jranch	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
32nd St	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Lcreek	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Pcliffs	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A68 Dup	Region 8 Upper Animas H. azteca 10-day Sed Tox Test

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	15.7%	

Bonferroni Adj t Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Control-N		A75CC	9.431	2.784	0.012	14	<0.0001	CDF	Significant Effect
		Control P	6.136	2.784	0.012	14	<0.0001	CDF	Significant Effect
		A55	12.95	2.784	0.012	14	<0.0001	CDF	Significant Effect
		A56	14.49	2.784	0.012	14	<0.0001	CDF	Significant Effect
		A60	12.49	2.784	0.012	14	<0.0001	CDF	Significant Effect
		A68	12.47	2.784	0.012	14	<0.0001	CDF	Significant Effect
		A72	11.4	2.784	0.012	14	<0.0001	CDF	Significant Effect
		A73	12.79	2.784	0.012	14	<0.0001	CDF	Significant Effect
		A75D	11.68	2.784	0.013	13	<0.0001	CDF	Significant Effect
		A75EC	9.507	2.784	0.012	14	<0.0001	CDF	Significant Effect
		Bbridge	10.75	2.784	0.012	14	<0.0001	CDF	Significant Effect
		Jranch	12.2	2.784	0.012	14	<0.0001	CDF	Significant Effect
		32nd St	10.16	2.784	0.012	14	<0.0001	CDF	Significant Effect
		Lcreek	12.21	2.784	0.012	14	<0.0001	CDF	Significant Effect
		Pcliffs	15.18	2.784	0.012	14	<0.0001	CDF	Significant Effect
		A68 Dup	12.31	2.784	0.012	14	<0.0001	CDF	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.03051157	0.001906973	16	24.62	<0.0001	Significant Effect
Error	0.009139366	7.745225E-05	118			
Total	0.03965093		134			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	12.07	32	0.7391	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9891	0.9736	0.3699	Normal Distribution

Hyalella 10-d Survival and Growth Sediment Test

U.S. EPA Region I Lab

Analysis ID: 19-5339-8603 Endpoint: Mean Dry Biomass-mg CETIS Version: CETISv1.8.7
Analyzed: 04 Mar-15 14:56 Analysis: Parametric-Multiple Comparison Official Results: Yes

Mean Dry Biomass-mg Summary

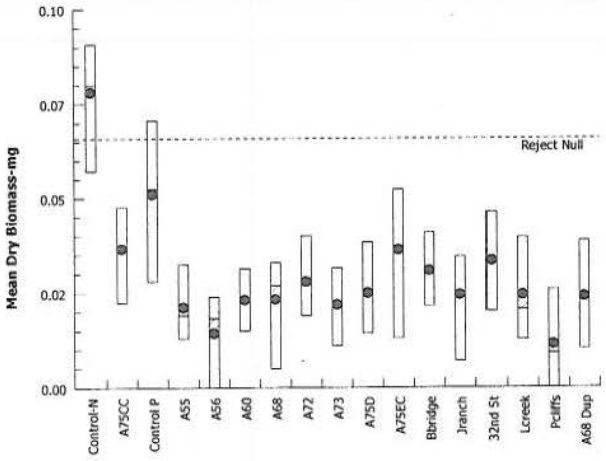
Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control-N	8	0.07809	0.06826	0.08792	0.07991	0.05721	0.09091	0.004157	15.06%	0.0%
A75CC	8	0.03659	0.02987	0.04332	0.03624	0.02241	0.04768	0.002843	21.97%	53.14%
Control P	8	0.05109	0.04011	0.06208	0.05252	0.02806	0.07079	0.004645	25.71%	34.57%
A55	8	0.02113	0.01544	0.02681	0.01898	0.01295	0.03257	0.002405	32.2%	72.95%
A56	8	0.01431	0.006699	0.02193	0.01824	0	0.02401	0.00322	63.64%	81.67%
A60	8	0.02314	0.01856	0.02773	0.02306	0.01504	0.03141	0.001939	23.69%	70.37%
A68	8	0.02323	0.01553	0.03094	0.02693	0.00504	0.03304	0.003259	39.67%	70.25%
A72	8	0.02792	0.02216	0.03369	0.0279	0.01887	0.04003	0.002437	24.68%	64.24%
A73	8	0.02181	0.01659	0.02703	0.02154	0.01099	0.03164	0.002207	28.62%	72.07%
A75D	7	0.02487	0.01716	0.03258	0.02574	0.01431	0.03834	0.003152	33.52%	68.15%
A75EC	8	0.03626	0.02689	0.04563	0.03725	0.01302	0.05234	0.003963	30.92%	53.57%
Bbridge	8	0.0308	0.02572	0.03588	0.03005	0.02152	0.04087	0.002149	19.74%	60.56%
Jranch	8	0.0244	0.0173	0.0315	0.02527	0.006981	0.0345	0.003003	34.81%	68.75%
32nd St	8	0.03341	0.02681	0.04	0.03333	0.02013	0.04627	0.002789	23.62%	57.22%
Lcreek	8	0.02438	0.01632	0.03243	0.02064	0.01261	0.03961	0.003407	39.53%	68.79%
Pcliffs	8	0.01131	0.004513	0.0181	0.009005	0	0.02595	0.002873	71.87%	85.52%
A68 Dup	8	0.02391	0.01625	0.03156	0.0233	0.01021	0.03872	0.003239	38.32%	69.39%

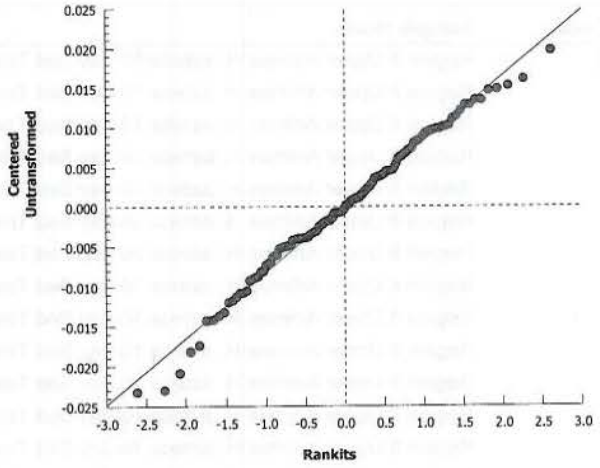
Mean Dry Biomass-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
Control-N	0.07313	0.08669	0.08704	0.06933	0.0874	0.05721	0.09091	0.07304
A75CC	0.04768	0.04614	0.03483	0.03137	0.03465	0.03801	0.02241	0.03766
Control P	0.07079	0.02806	0.05465	0.05786	0.06055	0.04616	0.0504	0.04028
A55	0.02553	0.0186	0.01295	0.01937	0.02778	0.01721	0.03257	0.01499
A56	0.00231	0.01815	0.01832	0	0.02401	0.01886	0.01021	0.02265
A60	0.02232	0.02379	0.02553	0.01504	0.02859	0.03141	0.02138	0.01707
A68	0.02697	0.03044	0.00504	0.03304	0.02689	0.01688	0.01841	0.02821
A72	0.02773	0.03427	0.02054	0.02807	0.02883	0.04003	0.01887	0.02505
A73	0.02203	0.01099	0.02809	0.03164	0.02034	0.01778	0.02105	0.02259
A75D	0.02574	0.02938	0.01431	0.02864	0.01599	0.03834	0.02171	
A75EC	0.03546	0.03574	0.05234	0.03911	0.03231	0.04334	0.03875	0.01302
Bbridge	0.04087	0.02997	0.02686	0.03489	0.02675	0.03542	0.03012	0.02152
Jranch	0.02237	0.02587	0.0345	0.0318	0.02013	0.006981	0.02467	0.02889
32nd St	0.04627	0.03646	0.02013	0.03559	0.0283	0.03946	0.03107	0.02998
Lcreek	0.0205	0.03782	0.03961	0.01721	0.02613	0.01261	0.02035	0.02078
Pcliffs	0.0099	0.005971	0.01932	0.00795	0.01325	0	0.02595	0.00811
A68 Dup	0.03872	0.01971	0.02496	0.01686	0.01021	0.03419	0.02164	0.02496

Analysis ID:	19-5339-8603	**Endpoint:**	Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	04 Mar-15 14:56	**Analysis:**	Parametric-Multiple Comparison	**Official Results:**	Yes

Graphics





Hyalella 10-d Survival and Growth Sediment Test — **U.S. EPA Region I Lab**

Analysis ID:	12-4710-3062	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	04 Mar-15 14:55	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch Note: Region 8 Upper Animas H. azteca 10-day Sed Tox Test

Sample Code	Sample Notes
Control-N	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A75CC	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Control P	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A55	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A56	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A60	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A68	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A72	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A73	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A75D	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A75EC	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Bbridge	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Jranch	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
32nd St	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Lcreek	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Pcliffs	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A68 Dup	Region 8 Upper Animas H. azteca 10-day Sed Tox Test

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Angular (Corrected)	NA	C > T	NA	NA	25.6%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Control-N		A75CC	1.986	2.617	0.317	14	0.1835	CDF	Non-Significant Effect
		Control P	0.08184	2.617	0.317	14	0.9280	CDF	Non-Significant Effect
		A55	3.31	2.617	0.317	14	0.0077	CDF	Significant Effect
		A56	4.916	2.617	0.317	14	<0.0001	CDF	Significant Effect
		A60	1.622	2.617	0.317	14	0.3217	CDF	Non-Significant Effect
		A68	2.356	2.617	0.317	14	0.0899	CDF	Non-Significant Effect
		A72	2.436	2.617	0.317	14	0.0756	CDF	Non-Significant Effect
		A73	1.916	2.617	0.317	14	0.2064	CDF	Non-Significant Effect
		A75D	1.627	2.617	0.317	14	0.3196	CDF	Non-Significant Effect
		A75EC	1.078	2.617	0.317	14	0.5817	CDF	Non-Significant Effect
		Bbridge	0.7501	2.617	0.317	14	0.7312	CDF	Non-Significant Effect
		Jranch	2.807	2.617	0.317	14	0.0313	CDF	Significant Effect
		32nd St	0.6035	2.617	0.317	14	0.7884	CDF	Non-Significant Effect
		Lcreek	1.916	2.617	0.317	14	0.2064	CDF	Non-Significant Effect
		Pcliffs	6.033	2.617	0.317	14	<0.0001	CDF	Significant Effect
		A68 Dup	2.372	2.617	0.317	14	0.0869	CDF	Non-Significant Effect

Hyalella 10-d Survival and Growth Sediment Test — U.S. EPA Region I Lab

Analysis ID: 12-4710-3062 Endpoint: Survival Rate CETIS Version: CETISv1.8.7
Analyzed: 04 Mar-15 14:55 Analysis: Parametric-Control vs Treatments Official Results: Yes

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	0.925	0.8 - NL	Yes	Passes Acceptability Criteria

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	4.649254	0.2905784	16	4.967	<0.0001	Significant Effect
Error	6.96171	0.05850177	119			
Total	11.61096		135			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	17.25	32	0.3698	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9814	0.9738	0.0597	Normal Distribution

Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control-N	8	0.925	0.8509	0.9991	0.95	0.8	1	0.03134	9.58%	0.0%
A75CC	8	0.7375	0.5768	0.8982	0.8	0.4	1	0.06797	26.07%	20.27%
Control P	8	0.9125	0.7991	1	0.95	0.6	1	0.04795	14.86%	1.35%
A55	8	0.6	0.4659	0.7341	0.55	0.4	0.9	0.05669	26.73%	35.14%
A56	8	0.4375	0.2189	0.6561	0.5	0	0.7	0.09246	59.78%	52.7%
A60	8	0.775	0.6218	0.9282	0.8	0.4	1	0.06478	23.64%	16.22%
A68	8	0.7	0.4635	0.9365	0.8	0.1	1	0.1	40.41%	24.32%
A72	8	0.7	0.5905	0.8095	0.7	0.5	0.9	0.04629	18.7%	24.32%
A73	8	0.7375	0.5536	0.9214	0.8	0.4	1	0.07778	29.83%	20.27%
A75D	8	0.7625	0.5841	0.9409	0.7	0.5	1	0.07545	27.99%	17.57%
A75EC	8	0.8125	0.6056	1	0.9	0.3	1	0.0875	30.46%	12.16%
Bbridge	8	0.8625	0.7738	0.9512	0.85	0.7	1	0.0375	12.3%	6.76%
Jranch	8	0.6625	0.458	0.867	0.7	0.1	0.9	0.08647	36.92%	28.38%
32nd St	8	0.875	0.7885	0.9615	0.9	0.7	1	0.0366	11.83%	5.41%
Lcreek	8	0.7375	0.5536	0.9214	0.8	0.4	1	0.07778	29.83%	20.27%
Pcliffs	8	0.3125	0.08273	0.5423	0.25	0	0.8	0.09717	87.95%	66.22%
A68 Dup	8	0.7	0.5328	0.8672	0.7	0.3	1	0.07071	28.57%	24.32%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control-N	8	1.295	1.181	1.409	1.331	1.107	1.412	0.0481	10.51%	0.0%
A75CC	8	1.055	0.8634	1.246	1.107	0.6847	1.412	0.081	21.72%	18.54%
Control P	8	1.285	1.134	1.436	1.331	0.8861	1.412	0.06374	14.03%	0.76%
A55	8	0.8948	0.7452	1.044	0.8357	0.6847	1.249	0.06327	20.0%	30.91%
A56	8	0.7006	0.4448	0.9563	0.7854	0.1588	0.9912	0.1081	43.66%	45.91%
A60	8	1.099	0.9152	1.283	1.107	0.6847	1.412	0.07769	20.0%	15.14%
A68	8	1.01	0.7325	1.288	1.107	0.3218	1.412	0.1174	32.87%	22.0%
A72	8	1	0.8751	1.126	0.9912	0.7854	1.249	0.05297	14.98%	22.75%
A73	8	1.063	0.8439	1.283	1.12	0.6847	1.412	0.0928	24.69%	17.89%
A75D	8	1.098	0.8687	1.328	0.9966	0.7854	1.412	0.09713	25.01%	15.19%
A75EC	8	1.165	0.9098	1.42	1.26	0.5796	1.412	0.1078	26.17%	10.07%
Bbridge	8	1.204	1.076	1.332	1.178	0.9912	1.412	0.05412	12.71%	7.01%
Jranch	8	0.9556	0.7229	1.188	0.9912	0.3218	1.249	0.09842	29.13%	26.21%
32nd St	8	1.222	1.098	1.346	1.249	0.9912	1.412	0.05245	12.14%	5.64%
Lcreek	8	1.063	0.8439	1.283	1.12	0.6847	1.412	0.0928	24.69%	17.89%
Pcliffs	8	0.5654	0.3001	0.8308	0.5216	0.1588	1.107	0.1122	56.13%	56.34%
A68 Dup	8	1.008	0.8129	1.204	0.9912	0.5796	1.412	0.0826	23.17%	22.15%

Hyalella 10-d Survival and Growth Sediment Test — U.S. EPA Region I Lab

Analysis ID: 12-4710-3062 Endpoint: Survival Rate CETIS Version: CETISv1.8.7
Analyzed: 04 Mar-15 14:55 Analysis: Parametric-Control vs Treatments Official Results: Yes

Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
Control-N	0.9	0.9	1	1	1	0.8	1	0.8
A75CC	0.8	1	0.6	0.6	0.8	0.8	0.4	0.9
Control P	1	0.9	1	0.9	1	1	0.9	0.6
A55	0.7	0.5	0.5	0.7	0.9	0.5	0.6	0.4
A56	0.1	0.5	0.7	0	0.6	0.7	0.4	0.5
A60	0.8	0.9	1	0.7	0.9	0.8	0.7	0.4
A68	0.8	0.9	0.1	0.8	0.8	0.5	0.7	1
A72	0.6	0.8	0.5	0.7	0.9	0.8	0.7	0.6
A73	0.7	0.4	0.9	1	0.6	0.5	0.9	0.9
A75D	0.6	0.6	1	0.5	1	0.6	1	0.8
A75EC	0.8	0.7	1	1	0.7	1	1	0.3
Bbridge	1	0.8	0.9	0.8	0.8	0.9	1	0.7
Jranch	0.6	0.8	0.9	0.7	0.7	0.1	0.7	0.8
32nd St	1	1	0.7	0.9	0.9	0.8	0.8	0.9
Lcreek	0.6	0.9	1	0.5	0.9	0.4	0.7	0.9
Pcliffs	0.4	0.1	0.6	0.2	0.3	0	0.8	0.1
A68 Dup	1	0.6	0.7	0.7	0.3	0.8	0.7	0.8

Angular (Corrected) Transformed Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
Control-N	1.249	1.249	1.412	1.412	1.412	1.107	1.412	1.107
A75CC	1.107	1.412	0.8861	0.8861	1.107	1.107	0.6847	1.249
Control P	1.412	1.249	1.412	1.249	1.412	1.412	1.249	0.8861
A55	0.9912	0.7854	0.7854	0.9912	1.249	0.7854	0.8861	0.6847
A56	0.3218	0.7854	0.9912	0.1588	0.8861	0.9912	0.6847	0.7854
A60	1.107	1.249	1.412	0.9912	1.249	1.107	0.9912	0.6847
A68	1.107	1.249	0.3218	1.107	1.107	0.7854	0.9912	1.412
A72	0.8861	1.107	0.7854	0.9912	1.249	1.107	0.9912	0.8861
A73	0.9912	0.6847	1.249	1.412	0.8861	0.7854	1.249	1.249
A75D	0.8861	0.8861	1.412	0.7854	1.412	0.8861	1.412	1.107
A75EC	1.107	0.9912	1.412	1.412	0.9912	1.412	1.412	0.5796
Bbridge	1.412	1.107	1.249	1.107	1.107	1.249	1.412	0.9912
Jranch	0.8861	1.107	1.249	0.9912	0.9912	0.3218	0.9912	1.107
32nd St	1.412	1.412	0.9912	1.249	1.249	1.107	1.107	1.249
Lcreek	0.8861	1.249	1.412	0.7854	1.249	0.6847	0.9912	1.249
Pcliffs	0.6847	0.3218	0.8861	0.4636	0.5796	0.1588	1.107	0.3218
A68 Dup	1.412	0.8861	0.9912	0.9912	0.5796	1.107	0.9912	1.107

Hyalella 10-d Survival and Growth Sediment Test

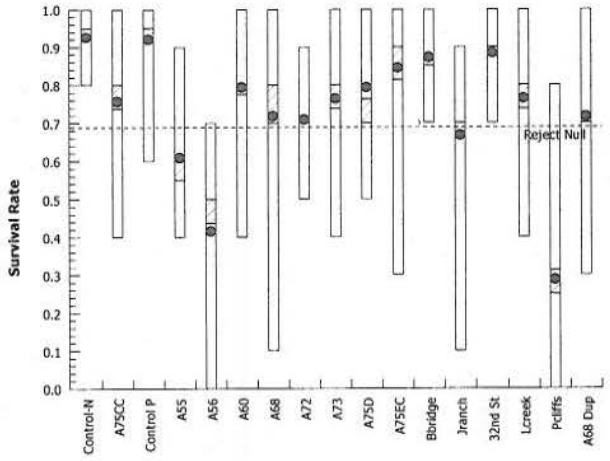
U.S. EPA Region I Lab

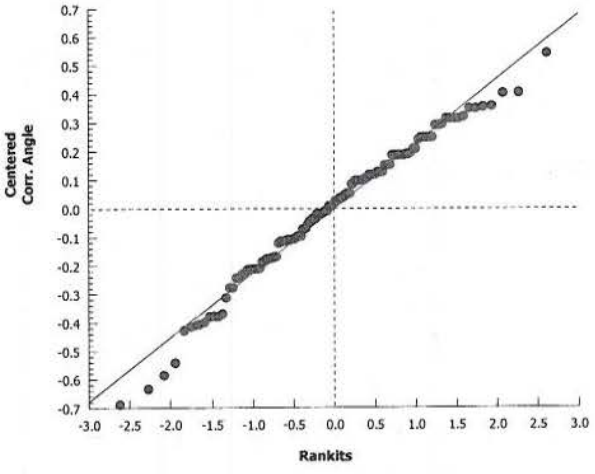
Analysis ID:	12-4710-3062	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	04 Mar-15 14:55	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

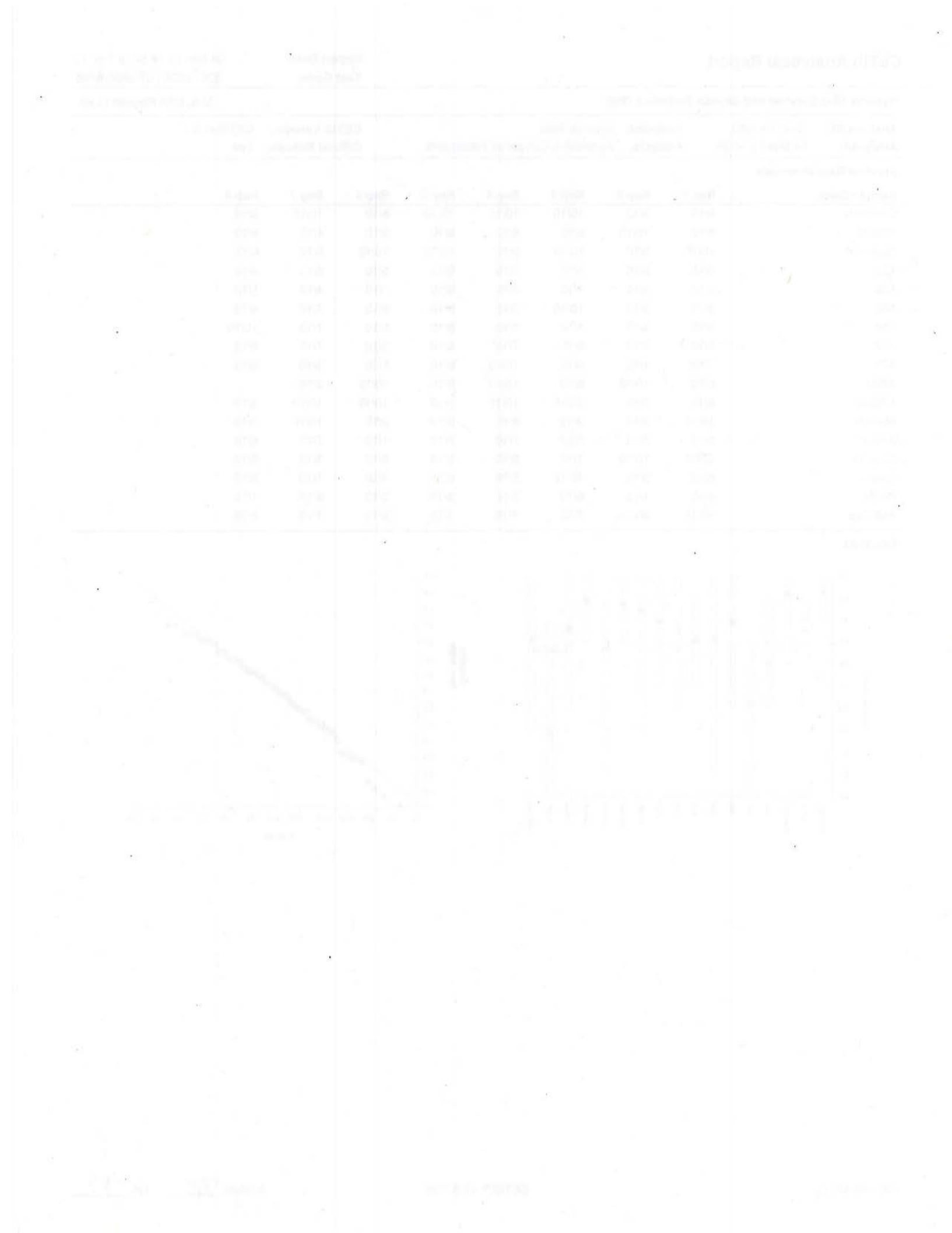
Survival Rate Binomials

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
Control-N	9/10	9/10	10/10	10/10	10/10	8/10	10/10	8/10
A75CC	8/10	10/10	6/10	6/10	8/10	8/10	4/10	9/10
Control P	10/10	9/10	10/10	9/10	10/10	10/10	9/10	6/10
A55	7/10	5/10	5/10	7/10	9/10	5/10	6/10	4/10
A56	1/10	5/10	7/10	0/10	6/10	7/10	4/10	5/10
A60	8/10	9/10	10/10	7/10	9/10	8/10	7/10	4/10
A68	8/10	9/10	1/10	8/10	8/10	5/10	7/10	10/10
A72	6/10	8/10	5/10	7/10	9/10	8/10	7/10	6/10
A73	7/10	4/10	9/10	10/10	6/10	5/10	9/10	9/10
A75D	6/10	10/10	5/10	10/10	6/10	10/10	8/10	
A75EC	8/10	7/10	10/10	10/10	7/10	10/10	10/10	3/10
Bbridge	10/10	8/10	9/10	8/10	8/10	9/10	10/10	7/10
Jranch	6/10	8/10	9/10	7/10	7/10	1/10	7/10	8/10
32nd St	10/10	10/10	7/10	9/10	9/10	8/10	8/10	9/10
Lcreek	6/10	9/10	10/10	5/10	9/10	4/10	7/10	9/10
Pcliffs	4/10	1/10	6/10	2/10	3/10	0/10	8/10	1/10
A68 Dup	10/10	6/10	7/10	7/10	3/10	8/10	7/10	8/10

Graphics







Hyalella 10-d Survival and Growth Sediment Test
U.S. EPA Region I Lab

Batch Note: Region 8 Upper Animas H. azteca 10-day Sed Tox Test

Sample Code	Sample Notes
Control-N	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A75CC	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Control P	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A55	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A56	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A60	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A68	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A72	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A73	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A75D	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A75EC	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Bbridge	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Jranch	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
32nd St	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Lcreek	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
Pcliffs	Region 8 Upper Animas H. azteca 10-day Sed Tox Test
A68 Dup	Region 8 Upper Animas H. azteca 10-day Sed Tox Test

Test Acceptability

Analysis ID	Endpoint	Attribute	Test Stat	TAC Limits	Overlap	Decision
12-4710-3062	Survival Rate	Control Resp	0.925	0.8 - NL	Yes	Passes Acceptability Criteria

Hyalella 10-d Survival and Growth Sediment Test

U.S. EPA Region I Lab

Mean Dry Biomass-mg Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
Control-N	8	0.07809	0.06826	0.08792	0.05721	0.09091	0.004157	0.01176	15.06%	0.0%
A75CC	8	0.03659	0.02987	0.04332	0.02241	0.04768	0.002843	0.00804	21.97%	53.14%
Control P	8	0.05109	0.04011	0.06208	0.02806	0.07079	0.004645	0.01314	25.71%	34.57%
A55	8	0.02113	0.01544	0.02681	0.01295	0.03257	0.002405	0.006803	32.2%	72.95%
A56	8	0.01431	0.006699	0.02193	0	0.02401	0.00322	0.009109	63.64%	81.67%
A60	8	0.02314	0.01856	0.02773	0.01504	0.03141	0.001939	0.005483	23.69%	70.37%
A68	8	0.02323	0.01553	0.03094	0.00504	0.03304	0.003259	0.009218	39.67%	70.25%
A72	8	0.02792	0.02216	0.03369	0.01887	0.04003	0.002437	0.006892	24.68%	64.24%
A73	8	0.02181	0.01659	0.02703	0.01099	0.03164	0.002207	0.006242	28.62%	72.07%
A75D	7	0.02487	0.01716	0.03258	0.01431	0.03834	0.003152	0.008338	33.52%	68.15%
A75EC	8	0.03626	0.02689	0.04563	0.01302	0.05234	0.003963	0.01121	30.92%	53.57%
Bbridge	8	0.0308	0.02572	0.03588	0.02152	0.04087	0.002149	0.006079	19.74%	60.56%
Jranch	8	0.0244	0.0173	0.0315	0.006981	0.0345	0.003003	0.008493	34.81%	68.75%
32nd St	8	0.03341	0.02681	0.04	0.02013	0.04627	0.002789	0.00789	23.62%	57.22%
Lcreek	8	0.02438	0.01632	0.03243	0.01261	0.03961	0.003407	0.009635	39.53%	68.79%
Pcliffs	8	0.01131	0.004513	0.0181	0	0.02595	0.002873	0.008126	71.87%	85.52%
A68 Dup	8	0.02391	0.01625	0.03156	0.01021	0.03872	0.003239	0.00916	38.32%	69.39%

Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
Control-N	8	0.925	0.8509	0.9991	0.8	1	0.03134	0.08864	9.58%	0.0%
A75CC	8	0.7375	0.5768	0.8982	0.4	1	0.06797	0.1923	26.07%	20.27%
Control P	8	0.9125	0.7991	1	0.6	1	0.04795	0.1356	14.86%	1.35%
A55	8	0.6	0.4659	0.7341	0.4	0.9	0.05669	0.1604	26.73%	35.14%
A56	8	0.4375	0.2189	0.6561	0	0.7	0.09246	0.2615	59.78%	52.7%
A60	8	0.775	0.6218	0.9282	0.4	1	0.06478	0.1832	23.64%	16.22%
A68	8	0.7	0.4635	0.9365	0.1	1	0.1	0.2828	40.41%	24.32%
A72	8	0.7	0.5905	0.8095	0.5	0.9	0.04629	0.1309	18.7%	24.32%
A73	8	0.7375	0.5536	0.9214	0.4	1	0.07778	0.22	29.83%	20.27%
A75D	7	0.7857	0.5829	0.9885	0.5	1	0.08289	0.2193	27.91%	15.06%
A75EC	8	0.8125	0.6056	1	0.3	1	0.0875	0.2475	30.46%	12.16%
Bbridge	8	0.8625	0.7738	0.9512	0.7	1	0.0375	0.1061	12.3%	6.76%
Jranch	8	0.6625	0.458	0.867	0.1	0.9	0.08647	0.2446	36.92%	28.38%
32nd St	8	0.875	0.7885	0.9615	0.7	1	0.0366	0.1035	11.83%	5.41%
Lcreek	8	0.7375	0.5536	0.9214	0.4	1	0.07778	0.22	29.83%	20.27%
Pcliffs	8	0.3125	0.08273	0.5423	0	0.8	0.09717	0.2748	87.95%	66.22%
A68 Dup	8	0.7	0.5328	0.8672	0.3	1	0.07071	0.2	28.57%	24.32%

Hyalella 10-d Survival and Growth Sediment Test
U.S. EPA Region I Lab

Mean Dry Biomass-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
Control-N	0.07313	0.08669	0.08704	0.06933	0.0874	0.05721	0.09091	0.07304
A75CC	0.04768	0.04614	0.03483	0.03137	0.03465	0.03801	0.02241	0.03766
Control P	0.07079	0.02806	0.05465	0.05786	0.06055	0.04616	0.0504	0.04028
A55	0.02553	0.0186	0.01295	0.01937	0.02778	0.01721	0.03257	0.01499
A56	0.00231	0.01815	0.01832	0	0.02401	0.01886	0.01021	0.02265
A60	0.02232	0.02379	0.02553	0.01504	0.02859	0.03141	0.02138	0.01707
A68	0.02697	0.03044	0.00504	0.03304	0.02689	0.01688	0.01841	0.02821
A72	0.02773	0.03427	0.02054	0.02807	0.02883	0.04003	0.01887	0.02505
A73	0.02203	0.01099	0.02809	0.03164	0.02034	0.01778	0.02105	0.02259
A75D	0.02574	0.02938	0.01431	0.02864	0.01599	0.03834	0.02171	
A75EC	0.03546	0.03574	0.05234	0.03911	0.03231	0.04334	0.03875	0.01302
Bbridge	0.04087	0.02997	0.02686	0.03489	0.02675	0.03542	0.03012	0.02152
Jranch	0.02237	0.02587	0.0345	0.0318	0.02013	0.006981	0.02467	0.02889
32nd St	0.04627	0.03646	0.02013	0.03559	0.0283	0.03946	0.03107	0.02998
Lcreek	0.0205	0.03782	0.03961	0.01721	0.02613	0.01261	0.02035	0.02078
Pcliffs	0.0099	0.005971	0.01932	0.00795	0.01325	0	0.02595	0.00811
A68 Dup	0.03872	0.01971	0.02496	0.01686	0.01021	0.03419	0.02164	0.02496

Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
Control-N	0.9	0.9	1	1	1	0.8	1	0.8
A75CC	0.8	1	0.6	0.6	0.8	0.8	0.4	0.9
Control P	1	0.9	1	0.9	1	1	0.9	0.6
A55	0.7	0.5	0.5	0.7	0.9	0.5	0.6	0.4
A56	0.1	0.5	0.7	0	0.6	0.7	0.4	0.5
A60	0.8	0.9	1	0.7	0.9	0.8	0.7	0.4
A68	0.8	0.9	0.1	0.8	0.8	0.5	0.7	1
A72	0.6	0.8	0.5	0.7	0.9	0.8	0.7	0.6
A73	0.7	0.4	0.9	1	0.6	0.5	0.9	0.9
A75D	0.6	1	0.5	1	0.6	1	0.8	
A75EC	0.8	0.7	1	1	0.7	1	1	0.3
Bbridge	1	0.8	0.9	0.8	0.8	0.9	1	0.7
Jranch	0.6	0.8	0.9	0.7	0.7	0.1	0.7	0.8
32nd St	1	1	0.7	0.9	0.9	0.8	0.8	0.9
Lcreek	0.6	0.9	1	0.5	0.9	0.4	0.7	0.9
Pcliffs	0.4	0.1	0.6	0.2	0.3	0	0.8	0.1
A68 Dup	1	0.6	0.7	0.7	0.3	0.8	0.7	0.8

Hyalella 10-d Survival and Growth Sediment Test
U.S. EPA Region I Lab

Survival Rate Binomials

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
Control-N	9/10	9/10	10/10	10/10	10/10	8/10	10/10	8/10
A75CC	8/10	10/10	6/10	6/10	8/10	8/10	4/10	9/10
Control P	10/10	9/10	10/10	9/10	10/10	10/10	9/10	6/10
A55	7/10	5/10	5/10	7/10	9/10	5/10	6/10	4/10
A56	1/10	5/10	7/10	0/10	6/10	7/10	4/10	5/10
A60	8/10	9/10	10/10	7/10	9/10	8/10	7/10	4/10
A68	8/10	9/10	1/10	8/10	8/10	5/10	7/10	10/10
A72	6/10	8/10	5/10	7/10	9/10	8/10	7/10	6/10
A73	7/10	4/10	9/10	10/10	6/10	5/10	9/10	9/10
A75D	6/10	10/10	5/10	10/10	6/10	10/10	8/10	
A75EC	8/10	7/10	10/10	10/10	7/10	10/10	10/10	3/10
Bbridge	10/10	8/10	9/10	8/10	8/10	9/10	10/10	7/10
Jranch	6/10	8/10	9/10	7/10	7/10	1/10	7/10	8/10
32nd St	10/10	10/10	7/10	9/10	9/10	8/10	8/10	9/10
Lcreek	6/10	9/10	10/10	5/10	9/10	4/10	7/10	9/10
Pcliffs	4/10	1/10	6/10	2/10	3/10	0/10	8/10	1/10
A68 Dup.	10/10	6/10	7/10	7/10	3/10	8/10	7/10	8/10

CETIS Test Data Worksheet

Reference Toxicant 96-h Acute Survival Test — U.S. EPA Region I Lab

Start Date:	17 Nov-14	**Species:**	Hyalella azteca	**Sample Code:**	R81114HAARTT
End Date:	21 Nov-14	**Protocol:**	EPA/600/R-99/064 (2000)	**Sample Source:**	Reference Toxicant
Sample Date:	17 Nov-14	**Material:**	Zinc sulfate	**Sample Station:**	

Batch Note: Region 8: November 2014 Acute Reference Toxicity Test Using H. azteca (Concurrent with Upper Animas River sediment toxicity test)

Sample Note: Region 8: November 2014 Acute Reference Toxicity Test Using H. azteca (Concurrent with Upper Animas River sediment toxicity test)

C-µg/L	Code	Rep	Pos	# Exposed	# Survived	Notes
10.3	L	1	8	10	10	
10.3	L	2	11	10	10	
10.3	L	3	17	10	10	
10.3	L	4	23	10	10	
66.85		1	6	10	9	
66.85		2	15	10	10	
66.85		3	13	10	10	
66.85		4	2	10	10	
133		1	7	10	10	
133		2	4	10	10	
133		3	19	10	10	
133		4	9	10	10	
253.5		1	1	10	1	
253.5		2	18	10	0	
253.5		3	14	10	2	
253.5		4	12	10	2	
464		1	10	10	0	
464		2	20	10	0	
464		3	21	10	0	
464		4	5	10	0	
927		1	3	10	0	
927		2	24	10	0	
927		3	16	10	0	
927		4	22	10	0	

CETIS Analytical Report

Reference Toxicant 96-h Acute Survival Test — **U.S. EPA Region I Lab**

Analysis ID: 14-3963-7611 **Endpoint:** Survival Rate **CETIS Version:** CETISv1.8.7
Analyzed: 26 Feb-15 12:34 **Analysis:** Trimmed Spearman-Kärber **Official Results:** Yes

Batch Note: Region 8: November 2014 Acute Reference Toxicity Test Using H. azteca (Concurrent with Upper Animas River sediment toxicity test)

Sample Note: Region 8: November 2014 Acute Reference Toxicity Test Using H. azteca (Concurrent with Upper Animas River sediment toxicity test)

Trimmed Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	1.25%	2.294	0.0147	196.7	183.8	210.4

Survival Rate Summary — Calculated Variate(A/B)

C-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
10.3	Lab Water	4	1	1	1	0	0	0.0%	0.0%	40	40
66.85		4	0.975	0.9	1	0.025	0.05	5.13%	2.5%	39	40
133		4	1	1	1	0	0	0.0%	0.0%	40	40
253.5		4	0.125	0	0.2	0.04787	0.09574	76.59%	87.5%	5	40
464		4	0	0	0	0	0		100.0%	0	40
927		4	0	0	0	0	0		100.0%	0	40

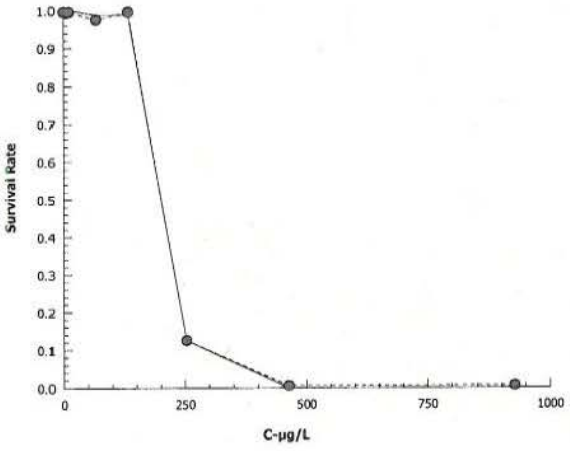
Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
10.3	Lab Water	1	1	1	1
66.85		0.9	1	1	1
133		1	1	1	1
253.5		0.1	0	0.2	0.2
464		0	0	0	0
927		0	0	0	0

Survival Rate Binomials

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
10.3	Lab Water	10/10	10/10	10/10	10/10
66.85		9/10	10/10	10/10	10/10
133		10/10	10/10	10/10	10/10
253.5		1/10	0/10	2/10	2/10
464		0/10	0/10	0/10	0/10
927		0/10	0/10	0/10	0/10

Graphics



Appendix 11

Benthic invertebrate community metrics (September 2014)

Timberline Aquatics, Inc.

February 6, 2015

Mr. Steve Auer
TechLaw
16194 W. 45th Drive
Denver, CO 80403

Dear Mr. Auer,

Enclosed are the results from fourteen (14) benthic macroinvertebrate samples collected for the Animas River Biomonitoring Project during the fall of 2014. Data are reported as 300-count subsamples (based on protocols for MMI calculation provided by the Colorado Department of Public Health and Environment). Specific information on subsampling has been provided in the enclosed Excel file entitled "Animas 2014 grid data". MMI scores were calculated from benthic data for each site. The MMI results are provided at the end of this report. Please contact me if you have any questions.

Sincerely,

Timberline Aquatics, Inc.

David E. Rees
President

Enc.

/dr

4219 Table Mountain Place, Suite A ◈ Fort Collins, CO 80526
Phone: (970) 266-9222 ◈ Web: http://www.timberlineaquatics.com ◈ E-mail: drees@timberlineaquatics.com

Animas River Macroinvertebrate Data
A53
11 Oct. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**55**
Baetidae	*Baetis bicaudatus/ tricaudatus*	1
Ephemerellidae	*Drunella doddsi*	11
Heptageniidae	*Epeorus* sp.	2
Heptageniidae	*Rhithrogena* sp.	41
PLECOPTERA		**164**
Capniidae	Capniidae (*Capnia*)	2
Capniidae	Capniidae (*Utacapnia*)	8
Nemouridae	*Zapada oregonensis* group	81
Taeniopterygidae	*Taenionema* sp.	71
Perlodidae	*Megarcys signata*	2
TRICHOPTERA		**22**
Hydropsychidae	*Arctopsyche grandis*	19
Rhyacophilidae	*Rhyacophila brunnea*	1
Rhyacophilidae	*Rhyacophila hyalinata*	2
DIPTERA		
Chironomidae		**47**
Chironomidae	*Cricotopus*/*Orthocladius* sp.	44
Chironomidae	*Heterotrissocladius* sp.	1
Chironomidae	*Pagastia* sp.	2
DIPTERA (other)		**9**
Ceratopogoninae	Ceratopogoninae	7
Empididae	*Metachela*/*Chelifera* sp.	2
ARACHNIDA		
HYDRACARINA		**4**
Lebertiidae	*Lebertia* sp.	4
TURBELLARIA		**2**
Planariidae	*Polycelis coronata*	2

Total Number (#/sample)	303
Number of Taxa	19
Shannon Weaver Diversity (H')	2.97
Hilsenhoff Biotic Index (HBI)	1.75
Total EPT Taxa	12.0
EPT Index (% of total number of taxa)	63.2%
Ephemeroptera Abundance (% of total number)	18.2%

# Ephemeroptera Taxa	4
# Plecoptera Taxa	5
# Trichoptera Taxa	3
% EPT (% of Total Number)	79.5%
# Intolerant Taxa	14
Tolerant Organisms (% of Total Number)	1.3%
Dominant Taxon (% of Total Number)	26.7%
Filterers (% of Total Number)	6.3%
Scrapers (% of Total Number)	41.3%
# Clinger Taxa	9
Clingers (% of Total Number)	53.8%

Animas River Macroinvertebrate Data
A55
24 Sept. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**163**
Ameletidae	*Ameletus* sp.	2
Baetidae	*Baetis bicaudatus/ tricaudatus*	35
Ephemerellidae	*Drunella doddsi*	50
Heptageniidae	*Epeorus* sp.	10
Heptageniidae	*Rhithrogena* sp.	66
PLECOPTERA		**93**
Capniidae	Capniidae (*Utacapnia*)	7
Nemouridae	*Zapada oregonensis* group	50
Taeniopterygidae	*Taenionema* sp.	29
Chloroperlidae	Chloroperlidae	3
Chloroperlidae	*Sweltsa* sp.	1
Perlodidae	*Isoperla* sp.	1
Perlodidae	*Megarcys signata*	2
TRICHOPTERA		**83**
Hydropsychidae	*Arctopsyche grandis*	61
Rhyacophilidae	*Rhyacophila brunnea*	7
Rhyacophilidae	*Rhyacophila hyalinata*	9
Rhyacophilidae	*Rhyacophila sibirica* group	5
Rhyacophilidae	*Rhyacophila vofixa* group	1
DIPTERA		
Chironomidae		**8**
Chironomidae	*Cricotopus*/*Orthocladius* sp.	6
Chironomidae	*Pagastia* sp.	2
DIPTERA (other)		**28**
Muscidae	*Lispoides* sp.	1
Simuliidae	*Simulium* sp.	27
COLEOPTERA		**1**
Elmidae	*Heterlimnius corpulentus*	1
ARACHNIDA		
HYDRACARINA		**5**
Lebertiidae	*Lebertia* sp.	4
Sperchontidae	*Sperchon* sp.	1
TURBELLARIA		**11**
Planariidae	*Polycelis coronata*	11

NEMATODA		**2**
Nematoda	Nematoda	2

Total Number (#/sample)	394
Number of Taxa	26
Shannon Weaver Diversity (H')	3.48
Hilsenhoff Biotic Index (HBI)	1.68
Total EPT Taxa	17.0
EPT Index (% of total number of taxa)	65.4%
Ephemeroptera Abundance (% of total number)	41.4%
# Ephemeroptera Taxa	5
# Plecoptera Taxa	7
# Trichoptera Taxa	5
% EPT (% of Total Number)	86.0%
# Intolerant Taxa	18
Tolerant Organisms (% of Total Number)	1.3%
Dominant Taxon (% of Total Number)	16.8%
Filterers (% of Total Number)	22.3%
Scrapers (% of Total Number)	39.3%
# Clinger Taxa	17
Clingers (% of Total Number)	75.9%

Animas River Macroinvertebrate Data
A56
24 Sept. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**34**
Ameletidae	*Ameletus* sp.	1
Baetidae	*Baetis bicaudatus/ tricaudatus*	13
Ephemerellidae	*Drunella doddsi*	9
Heptageniidae	*Epeorus* sp.	3
Heptageniidae	*Rhithrogena* sp.	8
PLECOPTERA		**39**
Capniidae	Capniidae (*Capnia*)	1
Nemouridae	*Zapada oregonensis* group	26
Taeniopterygidae	*Taenionema* sp.	6
Chloroperlidae	*Sweltsa* sp.	1
Perlodidae	*Isoperla* sp.	3
Perlodidae	*Megarcys signata*	2
TRICHOPTERA		**46**
Hydropsychidae	*Arctopsyche grandis*	44
Rhyacophilidae	*Rhyacophila brunnea*	2
DIPTERA		
Chironomidae		**8**
Chironomidae	*Cricotopus*/*Orthocladius* sp.	5
Chironomidae	*Diamesa* sp.	1
Chironomidae	*Eukiefferiella* sp.	2
DIPTERA (other)		**186**
Simuliidae	*Simulium* sp.	186
ARACHNIDA		
HYDRACARINA		**2**
Lebertiidae	*Lebertia* sp.	2

Total Number (#/sample)	315
Number of Taxa	18
Shannon Weaver Diversity (H')	2.24
Hilsenhoff Biotic Index (HBI)	4.28
Total EPT Taxa	13.0
EPT Index (% of total number of taxa)	72.2%
Ephemeroptera Abundance (% of total number)	10.8%
# Ephemeroptera Taxa	5
# Plecoptera Taxa	6
# Trichoptera Taxa	2
% EPT (% of Total Number)	37.8%

# Intolerant Taxa	12
Tolerant Organisms (% of Total Number)	1.3%
Dominant Taxon (% of Total Number)	59.0%
Filterers (% of Total Number)	73.0%
Scrapers (% of Total Number)	8.3%
# Clinger Taxa	11
Clingers (% of Total Number)	90.8%

Animas River Macroinvertebrate Data
A60
25 Sept. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**43**
Baetidae	*Baetis bicaudatus/ tricaudatus*	19
Ephemerellidae	*Drunella doddsi*	6
Heptageniidae	*Epeorus* sp.	7
Heptageniidae	*Rhithrogena* sp.	11
PLECOPTERA		**56**
Nemouridae	*Zapada cinctipes*	1
Nemouridae	*Zapada oregonensis* group	27
Taeniopterygidae	*Taenionema* sp.	23
Chloroperlidae	*Sweltsa* sp.	1
Perlodidae	*Isoperla* sp.	1
Perlodidae	*Megarcys signata*	3
TRICHOPTERA		**50**
Hydropsychidae	*Arctopsyche grandis*	40
Rhyacophilidae	*Rhyacophila brunnea*	1
Rhyacophilidae	*Rhyacophila coloradensis* group	8
Rhyacophilidae	*Rhyacophila hyalinata*	1
DIPTERA		
Chironomidae		**71**
Chironomidae	*Cricotopus*/*Orthocladius* sp.	63
Chironomidae	*Eukiefferiella* sp.	3
Chironomidae	*Micropsectra* sp.	1
Chironomidae	*Pagastia* sp.	2
Chironomidae	*Tvetenia* sp.	2
DIPTERA (other)		**137**
Ceratopogoninae	Ceratopogoninae	3
Simuliidae	*Simulium* sp.	131
Tipulidae	*Dicranota* sp.	3
ARACHNIDA		
HYDRACARINA		**9**
Lebertiidae	*Lebertia* sp.	9
TURBELLARIA		**5**
Planariidae	*Polycelis coronata*	5
NEMATODA		**10**
Nematoda	Nematoda	10

Total Number (#/sample)	381
Number of Taxa	25
Shannon Weaver Diversity (H')	3.21
Hilsenhoff Biotic Index (HBI)	3.67
Total EPT Taxa	14.0
EPT Index (% of total number of taxa)	56.0%
Ephemeroptera Abundance (% of total number)	11.3%
# Ephemeroptera Taxa	4
# Plecoptera Taxa	6
# Trichoptera Taxa	4
% EPT (% of Total Number)	39.1%
# Intolerant Taxa	16
Tolerant Organisms (% of Total Number)	3.4%
Dominant Taxon (% of Total Number)	34.4%
Filterers (% of Total Number)	44.9%
Scrapers (% of Total Number)	12.3%
# Clinger Taxa	14
Clingers (% of Total Number)	64.8%

Animas River Macroinvertebrate Data
A68
25 Sept. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**51**
Ameletidae	*Ameletus* sp.	1
Baetidae	*Baetis tricaudatus*	31
Heptageniidae	*Epeorus* sp.	7
Heptageniidae	*Rhithrogena* sp.	12
PLECOPTERA		**31**
Capniidae	Capniidae (*Capnia*)	1
Nemouridae	*Zapada oregonensis* group	9
Taeniopterygidae	*Taenionema* sp.	20
Chloroperlidae	Chloroperlidae	1
TRICHOPTERA		**25**
Hydropsychidae	*Arctopsyche grandis*	24
Rhyacophilidae	*Rhyacophila sibirica* group	1
DIPTERA		
Chironomidae		**103**
Chironomidae	*Cricotopus*/*Orthocladius* sp.	95
Chironomidae	*Eukiefferiella* sp.	6
Chironomidae	*Tvetenia* sp.	2
DIPTERA (other)		**113**
Ceratopogoninae	Ceratopogoninae	10
Simuliidae	*Simulium* sp.	103
ARACHNIDA		
HYDRACARINA		**3**
Lebertiidae	*Lebertia* sp.	3
NEMATODA		**2**
Nematoda	Nematoda	2

Total Number (#/sample)	328
Number of Taxa	17
Shannon Weaver Diversity (H')	2.83
Hilsenhoff Biotic Index (HBI)	4.19
Total EPT Taxa	10.0
EPT Index (% of total number of taxa)	58.8%
Ephemeroptera Abundance (% of total number)	15.5%
# Ephemeroptera Taxa	4
# Plecoptera Taxa	4

# Trichoptera Taxa	2
% EPT (% of Total Number)	32.6%
# Intolerant Taxa	9
Tolerant Organisms (% of Total Number)	2.7%
Dominant Taxon (% of Total Number)	31.4%
Filterers (% of Total Number)	38.7%
Scrapers (% of Total Number)	11.9%
# Clinger Taxa	8
Clingers (% of Total Number)	48.8%

Animas River Macroinvertebrate Data
CC49
25 Sept. 2014

		REP 1
INSECTA		
DIPTERA		
Chironomidae		**5**
Chironomidae	*Cricotopus*/*Orthocladius* sp.	4
Chironomidae	*Eukiefferiella* sp.	1

Total Number (#/sample)	5
Number of Taxa	2
Shannon Weaver Diversity (H')	0.72
Hilsenhoff Biotic Index (HBI)	8.00
Total EPT Taxa	0.0
EPT Index (% of total number of taxa)	0.0%
Ephemeroptera Abundance (% of total number)	0.0%
# Ephemeroptera Taxa	0
# Plecoptera Taxa	0
# Trichoptera Taxa	0
% EPT (% of Total Number)	0.0%
# Intolerant Taxa	0
Tolerant Organisms (% of Total Number)	20.0%
Dominant Taxon (% of Total Number)	80.0%
Filterers (% of Total Number)	0.0%
Scrapers (% of Total Number)	0.0%
# Clinger Taxa	0
Clingers (% of Total Number)	0.0%

Animas River Macroinvertebrate Data

M34

25 Sept. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**2**
Baetidae	*Baetis bicaudatus/ tricaudatus*	1
Heptageniidae	*Epeorus* sp.	1
PLECOPTERA		**11**
Nemouridae	*Zapada oregonensis* group	8
Taeniopterygidae	*Taenionema* sp.	1
Chloroperlidae	*Sweltsa* sp.	1
Perlodidae	*Megarcys signata*	1
TRICHOPTERA		**31**
Hydropsychidae	*Arctopsyche grandis*	31
DIPTERA		
Chironomidae		**5**
Chironomidae	*Cricotopus*/*Orthocladius* sp.	1
Chironomidae	*Eukiefferiella* sp.	1
Chironomidae	*Limnophyes* sp.	3
DIPTERA (other)		**1**
Simuliidae	*Simulium* sp.	1
ARACHNIDA		
HYDRACARINA		**1**
Lebertiidae	*Lebertia* sp.	1

Total Number (#/sample)	51
Number of Taxa	12
Shannon Weaver Diversity (H')	2.10
Hilsenhoff Biotic Index (HBI)	1.66
Total EPT Taxa	7.0
EPT Index (% of total number of taxa)	58.3%
Ephemeroptera Abundance (% of total number)	3.9%
# Ephemeroptera Taxa	2
# Plecoptera Taxa	4
# Trichoptera Taxa	1
% EPT (% of Total Number)	86.3%
# Intolerant Taxa	6
Tolerant Organisms (% of Total Number)	3.9%
Dominant Taxon (% of Total Number)	60.8%
Filterers (% of Total Number)	62.7%
Scrapers (% of Total Number)	3.9%
# Clinger Taxa	7
Clingers (% of Total Number)	86.3%

Animas River Macroinvertebrate Data
A72
25 Sept. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**4**
Baetidae	*Baetis bicaudatus/ tricaudatus*	4
PLECOPTERA		**15**
Nemouridae	*Zapada oregonensis* group	14
Taeniopterygidae	*Taenionema* sp.	1
TRICHOPTERA		**44**
Hydropsychidae	*Arctopsyche grandis*	44
DIPTERA		
Chironomidae		**48**
Chironomidae	*Cricotopus*/*Orthocladius* sp.	39
Chironomidae	*Limnophyes* sp.	9
DIPTERA (other)		**2**
Simuliidae	*Simulium* sp.	1
Tipulidae	*Tipula* sp.	1
ARACHNIDA		
HYDRACARINA		**3**
Lebertiidae	*Lebertia* sp.	3

Total Number (#/sample)	116
Number of Taxa	9
Shannon Weaver Diversity (H')	2.19
Hilsenhoff Biotic Index (HBI)	1.87
Total EPT Taxa	4.0
EPT Index (% of total number of taxa)	44.4%
Ephemeroptera Abundance (% of total number)	3.4%
# Ephemeroptera Taxa	1
# Plecoptera Taxa	2
# Trichoptera Taxa	1
% EPT (% of Total Number)	54.3%
# Intolerant Taxa	3
Tolerant Organisms (% of Total Number)	2.6%
Dominant Taxon (% of Total Number)	37.9%
Filterers (% of Total Number)	38.8%
Scrapers (% of Total Number)	0.9%
# Clinger Taxa	4
Clingers (% of Total Number)	53.4%

Animas River Macroinvertebrate Data
A73
16 Oct. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**5**
Heptageniidae	*Rhithrogena* sp.	5
PLECOPTERA		**25**
Nemouridae	*Zapada oregonensis* group	16
Taeniopterygidae	*Taenionema* sp.	5
Perlodidae	*Isoperla* sp.	1
Perlodidae	*Megarcys signata*	3
TRICHOPTERA		**94**
Hydropsychidae	*Arctopsyche grandis*	92
Rhyacophilidae	*Rhyacophila sibirica* group	2
DIPTERA (other)		**4**
Ceratopogoninae	Ceratopogoninae	2
Empididae	*Neoplasta* sp.	1
Tipulidae	*Prionocera* sp.	1
TURBELLARIA		**1**
Planariidae	*Polycelis coronata*	1

Total Number (#/sample)	129
Number of Taxa	11
Shannon Weaver Diversity (H')	1.61
Hilsenhoff Biotic Index (HBI)	1.28
Total EPT Taxa	7.0
EPT Index (% of total number of taxa)	63.6%
Ephemeroptera Abundance (% of total number)	3.9%
# Ephemeroptera Taxa	1
# Plecoptera Taxa	4
# Trichoptera Taxa	2
% EPT (% of Total Number)	96.1%
# Intolerant Taxa	8
Tolerant Organisms (% of Total Number)	0.0%
Dominant Taxon (% of Total Number)	71.3%
Filterers (% of Total Number)	71.3%
Scrapers (% of Total Number)	7.8%
# Clinger Taxa	6
Clingers (% of Total Number)	92.2%

Animas River Macroinvertebrate Data
A75EC
16 Oct. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**61**
Ameletidae	*Ameletus* sp.	1
Baetidae	*Baetis bicaudatus/ tricaudatus*	1
Ephemerellidae	*Drunella doddsi*	30
Heptageniidae	*Rhithrogena* sp.	29
PLECOPTERA		**249**
Capniidae	Capniidae (*Utacapnia*)	3
Capniidae	*Eucapnopsis brevicauda*	2
Leuctridae	*Paraleuctra*sp.	1
Nemouridae	*Zapada cinctipes*	1
Nemouridae	*Zapada oregonensis* group	14
Taeniopterygidae	*Taenionema* sp.	211
Chloroperlidae	Chloroperlidae	5
Chloroperlidae	*Sweltsa* sp.	3
Perlodidae	*Isoperla* sp.	7
Perlodidae	*Megarcys signata*	2
TRICHOPTERA		**20**
Glossosomatidae	*Glossosoma* sp.	1
Hydropsychidae	*Arctopsyche grandis*	2
Hydropsychidae	*Parapsyche elsis*	2
Lepidostomatidae	*Lepidostoma* sp.	1
Limnephilidae	Limnephilidae (*Hesperophylax*)	1
Rhyacophilidae	*Rhyacophila brunnea*	1
Rhyacophilidae	*Rhyacophila coloradensis* group	1
Rhyacophilidae	*Rhyacophila hyalinata*	1
Rhyacophilidae	*Rhyacophila sibirica* group	1
Rhyacophilidae	*Rhyacophila vofixa* group	1
Uenoidae	*Oligophlebodes*sp.	8
DIPTERA		
Chironomidae		**3**
Chironomidae	*Diamesa* sp.	1
Chironomidae	*Eukiefferiella* sp.	1
Chironomidae	*Limnophyes* sp.	1
DIPTERA (other)		**2**
Tipulidae	*Dicranota* sp.	1
Tipulidae	*Tipula* sp.	1
TURBELLARIA		**2**
Planariidae	*Polycelis coronata*	2

Total Number (#/sample)	337
Number of Taxa	31
Shannon Weaver Diversity (H')	2.28
Hilsenhoff Biotic Index (HBI)	1.58
Total EPT Taxa	25.0
EPT Index (% of total number of taxa)	80.6%
Ephemeroptera Abundance (% of total number)	18.1%
# Ephemeroptera Taxa	4
# Plecoptera Taxa	10
# Trichoptera Taxa	11
% EPT (% of Total Number)	97.9%
# Intolerant Taxa	25
Tolerant Organisms (% of Total Number)	0.3%
Dominant Taxon (% of Total Number)	62.6%
Filterers (% of Total Number)	1.2%
Scrapers (% of Total Number)	82.8%
# Clinger Taxa	17
Clingers (% of Total Number)	32.3%

Animas River Macroinvertebrate Data
A75CC
16 Oct. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**167**
Baetidae	*Baetis bicaudatus/ tricaudatus*	73
Ephemerellidae	*Drunella doddsi*	13
Ephemerellidae	*Drunella grandis*	3
Ephemerellidae	*Ephemerella dorothea infrequens*	5
Heptageniidae	*Cinygmula*sp.	22
Heptageniidae	*Epeorus* sp.	30
Heptageniidae	*Rhithrogena* sp.	21
PLECOPTERA		**33**
Capniidae	Capniidae (*Capnia*)	10
Capniidae	Capniidae (*Utacapnia*)	2
Taeniopterygidae	*Taenionema* sp.	1
Chloroperlidae	*Sweltsa* sp.	3
Perlidae	*Hesperoperla pacifica*	15
Perlodidae	*Diura knowltoni*	1
Perlodidae	*Isoperla fulva*	1
TRICHOPTERA		**56**
Hydropsychidae	*Arctopsyche grandis*	3
Hydropsychidae	*Hydropsyche* (*oslari*)	44
Rhyacophilidae	*Rhyacophila coloradensis* group	9
DIPTERA		
Chironomidae		**41**
Chironomidae	*Cricotopus*/*Orthocladius* sp.	39
Chironomidae	*Diamesa* sp.	1
Chironomidae	*Limnophyes* sp.	1
DIPTERA (other)		**4**
Simuliidae	*Simulium* sp.	3
Tipulidae	*Hexatoma* sp.	1
ARACHNIDA		
HYDRACARINA		**1**
Lebertiidae	*Lebertia* sp.	1
ANNELIDA		
OLIGOCHAETA		**1**
Lumbricidae	Lumbricidae	1
NEMATODA		**1**
Nematoda	Nematoda	1

Total Number (#/sample)	304
Number of Taxa	25
Shannon Weaver Diversity (H')	3.48
Hilsenhoff Biotic Index (HBI)	2.57
Total EPT Taxa	17.0
EPT Index (% of total number of taxa)	68.0%
Ephemeroptera Abundance (% of total number)	54.9%
# Ephemeroptera Taxa	7
# Plecoptera Taxa	7
# Trichoptera Taxa	3
% EPT (% of Total Number)	84.2%
# Intolerant Taxa	15
Tolerant Organisms (% of Total Number)	0.7%
Dominant Taxon (% of Total Number)	24.0%
Filterers (% of Total Number)	16.4%
Scrapers (% of Total Number)	29.9%
# Clinger Taxa	15
Clingers (% of Total Number)	57.2%

Animas River Macroinvertebrate Data
A75D
16 Oct. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**50**
Baetidae	*Baetis bicaudatus/ tricaudatus*	24
Ephemerellidae	*Drunella doddsi*	2
Heptageniidae	*Rhithrogena* sp.	24
PLECOPTERA		**12**
Capniidae	Capniidae (*Utacapnia*)	4
Nemouridae	*Zapada cinctipes*	2
Taeniopterygidae	*Taenionema* sp.	4
Perlidae	*Hesperoperla pacifica*	2
TRICHOPTERA		**68**
Hydropsychidae	*Arctopsyche grandis*	66
Rhyacophilidae	*Rhyacophila coloradensis* group	2
DIPTERA		
Chironomidae		**33**
Chironomidae	*Cricotopus*/*Orthocladius* sp.	1
Chironomidae	*Eukiefferiella* sp.	8
Chironomidae	*Limnophyes* sp.	23
Chironomidae	*Pagastia* sp.	1
DIPTERA (other)		**15**
Athericidae	*Atherix pachypus*	1
Blephariceridae	*Bibiocephala* sp.	2
Ceratopogoninae	Ceratopogoninae	1
Empididae	*Hemerodromia* sp.	2
Empididae	*Neoplasta* sp.	8
Tipulidae	*Dicranota* sp.	1
ARACHNIDA		
HYDRACARINA		**24**
Lebertiidae	*Lebertia* sp.	15
Sperchontidae	*Sperchon* sp.	9

Total Number (#/sample)	202
Number of Taxa	21
Shannon Weaver Diversity (H')	3.27
Hilsenhoff Biotic Index (HBI)	2.46
Total EPT Taxa	9.0
EPT Index (% of total number of taxa)	42.9%
Ephemeroptera Abundance (% of total number)	24.8%
# Ephemeroptera Taxa	3

# Plecoptera Taxa	4
# Trichoptera Taxa	2
% EPT (% of Total Number)	64.4%
# Intolerant Taxa	12
Tolerant Organisms (% of Total Number)	15.8%
Dominant Taxon (% of Total Number)	32.7%
Filterers (% of Total Number)	32.7%
Scrapers (% of Total Number)	15.8%
# Clinger Taxa	9
Clingers (% of Total Number)	61.4%

Animas River Macroinvertebrate Data
Bbridge
26 Sept. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**118**
Baetidae	*Baetis bicaudatus/ tricaudatus*	116
Heptageniidae	*Rhithrogena* sp.	2
PLECOPTERA		**3**
Capniidae	Capniidae (*Capnia*)	1
Perlodidae	*Diura knowltoni*	1
Perlodidae	*Isoperla* sp.	1
TRICHOPTERA		**51**
Brachycentridae	*Brachycentrus occidentalis*	2
Hydropsychidae	*Arctopsyche grandis*	25
Hydropsychidae	*Hydropsyche* (*oslari*)	24
DIPTERA		
Chironomidae		**9**
Chironomidae	*Cricotopus*/*Orthocladius* sp.	3
Chironomidae	*Eukiefferiella* sp.	5
Chironomidae	*Limnophyes* sp.	1
DIPTERA (other)		**40**
Athericidae	*Atherix pachypus*	5
Empididae	*Neoplasta* sp.	1
Simuliidae	*Simulium* sp.	33
Tipulidae	*Hexatoma* sp.	1
ARACHNIDA		
HYDRACARINA		**1**
Lebertiidae	*Lebertia* sp.	1
NEMATODA		**1**
Nematoda	Nematoda	1

Total Number (#/sample)	223
Number of Taxa	17
Shannon Weaver Diversity (H')	2.33
Hilsenhoff Biotic Index (HBI)	3.94
Total EPT Taxa	8.0
EPT Index (% of total number of taxa)	47.1%
Ephemeroptera Abundance (% of total number)	52.9%
# Ephemeroptera Taxa	2
# Plecoptera Taxa	3

# Trichoptera Taxa	3
% EPT (% of Total Number)	77.1%
# Intolerant Taxa	8
Tolerant Organisms (% of Total Number)	2.7%
Dominant Taxon (% of Total Number)	52.0%
Filterers (% of Total Number)	37.7%
Scrapers (% of Total Number)	1.3%
# Clinger Taxa	8
Clingers (% of Total Number)	39.9%

Animas River Macroinvertebrate Data
James Ranch
26 Sept. 2014

		REP 1
INSECTA		
EPHEMEROPTERA		**166**
Baetidae	*Baetis bicaudatus/ tricaudatus*	163
Ephemerellidae	*Drunella doddsi*	1
Heptageniidae	*Rhithrogena* sp.	2
PLECOPTERA		**6**
Capniidae	Capniidae (*Utacapnia*)	1
Chloroperlidae	*Sweltsa* sp.	2
Perlidae	*Hesperoperla pacifica*	2
Perlodidae	*Megarcys signata*	1
TRICHOPTERA		**73**
Brachycentridae	*Brachycentrus occidentalis*	18
Hydropsychidae	*Arctopsyche grandis*	14
Hydropsychidae	*Hydropsyche* (*oslari*)	41
DIPTERA		
Chironomidae		**34**
Chironomidae	*Brillia* sp.	1
Chironomidae	*Eukiefferiella* sp.	4
Chironomidae	*Limnophyes* sp.	27
Chironomidae	*Micropsectra* sp.	2
DIPTERA (other)		**79**
Athericidae	*Atherix pachypus*	2
Empididae	*Wiedemannia* sp.	1
Simuliidae	*Simulium* sp.	76
ARACHNIDA		
HYDRACARINA		**5**
Hygrobatidae	*Hygrobates* sp.	1
Lebertiidae	*Lebertia* sp.	1
Sperchontidae	*Sperchon* sp.	3

Total Number (#/sample)	363
Number of Taxa	20
Shannon Weaver Diversity (H')	2.51
Hilsenhoff Biotic Index (HBI)	4.26
Total EPT Taxa	10.0
EPT Index (% of total number of taxa)	50.0%
Ephemeroptera Abundance (% of total number)	45.7%
# Ephemeroptera Taxa	3
# Plecoptera Taxa	4

# Trichoptera Taxa	3
% EPT (% of Total Number)	67.5%
# Intolerant Taxa	9
Tolerant Organisms (% of Total Number)	3.0%
Dominant Taxon (% of Total Number)	44.9%
Filterers (% of Total Number)	41.0%
Scrapers (% of Total Number)	0.8%
# Clinger Taxa	12
Clingers (% of Total Number)	44.6%

Appendix 12

ProUCL calculations to derive EPCs for dissolved metals in surface water for aquatic community-level receptors

ProUCL calculations for dissolved Be in mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:20
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Be pre run

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
Number of Detects	3	Number of Non-Detects	1
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	1.1	Minimum Non-Detect	1
Maximum Detect	1.3	Maximum Non-Detect	1
Variance Detects	0.01	Percent Non-Detects	25%
Mean Detects	1.2	SD Detects	0.1
Median Detects	1.2	CV Detects	0.0833
Skewness Detects	1.01E-14	Kurtosis Detects	N/A
Mean of Logged Detects	0.18	SD of Logged Detects	0.0836

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	1	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.175	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.15	Standard Error of Mean	0.0685
SD	0.112	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.311	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.263	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.355	95% KM Chebyshev UCL	1.448
97.5% KM Chebyshev UCL	1.578	99% KM Chebyshev UCL	1.831

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	215.4	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00557	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	1292	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	105.8	nu hat (KM)	846.4
		Adjusted Level of Significance (β)	0.00498
Approximate Chi Square Value (846.40, α)	779.9	Adjusted Chi Square Value (846.40, β)	744.1
95% Gamma Approximate KM-UCL (use when n>=50)	1.248	95% Gamma Adjusted KM-UCL (use when n<50)	1.308

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.999	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.178	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.136	Mean in Log Scale	0.12
SD in Original Scale	0.152	SD in Log Scale	0.138
95% t UCL (assumes normality of ROS data)	1.315	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	1.367		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	0.135	95% H-UCL (KM -Log)	N/A
KM SD (logged)	0.0978	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0599		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.025	Mean in Log Scale	-0.0383
SD in Original Scale	0.359	SD in Log Scale	0.442
95% t UCL (Assumes normality)	1.448	95% H-Stat UCL	2.505

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.311	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Be in mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:20
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	14	Number of Distinct Observations	6
Number of Detects	6	Number of Non-Detects	8
Number of Distinct Detects	2	Number of Distinct Non-Detects	4
Minimum Detect	1.1	Minimum Non-Detect	0.2
Maximum Detect	1.2	Maximum Non-Detect	10
Variance Detects	0.00267	Percent Non-Detects	57.14%
Mean Detects	1.133	SD Detects	0.0516
Median Detects	1.1	CV Detects	0.0456
Skewness Detects	0.968	Kurtosis Detects	-1.875
Mean of Logged Detects	0.124	SD of Logged Detects	0.0449

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.64	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.407	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.362	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.709	Standard Error of Mean	0.154
SD	0.466	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.982	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.962	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.171	95% KM Chebyshev UCL	1.38
97.5% KM Chebyshev UCL	1.67	99% KM Chebyshev UCL	2.241

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.239	Anderson-Darling GOF Test	
5% A-D Critical Value	0.696	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.427	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.332	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	589	k star (bias corrected MLE)	294.6
Theta hat (MLE)	0.00192	Theta star (bias corrected MLE)	0.00385
nu hat (MLE)	7068	nu star (bias corrected)	3535
MLE Mean (bias corrected)	1.133	MLE Sd (bias corrected)	0.066

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	2.315	nu hat (KM)	64.82
Approximate Chi Square Value (64.82, α)	47.3	Adjusted Chi Square Value (64.82, β)	45.32
95% Gamma Approximate KM-UCL (use when n>=50)	0.972	95% Gamma Adjusted KM-UCL (use when n<50)	1.014

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.957	Mean	1.074
Maximum	1.2	Median	1.087
SD	0.0711	CV	0.0662
k hat (MLE)	248.2	k star (bias corrected MLE)	195.1
Theta hat (MLE)	0.00433	Theta star (bias corrected MLE)	0.00551
nu hat (MLE)	6950	nu star (bias corrected)	5462
MLE Mean (bias corrected)	1.074	MLE Sd (bias corrected)	0.0769
		Adjusted Level of Significance (β)	0.0312
Approximate Chi Square Value (N/A, α)	5291	Adjusted Chi Square Value (N/A, β)	5269
95% Gamma Approximate UCL (use when n>=50)	1.109	95% Gamma Adjusted UCL (use when n<50)	1.114

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.64	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.407	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.362	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.077	Mean in Log Scale	0.0722
SD in Original Scale	0.0684	SD in Log Scale	0.0629
95% t UCL (assumes normality of ROS data)	1.109	95% Percentile Bootstrap UCL	1.107
95% BCA Bootstrap UCL	1.11	95% Bootstrap t UCL	1.114
95% H-UCL (Log ROS)	N/A		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.421	Mean in Log Scale	-0.0793
SD in Original Scale	1.555	SD in Log Scale	0.977
95% t UCL (Assumes normality)	2.158	95% H-Stat UCL	3.143

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.982	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd in mainstem Mineral Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:27
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	1	Mean	1.3
Maximum	2	Median	1.1
SD	0.469	Std. Error of Mean	0.235
Coefficient of Variation	0.361	Skewness	1.938

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.716	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.415	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.852	95% Adjusted-CLT UCL (Chen-1995)	1.929
		95% Modified-t UCL (Johnson-1978)	1.89
Gamma GOF Test			
A-D Test Statistic	0.728	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.431	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	12.24	k star (bias corrected MLE)	3.225
Theta hat (MLE)	0.106	Theta star (bias corrected MLE)	0.403
nu hat (MLE)	97.88	nu star (bias corrected)	25.8
MLE Mean (bias corrected)	1.3	MLE Sd (bias corrected)	0.724
		Approximate Chi Square Value (0.05)	15.23
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	2.203	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.748	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.404	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0	Mean of logged Data	0.221
Maximum of Logged Data	0.693	SD of logged Data	0.318
Assuming Lognormal Distribution			
95% H-UCL	2.211	90% Chebyshev (MVUE) UCL	1.908
95% Chebyshev (MVUE) UCL	2.186	97.5% Chebyshev (MVUE) UCL	2.571
99% Chebyshev (MVUE) UCL	3.328		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1.686	95% Jackknife UCL	1.852
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	2.004	95% Chebyshev(Mean, Sd) UCL	2.322
97.5% Chebyshev(Mean, Sd) UCL	2.765	99% Chebyshev(Mean, Sd) UCL	3.633

Suggested UCL to Use

95% Student's-t UCL	1.852

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd in mainstem Mineral Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:27
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	4
Number of Detects	5	Number of Non-Detects	2
Number of Distinct Detects	3	Number of Distinct Non-Detects	2
Minimum Detect	0.2	Minimum Non-Detect	0.2
Maximum Detect	0.6	Maximum Non-Detect	0.5
Variance Detects	0.027	Percent Non-Detects	28.57%
Mean Detects	0.32	SD Detects	0.164
Median Detects	0.3	CV Detects	0.513
Skewness Detects	1.736	Kurtosis Detects	3.251
Mean of Logged Detects	-1.228	SD of Logged Detects	0.449

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.779	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.348	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.291	Standard Error of Mean	0.0572
SD	0.134	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.403	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.386	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.463	95% KM Chebyshev UCL	0.541
97.5% KM Chebyshev UCL	0.649	99% KM Chebyshev UCL	0.861

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.528	Anderson-Darling GOF Test	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.306	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.837	k star (bias corrected MLE)	2.468
Theta hat (MLE)	0.0548	Theta star (bias corrected MLE)	0.13
nu hat (MLE)	58.37	nu star (bias corrected)	24.68
MLE Mean (bias corrected)	0.32	MLE Sd (bias corrected)	0.204

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	4.738	nu hat (KM)	66.33
Approximate Chi Square Value (66.33, α)	48.59	Adjusted Chi Square Value (66.33, β)	44.04
95% Gamma Approximate KM-UCL (use when n>=50)	0.398	95% Gamma Adjusted KM-UCL (use when n<50)	0.439

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0421	Mean	0.265
Maximum	0.6	Median	0.214
SD	0.171	CV	0.645
k hat (MLE)	2.403	k star (bias corrected MLE)	1.468
Theta hat (MLE)	0.11	Theta star (bias corrected MLE)	0.181
nu hat (MLE)	33.64	nu star (bias corrected)	20.56
MLE Mean (bias corrected)	0.265	MLE Sd (bias corrected)	0.219
		Adjusted Level of Significance (β)	0.0158
Approximate Chi Square Value (20.56, α)	11.26	Adjusted Chi Square Value (20.56, β)	9.259
95% Gamma Approximate UCL (use when n>=50)	0.484	95% Gamma Adjusted UCL (use when n<50)	0.589

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.85	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.279	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.276	Mean in Log Scale	-1.409
SD in Original Scale	0.157	SD in Log Scale	0.519
95% t UCL (assumes normality of ROS data)	0.391	95% Percentile Bootstrap UCL	0.376
95% BCA Bootstrap UCL	0.403	95% Bootstrap t UCL	0.479
95% H-UCL (Log ROS)	0.475		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-1.313	95% H-UCL (KM -Log)	0.409
KM SD (logged)	0.376	95% Critical H Value (KM-Log)	2.28
KM Standard Error of Mean (logged)	0.163		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.279	Mean in Log Scale	-1.404
SD in Original Scale	0.158	SD in Log Scale	0.543
95% t UCL (Assumes normality)	0.394	95% H-Stat UCL	0.501

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.403	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd in mainstem Mineral Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:27
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	13	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.2	Mean	0.607
Maximum	1	Median	0.7
SD	0.237	Std. Error of Mean	0.0657
Coefficient of Variation	0.39	Skewness	-0.15

Normal GOF Test

Shapiro Wilk Test Statistic	0.964	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.191	Lilliefors GOF Test
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.724	95% Adjusted-CLT UCL (Chen-1995)	0.712
		95% Modified-t UCL (Johnson-1978)	0.724

Gamma GOF Test

A-D Test Statistic	0.421	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.736	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.227	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.869	k star (bias corrected MLE)	4.566
Theta hat (MLE)	0.103	Theta star (bias corrected MLE)	0.133
nu hat (MLE)	152.6	nu star (bias corrected)	118.7
MLE Mean (bias corrected)	0.607	MLE Sd (bias corrected)	0.284
		Approximate Chi Square Value (0.05)	94.55
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	91.48

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.762	95% Adjusted Gamma UCL (use when n<50)	0.788

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.915	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.228	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.609	Mean of logged Data	-0.587
Maximum of Logged Data	0	SD of logged Data	0.465

Assuming Lognormal Distribution

95% H-UCL	0.818	90% Chebyshev (MVUE) UCL	0.857
95% Chebyshev (MVUE) UCL	0.967	97.5% Chebyshev (MVUE) UCL	1.12
99% Chebyshev (MVUE) UCL	1.421		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.715	95% Jackknife UCL	0.724
95% Standard Bootstrap UCL	0.713	95% Bootstrap-t UCL	0.721
95% Hall's Bootstrap UCL	0.714	95% Percentile Bootstrap UCL	0.715
95% BCA Bootstrap UCL	0.707		
90% Chebyshev(Mean, Sd) UCL	0.804	95% Chebyshev(Mean, Sd) UCL	0.893
97.5% Chebyshev(Mean, Sd) UCL	1.017	99% Chebyshev(Mean, Sd) UCL	1.261

Suggested UCL to Use

95% Student's-t UCL	0.724

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Cd in mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:32
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	4.9	Mean	5.25
Maximum	5.5	Median	5.3
SD	0.252	Std. Error of Mean	0.126
Coefficient of Variation	0.0479	Skewness	-1.129

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.895	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.329	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.546	95% Adjusted-CLT UCL (Chen-1995)	5.381
		95% Modified-t UCL (Johnson-1978)	5.534

Gamma GOF Test

A-D Test Statistic	0.428	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.345	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	569.1	k star (bias corrected MLE)	142.4
Theta hat (MLE)	0.00923	Theta star (bias corrected MLE)	0.0369
nu hat (MLE)	4553	nu star (bias corrected)	1140
MLE Mean (bias corrected)	5.25	MLE Sd (bias corrected)	0.44
		Approximate Chi Square Value (0.05)	1062
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5.632	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.887	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.334	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.589	Mean of logged Data	1.657
Maximum of Logged Data	1.705	SD of logged Data	0.0487

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	5.633
95% Chebyshev (MVUE) UCL	5.807	97.5% Chebyshev (MVUE) UCL	6.047
99% Chebyshev (MVUE) UCL	6.521		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5.457	95% Jackknife UCL	5.546
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.627	95% Chebyshev(Mean, Sd) UCL	5.798
97.5% Chebyshev(Mean, Sd) UCL	6.036	99% Chebyshev(Mean, Sd) UCL	6.502

Suggested UCL to Use

95% Student's-t UCL	5.546

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Cd in mainstem Cement Creek during the runoff period

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	2/23/2015 11:32
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	2	Mean	2.8
Maximum	3.8	Median	2.9
SD	0.709	Std. Error of Mean	0.268
Coefficient of Variation	0.253	Skewness	0.137

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.908	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.23	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.321	95% Adjusted-CLT UCL (Chen-1995)	3.256
		95% Modified-t UCL (Johnson-1978)	3.323

Gamma GOF Test

A-D Test Statistic	0.413	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.707	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.245	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	17.92	k star (bias corrected MLE)	10.33
Theta hat (MLE)	0.156	Theta star (bias corrected MLE)	0.271
nu hat (MLE)	250.8	nu star (bias corrected)	144.7
MLE Mean (bias corrected)	2.8	MLE Sd (bias corrected)	0.871
		Approximate Chi Square Value (0.05)	117.9
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	110.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.437	95% Adjusted Gamma UCL (use when n<50)	3.664

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.899	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.224	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.693	Mean of logged Data	1.001
Maximum of Logged Data	1.335	SD of logged Data	0.258

Assuming Lognormal Distribution

95% H-UCL	3.512	90% Chebyshev (MVUE) UCL	3.62
95% Chebyshev (MVUE) UCL	3.992	97.5% Chebyshev (MVUE) UCL	4.507
99% Chebyshev (MVUE) UCL	5.52		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.241	95% Jackknife UCL	3.321
95% Standard Bootstrap UCL	3.202	95% Bootstrap-t UCL	3.335
95% Hall's Bootstrap UCL	3.151	95% Percentile Bootstrap UCL	3.229
95% BCA Bootstrap UCL	3.214		
90% Chebyshev(Mean, Sd) UCL	3.604	95% Chebyshev(Mean, Sd) UCL	3.969
97.5% Chebyshev(Mean, Sd) UCL	4.475	99% Chebyshev(Mean, Sd) UCL	5.468

Suggested UCL to Use

95% Student's-t UCL	3.321

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd in mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:32
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	14	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	3.1	Mean	5.6
Maximum	7	Median	5.65
SD	1.078	Std. Error of Mean	0.288
Coefficient of Variation	0.192	Skewness	-0.859

Normal GOF Test

Shapiro Wilk Test Statistic	0.936	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.143	Lilliefors GOF Test
5% Lilliefors Critical Value	0.237	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6.11	95% Adjusted-CLT UCL (Chen-1995)	6.003
		95% Modified-t UCL (Johnson-1978)	6.099

Gamma GOF Test

A-D Test Statistic	0.47	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.169	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.228	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	25.01	k star (bias corrected MLE)	19.7
Theta hat (MLE)	0.224	Theta star (bias corrected MLE)	0.284
nu hat (MLE)	700.2	nu star (bias corrected)	551.5
MLE Mean (bias corrected)	5.6	MLE Sd (bias corrected)	1.262
		Approximate Chi Square Value (0.05)	498
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	491.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	6.201	95% Adjusted Gamma UCL (use when n<50)	6.286

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.878	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.18	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.237	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.131	Mean of logged Data	1.703
Maximum of Logged Data	1.946	SD of logged Data	0.218

Assuming Lognormal Distribution

95% H-UCL	6.276	90% Chebyshev (MVUE) UCL	6.594
95% Chebyshev (MVUE) UCL	7.04	97.5% Chebyshev (MVUE) UCL	7.659
99% Chebyshev (MVUE) UCL	8.874		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	6.074	95% Jackknife UCL	6.11
95% Standard Bootstrap UCL	6.054	95% Bootstrap-t UCL	6.048
95% Hall's Bootstrap UCL	6.016	95% Percentile Bootstrap UCL	6.029
95% BCA Bootstrap UCL	5.993		
90% Chebyshev(Mean, Sd) UCL	6.464	95% Chebyshev(Mean, Sd) UCL	6.856
97.5% Chebyshev(Mean, Sd) UCL	7.399	99% Chebyshev(Mean, Sd) UCL	8.466

Suggested UCL to Use

95% Student's-t UCL	6.11

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Cd in the Animas River above mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:40
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	1.6	Mean	2.64
Maximum	4.1	Median	2.7
SD	1.006	Std. Error of Mean	0.45
Coefficient of Variation	0.381	Skewness	0.589

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.939	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.198	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.6	95% Adjusted-CLT UCL (Chen-1995)	3.507
		95% Modified-t UCL (Johnson-1978)	3.619

Gamma GOF Test

A-D Test Statistic	0.266	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.228	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.688	k star (bias corrected MLE)	3.609
Theta hat (MLE)	0.304	Theta star (bias corrected MLE)	0.732
nu hat (MLE)	86.88	nu star (bias corrected)	36.09
MLE Mean (bias corrected)	2.64	MLE Sd (bias corrected)	1.39
		Approximate Chi Square Value (0.05)	23.34
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	18.99

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4.082	95% Adjusted Gamma UCL (use when n<50)	5.018

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.949	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.201	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.47	Mean of logged Data	0.912
Maximum of Logged Data	1.411	SD of logged Data	0.384

Assuming Lognormal Distribution

95% H-UCL	4.425	90% Chebyshev (MVUE) UCL	3.994
95% Chebyshev (MVUE) UCL	4.607	97.5% Chebyshev (MVUE) UCL	5.458
99% Chebyshev (MVUE) UCL	7.131		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.38	95% Jackknife UCL	3.6
95% Standard Bootstrap UCL	3.306	95% Bootstrap-t UCL	3.779
95% Hall's Bootstrap UCL	3.543	95% Percentile Bootstrap UCL	3.36
95% BCA Bootstrap UCL	3.36		
90% Chebyshev(Mean, Sd) UCL	3.99	95% Chebyshev(Mean, Sd) UCL	4.602
97.5% Chebyshev(Mean, Sd) UCL	5.451	99% Chebyshev(Mean, Sd) UCL	7.119

Suggested UCL to Use

95% Student's-t UCL	3.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd in the Animas River above mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:40
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	17	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.7	Mean	1.042
Maximum	1.51	Median	0.9
SD	0.24	Std. Error of Mean	0.0581
Coefficient of Variation	0.23	Skewness	0.758

Normal GOF Test

Shapiro Wilk Test Statistic	0.851	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.892	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.259	Lilliefors GOF Test
5% Lilliefors Critical Value	0.215	Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level		

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.143	95% Adjusted-CLT UCL (Chen-1995)	1.149
		95% Modified-t UCL (Johnson-1978)	1.145

Gamma GOF Test

A-D Test Statistic	1.21	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.738	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.251	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.209	Data Not Gamma Distributed at 5% Significance Level
Data Not Gamma Distributed at 5% Significance Level		

Gamma Statistics

k hat (MLE)	21.46	k star (bias corrected MLE)	17.72
Theta hat (MLE)	0.0485	Theta star (bias corrected MLE)	0.0588
nu hat (MLE)	729.8	nu star (bias corrected)	602.3
MLE Mean (bias corrected)	1.042	MLE Sd (bias corrected)	0.248
		Approximate Chi Square Value (0.05)	546.4
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	540.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.148	95% Adjusted Gamma UCL (use when n<50)	1.16

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.881	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.892	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.241	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.215	Data Not Lognormal at 5% Significance Level
Data Not Lognormal at 5% Significance Level		

Lognormal Statistics

Minimum of Logged Data	-0.357	Mean of logged Data	0.0174
Maximum of Logged Data	0.412	SD of logged Data	0.22

Assuming Lognormal Distribution

95% H-UCL	1.152	90% Chebyshev (MVUE) UCL	1.209
95% Chebyshev (MVUE) UCL	1.285	97.5% Chebyshev (MVUE) UCL	1.391
99% Chebyshev (MVUE) UCL	1.599		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	1.137	95% Jackknife UCL	1.143
95% Standard Bootstrap UCL	1.135	95% Bootstrap-t UCL	1.153
95% Hall's Bootstrap UCL	1.14	95% Percentile Bootstrap UCL	1.138
95% BCA Bootstrap UCL	1.147		
90% Chebyshev(Mean, Sd) UCL	1.216	95% Chebyshev(Mean, Sd) UCL	1.295
97.5% Chebyshev(Mean, Sd) UCL	1.405	99% Chebyshev(Mean, Sd) UCL	1.62

Suggested UCL to Use

95% Student's-t UCL	1.143	or 95% Modified-t UCL	1.145

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd in the Animas River above mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:40
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	18	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.8	Mean	1.084
Maximum	1.7	Median	1.1
SD	0.227	Std. Error of Mean	0.0535
Coefficient of Variation	0.209	Skewness	1.112

Normal GOF Test

Shapiro Wilk Test Statistic	0.909	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.195	Lilliefors GOF Test
5% Lilliefors Critical Value	0.209	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.178	95% Adjusted-CLT UCL (Chen-1995)	1.187
		95% Modified-t UCL (Johnson-1978)	1.18

Gamma GOF Test

A-D Test Statistic	0.39	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.167	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.203	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	26.18	k star (bias corrected MLE)	21.85
Theta hat (MLE)	0.0414	Theta star (bias corrected MLE)	0.0496
nu hat (MLE)	942.4	nu star (bias corrected)	786.7
MLE Mean (bias corrected)	1.084	MLE Sd (bias corrected)	0.232
		Approximate Chi Square Value (0.05)	722.6
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	716.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.181	95% Adjusted Gamma UCL (use when n<50)	1.19

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.155	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.223	Mean of logged Data	0.0618
Maximum of Logged Data	0.531	SD of logged Data	0.199

Assuming Lognormal Distribution

95% H-UCL	1.183	90% Chebyshev (MVUE) UCL	1.237
95% Chebyshev (MVUE) UCL	1.307	97.5% Chebyshev (MVUE) UCL	1.403
99% Chebyshev (MVUE) UCL	1.592		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.172	95% Jackknife UCL	1.178
95% Standard Bootstrap UCL	1.171	95% Bootstrap-t UCL	1.203
95% Hall's Bootstrap UCL	1.222	95% Percentile Bootstrap UCL	1.172
95% BCA Bootstrap UCL	1.183		
90% Chebyshev(Mean, Sd) UCL	1.245	95% Chebyshev(Mean, Sd) UCL	1.318
97.5% Chebyshev(Mean, Sd) UCL	1.419	99% Chebyshev(Mean, Sd) UCL	1.617

Suggested UCL to Use

95% Student's-t UCL	1.178

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd at sampling location A72 in the Animas River below mainstem Mineral Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:46
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	2.6	Mean	2.7
Maximum	2.9	Median	2.65
SD	0.141	Std. Error of Mean	0.0707
Coefficient of Variation	0.0524	Skewness	1.414

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.828	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.26	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.866	95% Adjusted-CLT UCL (Chen-1995)	2.87
		95% Modified-t UCL (Johnson-1978)	2.875

Gamma GOF Test

A-D Test Statistic	0.486	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.294	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	497.5	k star (bias corrected MLE)	124.5
Theta hat (MLE)	0.00543	Theta star (bias corrected MLE)	0.0217
nu hat (MLE)	3980	nu star (bias corrected)	996.3
MLE Mean (bias corrected)	2.7	MLE Sd (bias corrected)	0.242
		Approximate Chi Square Value (0.05)	924
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.911	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.833	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.262	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.956	Mean of logged Data	0.992
Maximum of Logged Data	1.065	SD of logged Data	0.0515

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	2.908
95% Chebyshev (MVUE) UCL	3.003	97.5% Chebyshev (MVUE) UCL	3.134
99% Chebyshev (MVUE) UCL	3.391		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.816	95% Jackknife UCL	2.866
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	2.912	95% Chebyshev(Mean, Sd) UCL	3.008
97.5% Chebyshev(Mean, Sd) UCL	3.142	99% Chebyshev(Mean, Sd) UCL	3.404

Suggested UCL to Use

95% Student's-t UCL	2.866

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd at sampling location A72 in the Animas River below mainstem Mineral Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:46
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	0.6	Mean	0.886
Maximum	1.4	Median	0.8
SD	0.261	Std. Error of Mean	0.0986
Coefficient of Variation	0.295	Skewness	1.399

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.892	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.2	Lilliefors GOF Test
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level
Data appear Normal at 5% Significance Level		

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.077	95% Adjusted-CLT UCL (Chen-1995)	1.104
		95% Modified-t UCL (Johnson-1978)	1.086

Gamma GOF Test

A-D Test Statistic	0.294	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.191	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics

k hat (MLE)	15.18	k star (bias corrected MLE)	8.768
Theta hat (MLE)	0.0584	Theta star (bias corrected MLE)	0.101
nu hat (MLE)	212.5	nu star (bias corrected)	122.7
MLE Mean (bias corrected)	0.886	MLE Sd (bias corrected)	0.299
		Approximate Chi Square Value (0.05)	98.16
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	91.53

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.108	95% Adjusted Gamma UCL (use when n<50)	1.188

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.958	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.171	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics

Minimum of Logged Data	-0.511	Mean of logged Data	-0.155
Maximum of Logged Data	0.336	SD of logged Data	0.272

Assuming Lognormal Distribution

95% H-UCL	1.128	90% Chebyshev (MVUE) UCL	1.158
95% Chebyshev (MVUE) UCL	1.282	97.5% Chebyshev (MVUE) UCL	1.453
99% Chebyshev (MVUE) UCL	1.791		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.048	95% Jackknife UCL	1.077
95% Standard Bootstrap UCL	1.036	95% Bootstrap-t UCL	1.199
95% Hall's Bootstrap UCL	1.973	95% Percentile Bootstrap UCL	1.043
95% BCA Bootstrap UCL	1.086		
90% Chebyshev(Mean, Sd) UCL	1.182	95% Chebyshev(Mean, Sd) UCL	1.316
97.5% Chebyshev(Mean, Sd) UCL	1.502	99% Chebyshev(Mean, Sd) UCL	1.867

Suggested UCL to Use

95% Student's-t UCL	1.077

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd at sampling location A72 in the Animas River below mainstem Mineral Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 11:46
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	13	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.7	Mean	1.585
Maximum	2.8	Median	1.7
SD	0.552	Std. Error of Mean	0.153
Coefficient of Variation	0.348	Skewness	0.449

Normal GOF Test

Shapiro Wilk Test Statistic	0.947	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.194	Lilliefors GOF Test
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.857	95% Adjusted-CLT UCL (Chen-1995)	1.857
		95% Modified-t UCL (Johnson-1978)	1.861

Gamma GOF Test

A-D Test Statistic	0.388	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.172	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.463	k star (bias corrected MLE)	6.561
Theta hat (MLE)	0.187	Theta star (bias corrected MLE)	0.242
nu hat (MLE)	220	nu star (bias corrected)	170.6
MLE Mean (bias corrected)	1.585	MLE Sd (bias corrected)	0.619
		Approximate Chi Square Value (0.05)	141.4
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	137.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.912	95% Adjusted Gamma UCL (use when n<50)	1.965

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.946	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.19	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.357	Mean of logged Data	0.4
Maximum of Logged Data	1.03	SD of logged Data	0.372

Assuming Lognormal Distribution

95% H-UCL	1.977	90% Chebyshev (MVUE) UCL	2.09
95% Chebyshev (MVUE) UCL	2.317	97.5% Chebyshev (MVUE) UCL	2.631
99% Chebyshev (MVUE) UCL	3.249		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.836	95% Jackknife UCL	1.857
95% Standard Bootstrap UCL	1.827	95% Bootstrap-t UCL	1.883
95% Hall's Bootstrap UCL	1.899	95% Percentile Bootstrap UCL	1.831
95% BCA Bootstrap UCL	1.846		
90% Chebyshev(Mean, Sd) UCL	2.044	95% Chebyshev(Mean, Sd) UCL	2.252
97.5% Chebyshev(Mean, Sd) UCL	2.541	99% Chebyshev(Mean, Sd) UCL	3.108

Suggested UCL to Use

95% Student's-t UCL	1.857

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd at sampling location A73 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 11:53
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.7	Mean	1.256
Maximum	1.79	Median	1.09
SD	0.47	Std. Error of Mean	0.21
Coefficient of Variation	0.374	Skewness	0.187

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.902	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.238	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.704	95% Adjusted-CLT UCL (Chen-1995)	1.621
		95% Modified-t UCL (Johnson-1978)	1.707

Gamma GOF Test

A-D Test Statistic	0.342	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.252	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.572	k star (bias corrected MLE)	3.562
Theta hat (MLE)	0.147	Theta star (bias corrected MLE)	0.353
nu hat (MLE)	85.72	nu star (bias corrected)	35.62
MLE Mean (bias corrected)	1.256	MLE Sd (bias corrected)	0.665
		Approximate Chi Square Value (0.05)	22.96
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	18.65

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.948	95% Adjusted Gamma UCL (use when n<50)	2.399

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.922	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.222	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.357	Mean of logged Data	0.168
Maximum of Logged Data	0.582	SD of logged Data	0.392

Assuming Lognormal Distribution

95% H-UCL	2.138	90% Chebyshev (MVUE) UCL	1.915
95% Chebyshev (MVUE) UCL	2.212	97.5% Chebyshev (MVUE) UCL	2.625
99% Chebyshev (MVUE) UCL	3.437		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.602	95% Jackknife UCL	1.704
95% Standard Bootstrap UCL	1.561	95% Bootstrap-t UCL	2.075
95% Hall's Bootstrap UCL	2.479	95% Percentile Bootstrap UCL	1.596
95% BCA Bootstrap UCL	1.56		
90% Chebyshev(Mean, Sd) UCL	1.887	95% Chebyshev(Mean, Sd) UCL	2.173
97.5% Chebyshev(Mean, Sd) UCL	2.569	99% Chebyshev(Mean, Sd) UCL	3.348

Suggested UCL to Use

95% Student's-t UCL	1.704

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd at sampling location A73B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 11:53
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	0.3	Mean	0.709
Maximum	1.4	Median	0.567
SD	0.478	Std. Error of Mean	0.239
Coefficient of Variation	0.674	Skewness	1.569

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.836	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.364	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.271	95% Adjusted-CLT UCL (Chen-1995)	1.302
		95% Modified-t UCL (Johnson-1978)	1.302

Gamma GOF Test

A-D Test Statistic	0.393	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.329	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.363	k star (bias corrected MLE)	1.007
Theta hat (MLE)	0.211	Theta star (bias corrected MLE)	0.703
nu hat (MLE)	26.91	nu star (bias corrected)	8.06
MLE Mean (bias corrected)	0.709	MLE Sd (bias corrected)	0.706
		Approximate Chi Square Value (0.05)	2.77
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.062	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.289	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.204	Mean of logged Data	-0.501
Maximum of Logged Data	0.336	SD of logged Data	0.634

Assuming Lognormal Distribution

95% H-UCL	3.71	90% Chebyshev (MVUE) UCL	1.349
95% Chebyshev (MVUE) UCL	1.642	97.5% Chebyshev (MVUE) UCL	2.049
99% Chebyshev (MVUE) UCL	2.848		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.102	95% Jackknife UCL	1.271
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1.425	95% Chebyshev(Mean, Sd) UCL	1.75
97.5% Chebyshev(Mean, Sd) UCL	2.201	99% Chebyshev(Mean, Sd) UCL	3.086

Suggested UCL to Use

95% Student's-t UCL	1.271

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd at sampling location A75D in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 11:54
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.5	Mean	0.774
Maximum	1.1	Median	0.711
SD	0.274	Std. Error of Mean	0.123
Coefficient of Variation	0.354	Skewness	0.318

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.881	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.215	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.036	95% Adjusted-CLT UCL (Chen-1995)	0.994
		95% Modified-t UCL (Johnson-1978)	1.038

Gamma GOF Test

A-D Test Statistic	0.389	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.245	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.942	k star (bias corrected MLE)	4.11
Theta hat (MLE)	0.0779	Theta star (bias corrected MLE)	0.188
nu hat (MLE)	99.42	nu star (bias corrected)	41.1
MLE Mean (bias corrected)	0.774	MLE Sd (bias corrected)	0.382
		Approximate Chi Square Value (0.05)	27.41
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	22.64

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.161	95% Adjusted Gamma UCL (use when n<50)	1.405

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.892	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.219	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.693	Mean of logged Data	-0.307
Maximum of Logged Data	0.0953	SD of logged Data	0.359

Assuming Lognormal Distribution

95% H-UCL	1.238	90% Chebyshev (MVUE) UCL	1.145
95% Chebyshev (MVUE) UCL	1.313	97.5% Chebyshev (MVUE) UCL	1.546
99% Chebyshev (MVUE) UCL	2.004		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.976	95% Jackknife UCL	1.036
95% Standard Bootstrap UCL	0.954	95% Bootstrap-t UCL	1.24
95% Hall's Bootstrap UCL	1.137	95% Percentile Bootstrap UCL	0.964
95% BCA Bootstrap UCL	0.974		
90% Chebyshev(Mean, Sd) UCL	1.142	95% Chebyshev(Mean, Sd) UCL	1.309
97.5% Chebyshev(Mean, Sd) UCL	1.54	99% Chebyshev(Mean, Sd) UCL	1.994

Suggested UCL to Use

95% Student's-t UCL	1.036

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd at sampling location A75B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 11:54
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	0.5	Mean	0.704
Maximum	1.1	Median	0.607
SD	0.278	Std. Error of Mean	0.139
Coefficient of Variation	0.396	Skewness	1.476

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test		
Shapiro Wilk Test Statistic	0.839	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.264	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.031	95% Adjusted-CLT UCL (Chen-1995)	1.042
		95% Modified-t UCL (Johnson-1978)	1.048

Gamma GOF Test		
A-D Test Statistic	0.423	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.284	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics			
k hat (MLE)	9.674	k star (bias corrected MLE)	2.585
Theta hat (MLE)	0.0727	Theta star (bias corrected MLE)	0.272
nu hat (MLE)	77.39	nu star (bias corrected)	20.68
MLE Mean (bias corrected)	0.704	MLE Sd (bias corrected)	0.438
		Approximate Chi Square Value (0.05)	11.35
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.281	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.878	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.254	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics			
Minimum of Logged Data	-0.693	Mean of logged Data	-0.404
Maximum of Logged Data	0.0953	SD of logged Data	0.364

Assuming Lognormal Distribution			
95% H-UCL	1.345	90% Chebyshev (MVUE) UCL	1.08
95% Chebyshev (MVUE) UCL	1.251	97.5% Chebyshev (MVUE) UCL	1.489
99% Chebyshev (MVUE) UCL	1.957		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	0.932	95% Jackknife UCL	1.031
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1.121	95% Chebyshev(Mean, Sd) UCL	1.31
97.5% Chebyshev(Mean, Sd) UCL	1.573	99% Chebyshev(Mean, Sd) UCL	2.088

Suggested UCL to Use

95% Student's-t UCL	1.031

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd at Bakers Bridge in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 11:54
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.3	Mean	0.461
Maximum	0.7	Median	0.422
SD	0.16	Std. Error of Mean	0.0714
Coefficient of Variation	0.347	Skewness	0.861

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.942	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.196	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.613	95% Adjusted-CLT UCL (Chen-1995)	0.608
		95% Modified-t UCL (Johnson-1978)	0.618

Gamma GOF Test

A-D Test Statistic	0.22	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.18	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	11	k star (bias corrected MLE)	4.534
Theta hat (MLE)	0.0419	Theta star (bias corrected MLE)	0.102
nu hat (MLE)	110	nu star (bias corrected)	45.34
MLE Mean (bias corrected)	0.461	MLE Sd (bias corrected)	0.216
		Approximate Chi Square Value (0.05)	30.89
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	25.79

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.677	95% Adjusted Gamma UCL (use when n<50)	0.81

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.975	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.152	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.204	Mean of logged Data	-0.82
Maximum of Logged Data	-0.357	SD of logged Data	0.337

Assuming Lognormal Distribution

95% H-UCL	0.708	90% Chebyshev (MVUE) UCL	0.668
95% Chebyshev (MVUE) UCL	0.761	97.5% Chebyshev (MVUE) UCL	0.892
99% Chebyshev (MVUE) UCL	1.147		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.579	95% Jackknife UCL	0.613
95% Standard Bootstrap UCL	0.567	95% Bootstrap-t UCL	0.728
95% Hall's Bootstrap UCL	1.267	95% Percentile Bootstrap UCL	0.564
95% BCA Bootstrap UCL	0.578		
90% Chebyshev(Mean, Sd) UCL	0.675	95% Chebyshev(Mean, Sd) UCL	0.772
97.5% Chebyshev(Mean, Sd) UCL	0.907	99% Chebyshev(Mean, Sd) UCL	1.172

Suggested UCL to Use

95% Student's-t UCL	0.613

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cu in mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 12:33
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	89.1	Mean	106.8
Maximum	119	Median	109.5
SD	12.61	Std. Error of Mean	6.306
Coefficient of Variation	0.118	Skewness	-1.213

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.899	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.32	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	121.6	95% Adjusted-CLT UCL (Chen-1995)	113.1
		95% Modified-t UCL (Johnson-1978)	121
Gamma GOF Test			
A-D Test Statistic	0.427	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.656	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.342	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	90.32	k star (bias corrected MLE)	22.75
Theta hat (MLE)	1.182	Theta star (bias corrected MLE)	4.694
nu hat (MLE)	722.6	nu star (bias corrected)	182
MLE Mean (bias corrected)	106.8	MLE Sd (bias corrected)	22.39
		Approximate Chi Square Value (0.05)	151.8
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	128	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.879	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.334	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.49	Mean of logged Data	4.665
Maximum of Logged Data	4.779	SD of logged Data	0.123
Assuming Lognormal Distribution			
95% H-UCL	125.8	90% Chebyshev (MVUE) UCL	126.5
95% Chebyshev (MVUE) UCL	135.5	97.5% Chebyshev (MVUE) UCL	147.9
99% Chebyshev (MVUE) UCL	172.3		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	117.1	95% Jackknife UCL	121.6
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	125.7	95% Chebyshev(Mean, Sd) UCL	134.3
97.5% Chebyshev(Mean, Sd) UCL	146.2	99% Chebyshev(Mean, Sd) UCL	169.5

Suggested UCL to Use

95% Student's-t UCL	121.6

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Cu in mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 12:33
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	55.6	Mean	68.63
Maximum	90.6	Median	65.4
SD	12.88	Std. Error of Mean	4.868
Coefficient of Variation	0.188	Skewness	0.801

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test		
Shapiro Wilk Test Statistic	0.922	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.17	Lilliefors GOF Test
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	78.09	95% Adjusted-CLT UCL (Chen-1995)	78.21
		95% Modified-t UCL (Johnson-1978)	78.33

Gamma GOF Test		
A-D Test Statistic	0.272	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.707	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.161	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.311	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics			
k hat (MLE)	34.8	k star (bias corrected MLE)	19.98
Theta hat (MLE)	1.972	Theta star (bias corrected MLE)	3.435
nu hat (MLE)	487.2	nu star (bias corrected)	279.7
MLE Mean (bias corrected)	68.63	MLE Sd (bias corrected)	15.35
		Approximate Chi Square Value (0.05)	242
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	231.3

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	79.33	95% Adjusted Gamma UCL (use when n<50)	82.98

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.939	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.145	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics			
Minimum of Logged Data	4.018	Mean of logged Data	4.214
Maximum of Logged Data	4.506	SD of logged Data	0.182

Assuming Lognormal Distribution			
95% H-UCL	79.55	90% Chebyshev (MVUE) UCL	82.74
95% Chebyshev (MVUE) UCL	89.15	97.5% Chebyshev (MVUE) UCL	98.04
99% Chebyshev (MVUE) UCL	115.5		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	76.64	95% Jackknife UCL	78.09
95% Standard Bootstrap UCL	75.98	95% Bootstrap-t UCL	82.98
95% Hall's Bootstrap UCL	80.97	95% Percentile Bootstrap UCL	76.56
95% BCA Bootstrap UCL	77.26		
90% Chebyshev(Mean, Sd) UCL	83.23	95% Chebyshev(Mean, Sd) UCL	89.85
97.5% Chebyshev(Mean, Sd) UCL	99.03	99% Chebyshev(Mean, Sd) UCL	117.1

Suggested UCL to Use

95% Student's-t UCL	78.09

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cu in mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 12:33
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	65.3	Mean	130.2
Maximum	221	Median	139.5
SD	46.09	Std. Error of Mean	12.32
Coefficient of Variation	0.354	Skewness	0.246

Normal GOF Test

Shapiro Wilk Test Statistic	0.947	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.156	Lilliefors GOF Test
5% Lilliefors Critical Value	0.237	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	152	95% Adjusted-CLT UCL (Chen-1995)	151.3
		95% Modified-t UCL (Johnson-1978)	152.1

Gamma GOF Test

A-D Test Statistic	0.442	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.736	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.191	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.229	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.11	k star (bias corrected MLE)	6.42
Theta hat (MLE)	16.05	Theta star (bias corrected MLE)	20.28
nu hat (MLE)	227.1	nu star (bias corrected)	179.7
MLE Mean (bias corrected)	130.2	MLE Sd (bias corrected)	51.38
		Approximate Chi Square Value (0.05)	149.7
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	146.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	156.3	95% Adjusted Gamma UCL (use when n<50)	160.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.929	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.205	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.237	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.179	Mean of logged Data	4.806
Maximum of Logged Data	5.398	SD of logged Data	0.377

Assuming Lognormal Distribution

95% H-UCL	161.2	90% Chebyshev (MVUE) UCL	170.7
95% Chebyshev (MVUE) UCL	188.9	97.5% Chebyshev (MVUE) UCL	214.2
99% Chebyshev (MVUE) UCL	263.8		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	150.4	95% Jackknife UCL	152
95% Standard Bootstrap UCL	149.9	95% Bootstrap-t UCL	152.4
95% Hall's Bootstrap UCL	152.5	95% Percentile Bootstrap UCL	149.3
95% BCA Bootstrap UCL	152.2		
90% Chebyshev(Mean, Sd) UCL	167.1	95% Chebyshev(Mean, Sd) UCL	183.9
97.5% Chebyshev(Mean, Sd) UCL	207.1	99% Chebyshev(Mean, Sd) UCL	252.8

Suggested UCL to Use

95% Student's-t UCL	152

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cu in the Animas River above mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 12:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	3
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	6	Minimum Non-Detect	3
Maximum Detect	8.3	Maximum Non-Detect	10
Variance Detects	2.645	Percent Non-Detects	60%
Mean Detects	7.15	SD Detects	1.626
Median Detects	7.15	CV Detects	0.227
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	1.954	SD of Logged Detects	0.229

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	5.075	Standard Error of Mean	1.576
SD	2.229	95% KM (BCA) UCL	N/A
95% KM (t) UCL	8.435	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	7.667	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	9.803	95% KM Chebyshev UCL	11.94
97.5% KM Chebyshev UCL	14.92	99% KM Chebyshev UCL	20.75

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	38.32	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.187	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	153.3	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	5.185	nu hat (KM)	51.85
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (51.85, α)	36.32	Adjusted Chi Square Value (51.85, β)	30.73
95% Gamma Approximate KM-UCL (use when n>=50)	7.247	95% Gamma Adjusted KM-UCL (use when n<50)	8.563

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.013	Mean in Log Scale	1.531
SD in Original Scale	2.234	SD in Log Scale	0.453
95% t UCL (assumes normality of ROS data)	7.143	95% Percentile Bootstrap UCL	6.433
95% BCA Bootstrap UCL	6.695	95% Bootstrap t UCL	8.184
95% H-UCL (Log ROS)	9.66		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	4.46	Mean in Log Scale	1.266
SD in Original Scale	2.955	SD in Log Scale	0.806
95% t UCL (Assumes normality)	7.277	95% H-Stat UCL	25.46

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	8.435	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!
Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cu in the Animas River above mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 12:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	17	Number of Distinct Observations	16
Number of Detects	15	Number of Non-Detects	2
Number of Distinct Detects	15	Number of Distinct Non-Detects	1
Minimum Detect	3.7	Minimum Non-Detect	10
Maximum Detect	16.5	Maximum Non-Detect	10
Variance Detects	15.21	Percent Non-Detects	11.76%
Mean Detects	9.96	SD Detects	3.9
Median Detects	9.6	CV Detects	0.392
Skewness Detects	-0.125	Kurtosis Detects	-0.802
Mean of Logged Detects	2.21	SD of Logged Detects	0.463

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.954	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.119	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.229	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	9.618	Standard Error of Mean	0.966
SD	3.745	95% KM (BCA) UCL	11.18
95% KM (t) UCL	11.3	95% KM (Percentile Bootstrap) UCL	11.14
95% KM (z) UCL	11.21	95% KM Bootstrap t UCL	11.22
90% KM Chebyshev UCL	12.51	95% KM Chebyshev UCL	13.83
97.5% KM Chebyshev UCL	15.65	99% KM Chebyshev UCL	19.23

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.478	Anderson-Darling GOF Test	
5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.142	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.822	k star (bias corrected MLE)	4.702
Theta hat (MLE)	1.711	Theta star (bias corrected MLE)	2.118
nu hat (MLE)	174.7	nu star (bias corrected)	141.1
MLE Mean (bias corrected)	9.96	MLE Sd (bias corrected)	4.593

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	6.595	nu hat (KM)	224.2
Approximate Chi Square Value (224.23, α)	190.6	Adjusted Chi Square Value (224.23, β)	187.3
95% Gamma Approximate KM-UCL (use when n>=50)	11.32	95% Gamma Adjusted KM-UCL (use when n<50)	11.51

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	3.7	Mean	9.622
Maximum	16.5	Median	9.1
SD	3.787	CV	0.394
k hat (MLE)	6.072	k star (bias corrected MLE)	5.04
Theta hat (MLE)	1.585	Theta star (bias corrected MLE)	1.909
nu hat (MLE)	206.4	nu star (bias corrected)	171.3
MLE Mean (bias corrected)	9.622	MLE Sd (bias corrected)	4.286
		Adjusted Level of Significance (β)	0.0346
Approximate Chi Square Value (171.35, α)	142.1	Adjusted Chi Square Value (171.35, β)	139.3
95% Gamma Approximate UCL (use when n>=50)	11.6	95% Gamma Adjusted UCL (use when n<50)	11.84

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.898	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.173	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.229	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	9.577	Mean in Log Scale	2.173
SD in Original Scale	3.82	SD in Log Scale	0.448
95% t UCL (assumes normality of ROS data)	11.19	95% Percentile Bootstrap UCL	11.06
95% BCA Bootstrap UCL	11.05	95% Bootstrap t UCL	11.13
95% H-UCL (Log ROS)	12.13		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	2.173	95% H-UCL (KM -Log)	12.16
KM SD (logged)	0.451	95% Critical H Value (KM-Log)	1.987
KM Standard Error of Mean (logged)	0.119		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	9.376	Mean in Log Scale	2.14
SD in Original Scale	4.003	SD in Log Scale	0.477
95% t UCL (Assumes normality)	11.07	95% H-Stat UCL	12.1

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	11.3	95% KM (Percentile Bootstrap) UCL	11.14

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cu in the Animas River above mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 12:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	18	Number of Distinct Observations	9
Number of Detects	7	Number of Non-Detects	11
Number of Distinct Detects	6	Number of Distinct Non-Detects	4
Minimum Detect	2.7	Minimum Non-Detect	3
Maximum Detect	3.5	Maximum Non-Detect	20
Variance Detects	0.112	Percent Non-Detects	61.11%
Mean Detects	3.171	SD Detects	0.335
Median Detects	3.3	CV Detects	0.106
Skewness Detects	-0.471	Kurtosis Detects	-1.867
Mean of Logged Detects	1.149	SD of Logged Detects	0.108

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.872	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.221	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	3.018	Standard Error of Mean	0.106
SD	0.321	95% KM (BCA) UCL	3.25
95% KM (t) UCL	3.203	95% KM (Percentile Bootstrap) UCL	3.223
95% KM (z) UCL	3.193	95% KM Bootstrap t UCL	3.213
90% KM Chebyshev UCL	3.336	95% KM Chebyshev UCL	3.48
97.5% KM Chebyshev UCL	3.68	99% KM Chebyshev UCL	4.073

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.486	Anderson-Darling GOF Test	
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.24	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.311	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	101.4	k star (bias corrected MLE)	58.05
Theta hat (MLE)	0.0313	Theta star (bias corrected MLE)	0.0546
nu hat (MLE)	1420	nu star (bias corrected)	812.7
MLE Mean (bias corrected)	3.171	MLE Sd (bias corrected)	0.416

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	88.18	nu hat (KM)	3174
Approximate Chi Square Value (N/A, α)	3045	Adjusted Chi Square Value (N/A, β)	3032
95% Gamma Approximate KM-UCL (use when n>=50)	3.147	95% Gamma Adjusted KM-UCL (use when n<50)	3.16

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	2.542	Mean	3.016
Maximum	3.5	Median	2.972
SD	0.297	CV	0.0984
k hat (MLE)	110.4	k star (bias corrected MLE)	92.05
Theta hat (MLE)	0.0273	Theta star (bias corrected MLE)	0.0328
nu hat (MLE)	3975	nu star (bias corrected)	3314
MLE Mean (bias corrected)	3.016	MLE Sd (bias corrected)	0.314
		Adjusted Level of Significance (β)	0.0357
Approximate Chi Square Value (N/A, α)	3181	Adjusted Chi Square Value (N/A, β)	3168
95% Gamma Approximate UCL (use when n>=50)	3.142	95% Gamma Adjusted UCL (use when n<50)	3.155

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.869	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.232	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.015	Mean in Log Scale	1.099
SD in Original Scale	0.295	SD in Log Scale	0.097
95% t UCL (assumes normality of ROS data)	3.136	95% Percentile Bootstrap UCL	3.126
95% BCA Bootstrap UCL	3.135	95% Bootstrap t UCL	3.147
95% H-UCL (Log ROS)	N/A		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	1.099	95% H-UCL (KM -Log)	3.153
KM SD (logged)	0.104	95% Critical H Value (KM-Log)	1.735
KM Standard Error of Mean (logged)	0.0346		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	4.289	Mean in Log Scale	1.215
SD in Original Scale	3.272	SD in Log Scale	0.693
95% t UCL (Assumes normality)	5.63	95% H-Stat UCL	6.23

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.203	95% KM (Percentile Bootstrap) UCL	3.223

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cu at sampling location A72 in the Animas River below mainstem Mineral Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 12:53
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	19.2	Mean	28.88
Maximum	35.9	Median	30.2
SD	8.093	Std. Error of Mean	4.046
Coefficient of Variation	0.28	Skewness	-0.447

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.881	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.283	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	38.4	95% Adjusted-CLT UCL (Chen-1995)	34.56
		95% Modified-t UCL (Johnson-1978)	38.25
Gamma GOF Test			
A-D Test Statistic	0.4	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.315	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	15.75	k star (bias corrected MLE)	4.103
Theta hat (MLE)	1.834	Theta star (bias corrected MLE)	7.038
nu hat (MLE)	126	nu star (bias corrected)	32.82
MLE Mean (bias corrected)	28.88	MLE Sd (bias corrected)	14.26
		Approximate Chi Square Value (0.05)	20.73
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	45.73	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.883	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.28	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.955	Mean of logged Data	3.331
Maximum of Logged Data	3.581	SD of logged Data	0.299
Assuming Lognormal Distribution			
95% H-UCL	47.16	90% Chebyshev (MVUE) UCL	41.77
95% Chebyshev (MVUE) UCL	47.6	97.5% Chebyshev (MVUE) UCL	55.69
99% Chebyshev (MVUE) UCL	71.57		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	35.53	95% Jackknife UCL	38.4
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	41.01	95% Chebyshev(Mean, Sd) UCL	46.51
97.5% Chebyshev(Mean, Sd) UCL	54.14	99% Chebyshev(Mean, Sd) UCL	69.13

Suggested UCL to Use

95% Student's-t UCL	38.4

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Cu at sampling location A72 in the Animas River below mainstem Mineral Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 12:53
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	6
Number of Detects	5	Number of Non-Detects	2
Number of Distinct Detects	5	Number of Distinct Non-Detects	1
Minimum Detect	3.6	Minimum Non-Detect	10
Maximum Detect	7.6	Maximum Non-Detect	10
Variance Detects	2.863	Percent Non-Detects	28.57%
Mean Detects	5.24	SD Detects	1.692
Median Detects	4.5	CV Detects	0.323
Skewness Detects	0.723	Kurtosis Detects	-1.587
Mean of Logged Detects	1.616	SD of Logged Detects	0.314

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.902	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.269	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	5.24	Standard Error of Mean	0.757
SD	1.513	95% KM (BCA) UCL	6.42
95% KM (t) UCL	6.71	95% KM (Percentile Bootstrap) UCL	6.417
95% KM (z) UCL	6.485	95% KM Bootstrap t UCL	10.02
90% KM Chebyshev UCL	7.51	95% KM Chebyshev UCL	8.538
97.5% KM Chebyshev UCL	9.966	99% KM Chebyshev UCL	12.77

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.347	Anderson-Darling GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.267	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	12.59	k star (bias corrected MLE)	5.17
Theta hat (MLE)	0.416	Theta star (bias corrected MLE)	1.014
nu hat (MLE)	125.9	nu star (bias corrected)	51.7
MLE Mean (bias corrected)	5.24	MLE Sd (bias corrected)	2.305

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	11.99	nu hat (KM)	167.8
Approximate Chi Square Value (167.83, α)	138.9	Adjusted Chi Square Value (167.83, β)	130.9
95% Gamma Approximate KM-UCL (use when n>=50)	6.333	95% Gamma Adjusted KM-UCL (use when n<50)	6.718

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	3.6	Mean	5.224
Maximum	7.6	Median	4.5
SD	1.485	CV	0.284
k hat (MLE)	15.07	k star (bias corrected MLE)	8.709
Theta hat (MLE)	0.347	Theta star (bias corrected MLE)	0.6
nu hat (MLE)	211	nu star (bias corrected)	121.9
MLE Mean (bias corrected)	5.224	MLE Sd (bias corrected)	1.77
		Adjusted Level of Significance (β)	0.0158
Approximate Chi Square Value (121.93, α)	97.43	Adjusted Chi Square Value (121.93, β)	90.82
95% Gamma Approximate UCL (use when n>=50)	6.538	95% Gamma Adjusted UCL (use when n<50)	7.014

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.925	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.239	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.203	Mean in Log Scale	1.616
SD in Original Scale	1.475	SD in Log Scale	0.276
95% t UCL (assumes normality of ROS data)	6.287	95% Percentile Bootstrap UCL	6.086
95% BCA Bootstrap UCL	6.243	95% Bootstrap t UCL	6.707
95% H-UCL (Log ROS)	6.66		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	1.616	95% H-UCL (KM -Log)	6.71
KM SD (logged)	0.281	95% Critical H Value (KM-Log)	2.163
KM Standard Error of Mean (logged)	0.14		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	5.171	Mean in Log Scale	1.614
SD in Original Scale	1.386	SD in Log Scale	0.256
95% t UCL (Assumes normality)	6.19	95% H-Stat UCL	6.471

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	6.71	95% KM (Percentile Bootstrap) UCL	6.417

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cu at sampling location A72 in the Animas River below mainstem Mineral Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 12:53
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	13	Number of Distinct Observations	10
Number of Detects	8	Number of Non-Detects	5
Number of Distinct Detects	8	Number of Distinct Non-Detects	2
Minimum Detect	3	Minimum Non-Detect	10
Maximum Detect	36.9	Maximum Non-Detect	20
Variance Detects	109	Percent Non-Detects	38.46%
Mean Detects	14.23	SD Detects	10.44
Median Detects	13.75	CV Detects	0.734
Skewness Detects	1.561	Kurtosis Detects	3.428
Mean of Logged Detects	2.414	SD of Logged Detects	0.78

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.852	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.256	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.313	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	12.38	Standard Error of Mean	2.776
SD	8.602	95% KM (BCA) UCL	17.27
95% KM (t) UCL	17.32	95% KM (Percentile Bootstrap) UCL	17.03
95% KM (z) UCL	16.94	95% KM Bootstrap t UCL	18.51
90% KM Chebyshev UCL	20.71	95% KM Chebyshev UCL	24.48
97.5% KM Chebyshev UCL	29.71	99% KM Chebyshev UCL	40

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.301	Anderson-Darling GOF Test	
5% A-D Critical Value	0.723	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.172	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.297	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.225	k star (bias corrected MLE)	1.474
Theta hat (MLE)	6.393	Theta star (bias corrected MLE)	9.651
nu hat (MLE)	35.6	nu star (bias corrected)	23.58
MLE Mean (bias corrected)	14.23	MLE Sd (bias corrected)	11.72

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	2.07	nu hat (KM)	53.83
Approximate Chi Square Value (53.83, α)	37.97	Adjusted Chi Square Value (53.83, β)	36.08
95% Gamma Approximate KM-UCL (use when n>=50)	17.55	95% Gamma Adjusted KM-UCL (use when n<50)	18.46

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	3	Mean	12.3
Maximum	36.9	Median	11.84
SD	8.935	CV	0.727
k hat (MLE)	2.389	k star (bias corrected MLE)	1.889
Theta hat (MLE)	5.147	Theta star (bias corrected MLE)	6.509
nu hat (MLE)	62.12	nu star (bias corrected)	49.12
MLE Mean (bias corrected)	12.3	MLE Sd (bias corrected)	8.947
		Adjusted Level of Significance (β)	0.0301
Approximate Chi Square Value (49.12, α)	34.03	Adjusted Chi Square Value (49.12, β)	32.25
95% Gamma Approximate UCL (use when n>=50)	17.75	95% Gamma Adjusted UCL (use when n<50)	18.73

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.947	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.202	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.313	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	12.14	Mean in Log Scale	2.283
SD in Original Scale	8.84	SD in Log Scale	0.684
95% t UCL (assumes normality of ROS data)	16.51	95% Percentile Bootstrap UCL	15.94
95% BCA Bootstrap UCL	17.21	95% Bootstrap t UCL	18.95
95% H-UCL (Log ROS)	19.69		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	2.278	95% H-UCL (KM -Log)	20.7
KM SD (logged)	0.716	95% Critical H Value (KM-Log)	2.395
KM Standard Error of Mean (logged)	0.256		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	12.22	Mean in Log Scale	2.318
SD in Original Scale	8.501	SD in Log Scale	0.635
95% t UCL (Assumes normality)	16.42	95% H-Stat UCL	18.86

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	17.32	95% KM (Percentile Bootstrap) UCL	17.03

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cu at sampling location A73 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 13:03
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	1.9	Mean	3.72
Maximum	5	Median	4.3
SD	1.429	Std. Error of Mean	0.639
Coefficient of Variation	0.384	Skewness	-0.558

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.853	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.258	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.082	95% Adjusted-CLT UCL (Chen-1995)	4.601
		95% Modified-t UCL (Johnson-1978)	5.056

Gamma GOF Test

A-D Test Statistic	0.503	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.299	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.241	k star (bias corrected MLE)	3.03
Theta hat (MLE)	0.514	Theta star (bias corrected MLE)	1.228
nu hat (MLE)	72.41	nu star (bias corrected)	30.3
MLE Mean (bias corrected)	3.72	MLE Sd (bias corrected)	2.137
		Approximate Chi Square Value (0.05)	18.73
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	14.89

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	6.018	95% Adjusted Gamma UCL (use when n<50)	7.568

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.844	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.289	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.642	Mean of logged Data	1.243
Maximum of Logged Data	1.609	SD of logged Data	0.438

Assuming Lognormal Distribution

95% H-UCL	6.986	90% Chebyshev (MVUE) UCL	5.924
95% Chebyshev (MVUE) UCL	6.914	97.5% Chebyshev (MVUE) UCL	8.287
99% Chebyshev (MVUE) UCL	10.98		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.771	95% Jackknife UCL	5.082
95% Standard Bootstrap UCL	4.651	95% Bootstrap-t UCL	4.868
95% Hall's Bootstrap UCL	4.29	95% Percentile Bootstrap UCL	4.7
95% BCA Bootstrap UCL	4.44		
90% Chebyshev(Mean, Sd) UCL	5.637	95% Chebyshev(Mean, Sd) UCL	6.506
97.5% Chebyshev(Mean, Sd) UCL	7.711	99% Chebyshev(Mean, Sd) UCL	10.08

Suggested UCL to Use

95% Student's-t UCL	5.082

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Cu at sampling location A73B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 13:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1.4	Mean	2.575
Maximum	3.8	Median	2.55
SD	1.078	Std. Error of Mean	0.539
Coefficient of Variation	0.419	Skewness	0.0908

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.964	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.203	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.844	95% Adjusted-CLT UCL (Chen-1995)	3.488
		95% Modified-t UCL (Johnson-1978)	3.848
Gamma GOF Test			
A-D Test Statistic	0.255	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.658	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.237	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	7.122	k star (bias corrected MLE)	1.947
Theta hat (MLE)	0.362	Theta star (bias corrected MLE)	1.322
nu hat (MLE)	56.98	nu star (bias corrected)	15.58
MLE Mean (bias corrected)	2.575	MLE Sd (bias corrected)	1.845
		Approximate Chi Square Value (0.05)	7.665
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	5.233	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.961	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.217	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.336	Mean of logged Data	0.874
Maximum of Logged Data	1.335	SD of logged Data	0.447
Assuming Lognormal Distribution			
95% H-UCL	6.363	90% Chebyshev (MVUE) UCL	4.286
95% Chebyshev (MVUE) UCL	5.059	97.5% Chebyshev (MVUE) UCL	6.131
99% Chebyshev (MVUE) UCL	8.238		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	3.462	95% Jackknife UCL	3.844
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	4.192	95% Chebyshev(Mean, Sd) UCL	4.925
97.5% Chebyshev(Mean, Sd) UCL	5.942	99% Chebyshev(Mean, Sd) UCL	7.939

Suggested UCL to Use

95% Student's-t UCL	3.844

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cu at sampling location A75D in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 13:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.6	Mean	2.5
Maximum	4.2	Median	2.1
SD	1.454	Std. Error of Mean	0.65
Coefficient of Variation	0.582	Skewness	-0.0675

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.945	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.208	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.887	95% Adjusted-CLT UCL (Chen-1995)	3.549
		95% Modified-t UCL (Johnson-1978)	3.883

Gamma GOF Test

A-D Test Statistic	0.321	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.683	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.213	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.36	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.746	k star (bias corrected MLE)	1.232
Theta hat (MLE)	0.91	Theta star (bias corrected MLE)	2.03
nu hat (MLE)	27.46	nu star (bias corrected)	12.32
MLE Mean (bias corrected)	2.5	MLE Sd (bias corrected)	2.253
		Approximate Chi Square Value (0.05)	5.436
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	3.621

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5.664	95% Adjusted Gamma UCL (use when n<50)	8.503

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.889	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.258	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.511	Mean of logged Data	0.723
Maximum of Logged Data	1.435	SD of logged Data	0.771

Assuming Lognormal Distribution

95% H-UCL	12.7	90% Chebyshev (MVUE) UCL	5.212
95% Chebyshev (MVUE) UCL	6.398	97.5% Chebyshev (MVUE) UCL	8.045
99% Chebyshev (MVUE) UCL	11.28		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.57	95% Jackknife UCL	3.887
95% Standard Bootstrap UCL	3.445	95% Bootstrap-t UCL	4.586
95% Hall's Bootstrap UCL	4.864	95% Percentile Bootstrap UCL	3.38
95% BCA Bootstrap UCL	3.38		
90% Chebyshev(Mean, Sd) UCL	4.451	95% Chebyshev(Mean, Sd) UCL	5.335
97.5% Chebyshev(Mean, Sd) UCL	6.562	99% Chebyshev(Mean, Sd) UCL	8.971

Suggested UCL to Use

95% Student's-t UCL	3.887

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Cu at sampling location A75B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 13:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	0.7	Mean	2.625
Maximum	4.1	Median	2.85
SD	1.573	Std. Error of Mean	0.787
Coefficient of Variation	0.599	Skewness	-0.501

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.925	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.253	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4.476	95% Adjusted-CLT UCL (Chen-1995)	3.709
		95% Modified-t UCL (Johnson-1978)	4.444
Gamma GOF Test			
A-D Test Statistic	0.36	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.286	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.641	k star (bias corrected MLE)	0.827
Theta hat (MLE)	0.994	Theta star (bias corrected MLE)	3.175
nu hat (MLE)	21.13	nu star (bias corrected)	6.615
MLE Mean (bias corrected)	2.625	MLE Sd (bias corrected)	2.887
		Approximate Chi Square Value (0.05)	1.962
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	8.852	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.879	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.249	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.357	Mean of logged Data	0.764
Maximum of Logged Data	1.411	SD of logged Data	0.812
Assuming Lognormal Distribution			
95% H-UCL	39	90% Chebyshev (MVUE) UCL	5.867
95% Chebyshev (MVUE) UCL	7.294	97.5% Chebyshev (MVUE) UCL	9.274
99% Chebyshev (MVUE) UCL	13.16		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	3.919	95% Jackknife UCL	4.476
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	4.985	95% Chebyshev(Mean, Sd) UCL	6.054
97.5% Chebyshev(Mean, Sd) UCL	7.538	99% Chebyshev(Mean, Sd) UCL	10.45

Suggested UCL to Use

95% Student's-t UCL	4.476

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Cu at Bakers Bridge in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 13:05
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	1
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	1.9	Minimum Non-Detect	0.5
Maximum Detect	3.7	Maximum Non-Detect	0.5
Variance Detects	0.72	Percent Non-Detects	20%
Mean Detects	2.9	SD Detects	0.849
Median Detects	3	CV Detects	0.293
Skewness Detects	-0.367	Kurtosis Detects	-3.438
Mean of Logged Detects	1.03	SD of Logged Detects	0.311

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.913	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.26	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	2.42	Standard Error of Mean	0.601
SD	1.163	95% KM (BCA) UCL	N/A
95% KM (t) UCL	3.701	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	3.408	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	4.222	95% KM Chebyshev UCL	5.039
97.5% KM Chebyshev UCL	6.172	99% KM Chebyshev UCL	8.398

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.348	Anderson-Darling GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.295	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	14.49	k star (bias corrected MLE)	3.789
Theta hat (MLE)	0.2	Theta star (bias corrected MLE)	0.765
nu hat (MLE)	115.9	nu star (bias corrected)	30.32
MLE Mean (bias corrected)	2.9	MLE Sd (bias corrected)	1.49

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	4.327	nu hat (KM)	43.27
Approximate Chi Square Value (43.27, α)	29.18	Adjusted Chi Square Value (43.27, β)	24.24
95% Gamma Approximate KM-UCL (use when n>=50)	3.588	95% Gamma Adjusted KM-UCL (use when n<50)	4.319

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.98	Mean	2.516
Maximum	3.7	Median	2.5
SD	1.13	CV	0.449
k hat (MLE)	5.019	k star (bias corrected MLE)	2.141
Theta hat (MLE)	0.501	Theta star (bias corrected MLE)	1.175
nu hat (MLE)	50.19	nu star (bias corrected)	21.41
MLE Mean (bias corrected)	2.516	MLE Sd (bias corrected)	1.719
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (21.41, α)	11.9	Adjusted Chi Square Value (21.41, β)	8.959
95% Gamma Approximate UCL (use when n>=50)	4.528	95% Gamma Adjusted UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.91	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.263	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.571	Mean in Log Scale	0.869
SD in Original Scale	1.04	SD in Log Scale	0.449
95% t UCL (assumes normality of ROS data)	3.562	95% Percentile Bootstrap UCL	3.22
95% BCA Bootstrap UCL	3.14	95% Bootstrap t UCL	3.694
95% H-UCL (Log ROS)	4.937		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	0.685	95% H-UCL (KM -Log)	10.3
KM SD (logged)	0.73	95% Critical H Value (KM-Log)	3.78
KM Standard Error of Mean (logged)	0.377		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.37	Mean in Log Scale	0.547
SD in Original Scale	1.394	SD in Log Scale	1.114
95% t UCL (Assumes normality)	3.699	95% H-Stat UCL	64.87

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.701	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Pb in mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:56
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	13.2	Mean	14.2
Maximum	15.1	Median	14.25
SD	0.779	Std. Error of Mean	0.389
Coefficient of Variation	0.0549	Skewness	-0.381

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.961	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.25	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	15.12	95% Adjusted-CLT UCL (Chen-1995)	14.76
		95% Modified-t UCL (Johnson-1978)	15.1

Gamma GOF Test

A-D Test Statistic	0.291	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.256	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	439.3	k star (bias corrected MLE)	110
Theta hat (MLE)	0.0323	Theta star (bias corrected MLE)	0.129
nu hat (MLE)	3514	nu star (bias corrected)	879.9
MLE Mean (bias corrected)	14.2	MLE Sd (bias corrected)	1.354
		Approximate Chi Square Value (0.05)	812
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	15.39	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.957	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.258	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.58	Mean of logged Data	2.652
Maximum of Logged Data	2.715	SD of logged Data	0.0552

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	15.38
95% Chebyshev (MVUE) UCL	15.91	97.5% Chebyshev (MVUE) UCL	16.65
99% Chebyshev (MVUE) UCL	18.1		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	14.84	95% Jackknife UCL	15.12
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	15.37	95% Chebyshev(Mean, Sd) UCL	15.9
97.5% Chebyshev(Mean, Sd) UCL	16.63	99% Chebyshev(Mean, Sd) UCL	18.07

Suggested UCL to Use

95% Student's-t UCL	15.12

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Pb in mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:56
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	4.2	Mean	8.4
Maximum	13.1	Median	8
SD	2.711	Std. Error of Mean	1.025
Coefficient of Variation	0.323	Skewness	0.33

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.96	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.186	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	10.39	95% Adjusted-CLT UCL (Chen-1995)	10.22
		95% Modified-t UCL (Johnson-1978)	10.41

Gamma GOF Test

A-D Test Statistic	0.293	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.193	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	10.44	k star (bias corrected MLE)	6.062
Theta hat (MLE)	0.804	Theta star (bias corrected MLE)	1.386
nu hat (MLE)	146.2	nu star (bias corrected)	84.87
MLE Mean (bias corrected)	8.4	MLE Sd (bias corrected)	3.412
		Approximate Chi Square Value (0.05)	64.63
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	59.33

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	11.03	95% Adjusted Gamma UCL (use when n<50)	12.02

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.937	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.214	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.435	Mean of logged Data	2.08
Maximum of Logged Data	2.573	SD of logged Data	0.348

Assuming Lognormal Distribution

95% H-UCL	11.73	90% Chebyshev (MVUE) UCL	11.76
95% Chebyshev (MVUE) UCL	13.27	97.5% Chebyshev (MVUE) UCL	15.37
99% Chebyshev (MVUE) UCL	19.49		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	10.09	95% Jackknife UCL	10.39
95% Standard Bootstrap UCL	9.961	95% Bootstrap-t UCL	10.52
95% Hall's Bootstrap UCL	10.97	95% Percentile Bootstrap UCL	10.01
95% BCA Bootstrap UCL	10.01		
90% Chebyshev(Mean, Sd) UCL	11.47	95% Chebyshev(Mean, Sd) UCL	12.87
97.5% Chebyshev(Mean, Sd) UCL	14.8	99% Chebyshev(Mean, Sd) UCL	18.6

Suggested UCL to Use

95% Student's-t UCL	10.39

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Pb in mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:56
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	14	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	8.5	Mean	15.45
Maximum	21.4	Median	16.5
SD	3.539	Std. Error of Mean	0.946
Coefficient of Variation	0.229	Skewness	-0.378

Normal GOF Test

Shapiro Wilk Test Statistic	0.972	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.155	Lilliefors GOF Test
5% Lilliefors Critical Value	0.237	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	17.12	95% Adjusted-CLT UCL (Chen-1995)	16.9
		95% Modified-t UCL (Johnson-1978)	17.11

Gamma GOF Test

A-D Test Statistic	0.364	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.183	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.228	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	18.43	k star (bias corrected MLE)	14.53
Theta hat (MLE)	0.838	Theta star (bias corrected MLE)	1.063
nu hat (MLE)	516	nu star (bias corrected)	406.8
MLE Mean (bias corrected)	15.45	MLE Sd (bias corrected)	4.053
		Approximate Chi Square Value (0.05)	361
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	355.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	17.41	95% Adjusted Gamma UCL (use when n<50)	17.69

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.189	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.237	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.14	Mean of logged Data	2.71
Maximum of Logged Data	3.063	SD of logged Data	0.251

Assuming Lognormal Distribution

95% H-UCL	17.65	90% Chebyshev (MVUE) UCL	18.62
95% Chebyshev (MVUE) UCL	20.04	97.5% Chebyshev (MVUE) UCL	22.01
99% Chebyshev (MVUE) UCL	25.89		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	17.01	95% Jackknife UCL	17.12
95% Standard Bootstrap UCL	16.96	95% Bootstrap-t UCL	17.07
95% Hall's Bootstrap UCL	16.9	95% Percentile Bootstrap UCL	16.89
95% BCA Bootstrap UCL	16.98		
90% Chebyshev(Mean, Sd) UCL	18.29	95% Chebyshev(Mean, Sd) UCL	19.57
97.5% Chebyshev(Mean, Sd) UCL	21.36	99% Chebyshev(Mean, Sd) UCL	24.86

Suggested UCL to Use

95% Student's-t UCL	17.12

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Pb in the Animas River above of the confluence with mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	17	Number of Distinct Observations	8
Number of Detects	13	Number of Non-Detects	4
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	0.6	Minimum Non-Detect	1
Maximum Detect	1.5	Maximum Non-Detect	1
Variance Detects	0.0703	Percent Non-Detects	23.53%
Mean Detects	1.023	SD Detects	0.265
Median Detects	1	CV Detects	0.259
Skewness Detects	0.0554	Kurtosis Detects	-0.608
Mean of Logged Detects	-0.0101	SD of Logged Detects	0.272

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.972	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.119	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.246	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.961	Standard Error of Mean	0.0675
SD	0.256	95% KM (BCA) UCL	1.065
95% KM (t) UCL	1.079	95% KM (Percentile Bootstrap) UCL	1.076
95% KM (z) UCL	1.072	95% KM Bootstrap t UCL	1.088
90% KM Chebyshev UCL	1.164	95% KM Chebyshev UCL	1.255
97.5% KM Chebyshev UCL	1.383	99% KM Chebyshev UCL	1.633

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.255	Anderson-Darling GOF Test	
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.136	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.236	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	15.34	k star (bias corrected MLE)	11.85
Theta hat (MLE)	0.0667	Theta star (bias corrected MLE)	0.0863
nu hat (MLE)	398.8	nu star (bias corrected)	308.1
MLE Mean (bias corrected)	1.023	MLE Sd (bias corrected)	0.297

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	14.12	nu hat (KM)	480
Approximate Chi Square Value (480.05, α)	430.2	Adjusted Chi Square Value (480.05, β)	425.3
95% Gamma Approximate KM-UCL (use when n>=50)	1.072	95% Gamma Adjusted KM-UCL (use when n<50)	1.085

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.6	Mean	0.96
Maximum	1.5	Median	0.9
SD	0.262	CV	0.273
k hat (MLE)	14.4	k star (bias corrected MLE)	11.9
Theta hat (MLE)	0.0667	Theta star (bias corrected MLE)	0.0807
nu hat (MLE)	489.7	nu star (bias corrected)	404.6
MLE Mean (bias corrected)	0.96	MLE Sd (bias corrected)	0.278
		Adjusted Level of Significance (β)	0.0346
Approximate Chi Square Value (404.61, α)	359	Adjusted Chi Square Value (404.61, β)	354.5
95% Gamma Approximate UCL (use when n>=50)	1.082	95% Gamma Adjusted UCL (use when n<50)	1.096

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.956	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.133	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.246	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.96	Mean in Log Scale	-0.0753
SD in Original Scale	0.261	SD in Log Scale	0.272
95% t UCL (assumes normality of ROS data)	1.071	95% Percentile Bootstrap UCL	1.068
95% BCA Bootstrap UCL	1.058	95% Bootstrap t UCL	1.085
95% H-UCL (Log ROS)	1.091		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-0.0753	95% H-UCL (KM -Log)	1.088
KM SD (logged)	0.268	95% Critical H Value (KM-Log)	1.838
KM Standard Error of Mean (logged)	0.0726		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.9	Mean in Log Scale	-0.171
SD in Original Scale	0.324	SD in Log Scale	0.381
95% t UCL (Assumes normality)	1.037	95% H-Stat UCL	1.088

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.079	95% KM (Percentile Bootstrap) UCL	1.076

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Pb in the Animas River above of the confluence with mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	18	Number of Distinct Observations	9
Number of Detects	7	Number of Non-Detects	11
Number of Distinct Detects	7	Number of Distinct Non-Detects	2
Minimum Detect	0.1	Minimum Non-Detect	0.2
Maximum Detect	0.436	Maximum Non-Detect	1
Variance Detects	0.0112	Percent Non-Detects	61.11%
Mean Detects	0.308	SD Detects	0.106
Median Detects	0.322	CV Detects	0.344
Skewness Detects	-1.27	Kurtosis Detects	2.635
Mean of Logged Detects	-1.257	SD of Logged Detects	0.485

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.905	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.253	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.262	Standard Error of Mean	0.044
SD	0.122	95% KM (BCA) UCL	0.351
95% KM (t) UCL	0.338	95% KM (Percentile Bootstrap) UCL	0.339
95% KM (z) UCL	0.334	95% KM Bootstrap t UCL	0.323
90% KM Chebyshev UCL	0.394	95% KM Chebyshev UCL	0.454
97.5% KM Chebyshev UCL	0.537	99% KM Chebyshev UCL	0.7

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.687	Anderson-Darling GOF Test	
5% A-D Critical Value	0.709	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.315	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.313	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	6.479	k star (bias corrected MLE)	3.797
Theta hat (MLE)	0.0475	Theta star (bias corrected MLE)	0.0811
nu hat (MLE)	90.7	nu star (bias corrected)	53.16
MLE Mean (bias corrected)	0.308	MLE Sd (bias corrected)	0.158

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	4.581	nu hat (KM)	164.9
Approximate Chi Square Value (164.92, α)	136.2	Adjusted Chi Square Value (164.92, β)	133.7
95% Gamma Approximate KM-UCL (use when n>=50)	0.317	95% Gamma Adjusted KM-UCL (use when n<50)	0.323

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.1	Mean	0.273
Maximum	0.456	Median	0.287
SD	0.108	CV	0.395
k hat (MLE)	5.892	k star (bias corrected MLE)	4.947
Theta hat (MLE)	0.0463	Theta star (bias corrected MLE)	0.0551
nu hat (MLE)	212.1	nu star (bias corrected)	178.1
MLE Mean (bias corrected)	0.273	MLE Sd (bias corrected)	0.123
		Adjusted Level of Significance (β)	0.0357
Approximate Chi Square Value (178.09, α)	148.2	Adjusted Chi Square Value (178.09, β)	145.6
95% Gamma Approximate UCL (use when n>=50)	0.328	95% Gamma Adjusted UCL (use when n<50)	0.334

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.755	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.344	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.268	Mean in Log Scale	-1.425
SD in Original Scale	0.121	SD in Log Scale	0.5
95% t UCL (assumes normality of ROS data)	0.318	95% Percentile Bootstrap UCL	0.314
95% BCA Bootstrap UCL	0.315	95% Bootstrap t UCL	0.322
95% H-UCL (Log ROS)	0.348		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.381	Mean in Log Scale	-1.091
SD in Original Scale	0.151	SD in Log Scale	0.592
95% t UCL (Assumes normality)	0.443	95% H-Stat UCL	0.542

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.338	95% KM (Percentile Bootstrap) UCL	0.339

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Mn in mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 14:06
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	3040	Mean	4618
Maximum	5290	Median	5070
SD	1062	Std. Error of Mean	531
Coefficient of Variation	0.23	Skewness	-1.887

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.747	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.369	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5867	95% Adjusted-CLT UCL (Chen-1995)	4956
		95% Modified-t UCL (Johnson-1978)	5784
Gamma GOF Test			
A-D Test Statistic	0.716	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.4	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	21.06	k star (bias corrected MLE)	5.432
Theta hat (MLE)	219.2	Theta star (bias corrected MLE)	850.1
nu hat (MLE)	168.5	nu star (bias corrected)	43.46
MLE Mean (bias corrected)	4618	MLE Sd (bias corrected)	1981
		Approximate Chi Square Value (0.05)	29.34
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	6839	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.723	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.385	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	8.02	Mean of logged Data	8.414
Maximum of Logged Data	8.574	SD of logged Data	0.264
Assuming Lognormal Distribution			
95% H-UCL	7002	90% Chebyshev (MVUE) UCL	6452
95% Chebyshev (MVUE) UCL	7279	97.5% Chebyshev (MVUE) UCL	8426
99% Chebyshev (MVUE) UCL	10680		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	5491	95% Jackknife UCL	5867
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	6211	95% Chebyshev(Mean, Sd) UCL	6932
97.5% Chebyshev(Mean, Sd) UCL	7934	99% Chebyshev(Mean, Sd) UCL	9901

Suggested UCL to Use

95% Student's-t UCL	5867

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Mn in mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 14:06
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	731	Mean	1268
Maximum	1770	Median	1440
SD	479.1	Std. Error of Mean	181.1
Coefficient of Variation	0.378	Skewness	-0.207

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.81	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.259	Lilliefors GOF Test
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1620	95% Adjusted-CLT UCL (Chen-1995)	1551
		95% Modified-t UCL (Johnson-1978)	1618

Gamma GOF Test

A-D Test Statistic	0.75	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.709	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.272	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.437	k star (bias corrected MLE)	4.345
Theta hat (MLE)	170.5	Theta star (bias corrected MLE)	291.9
nu hat (MLE)	104.1	nu star (bias corrected)	60.83
MLE Mean (bias corrected)	1268	MLE Sd (bias corrected)	608.4
		Approximate Chi Square Value (0.05)	43.89
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	39.59

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1758	95% Adjusted Gamma UCL (use when n<50)	1949

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.795	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.803	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.255	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.594	Mean of logged Data	7.077
Maximum of Logged Data	7.479	SD of logged Data	0.411

Assuming Lognormal Distribution

95% H-UCL	1893	90% Chebyshev (MVUE) UCL	1866
95% Chebyshev (MVUE) UCL	2136	97.5% Chebyshev (MVUE) UCL	2509
99% Chebyshev (MVUE) UCL	3244		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1566	95% Jackknife UCL	1620
95% Standard Bootstrap UCL	1548	95% Bootstrap-t UCL	1620
95% Hall's Bootstrap UCL	1465	95% Percentile Bootstrap UCL	1545
95% BCA Bootstrap UCL	1514		
90% Chebyshev(Mean, Sd) UCL	1812	95% Chebyshev(Mean, Sd) UCL	2058
97.5% Chebyshev(Mean, Sd) UCL	2399	99% Chebyshev(Mean, Sd) UCL	3070

Suggested UCL to Use

95% Student's-t UCL	1620

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Mn in mainstem Cement Creek during the post- runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 14:06
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	710	Mean	4112
Maximum	5300	Median	4855
SD	1449	Std. Error of Mean	387.3
Coefficient of Variation	0.352	Skewness	-1.408

Normal GOF Test			
Shapiro Wilk Test Statistic	0.793	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.28	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.237	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4798	95% Adjusted-CLT UCL (Chen-1995)	4594
		95% Modified-t UCL (Johnson-1978)	4774

Gamma GOF Test			
A-D Test Statistic	1.628	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.738	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.303	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.229	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics			
k hat (MLE)	4.838	k star (bias corrected MLE)	3.849
Theta hat (MLE)	850	Theta star (bias corrected MLE)	1068
nu hat (MLE)	135.5	nu star (bias corrected)	107.8
MLE Mean (bias corrected)	4112	MLE Sd (bias corrected)	2096
		Approximate Chi Square Value (0.05)	84.8
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	82.1

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	5225	95% Adjusted Gamma UCL (use when n<50)	5397

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.675	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.295	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.237	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			

Lognormal Statistics			
Minimum of Logged Data	6.565	Mean of logged Data	8.215
Maximum of Logged Data	8.575	SD of logged Data	0.57

Assuming Lognormal Distribution			
95% H-UCL	6087	90% Chebyshev (MVUE) UCL	6322
95% Chebyshev (MVUE) UCL	7242	97.5% Chebyshev (MVUE) UCL	8519
99% Chebyshev (MVUE) UCL	11027		

Nonparametric Distribution Free UCL Statistics	
Data do not follow a Discernible Distribution (0.05)	

Nonparametric Distribution Free UCLs			
95% CLT UCL	4749	95% Jackknife UCL	4798
95% Standard Bootstrap UCL	4718	95% Bootstrap-t UCL	4683
95% Hall's Bootstrap UCL	4605	95% Percentile Bootstrap UCL	4673
95% BCA Bootstrap UCL	4614		
90% Chebyshev(Mean, Sd) UCL	5274	95% Chebyshev(Mean, Sd) UCL	5801
97.5% Chebyshev(Mean, Sd) UCL	6531	99% Chebyshev(Mean, Sd) UCL	7966

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	5801

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Mn in the Animas River above of the confluence with mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 14:09
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	2710	Mean	3300
Maximum	3730	Median	3340
SD	394.3	Std. Error of Mean	176.3
Coefficient of Variation	0.119	Skewness	-0.754

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.964	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.161	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3676	95% Adjusted-CLT UCL (Chen-1995)	3526
		95% Modified-t UCL (Johnson-1978)	3666
Gamma GOF Test			
A-D Test Statistic	0.246	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.678	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.17	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	83.63	k star (bias corrected MLE)	33.59
Theta hat (MLE)	39.46	Theta star (bias corrected MLE)	98.25
nu hat (MLE)	836.3	nu star (bias corrected)	335.9
MLE Mean (bias corrected)	3300	MLE Sd (bias corrected)	569.4
		Approximate Chi Square Value (0.05)	294.4
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	277.2
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	3765	95% Adjusted Gamma UCL (use when n<50)	3998
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.947	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.181	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	7.905	Mean of logged Data	8.096
Maximum of Logged Data	8.224	SD of logged Data	0.124
Assuming Lognormal Distribution			
95% H-UCL	3758	90% Chebyshev (MVUE) UCL	3849
95% Chebyshev (MVUE) UCL	4097	97.5% Chebyshev (MVUE) UCL	4442
99% Chebyshev (MVUE) UCL	5119		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	3590	95% Jackknife UCL	3676
95% Standard Bootstrap UCL	3559	95% Bootstrap-t UCL	3640
95% Hall's Bootstrap UCL	3513	95% Percentile Bootstrap UCL	3548
95% BCA Bootstrap UCL	3504		
90% Chebyshev(Mean, Sd) UCL	3829	95% Chebyshev(Mean, Sd) UCL	4069
97.5% Chebyshev(Mean, Sd) UCL	4401	99% Chebyshev(Mean, Sd) UCL	5054

Suggested UCL to Use

95% Student's-t UCL	3676

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Mn in the Animas River above of the confluence with mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 14:09
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	153	Mean	514.3
Maximum	1220	Median	415
SD	279.8	Std. Error of Mean	67.87
Coefficient of Variation	0.544	Skewness	0.894

Normal GOF Test

Shapiro Wilk Test Statistic	0.908	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.892	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.2	Lilliefors GOF Test
5% Lilliefors Critical Value	0.215	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	632.8	95% Adjusted-CLT UCL (Chen-1995)	641.7
		95% Modified-t UCL (Johnson-1978)	635.2

Gamma GOF Test

A-D Test Statistic	0.466	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.194	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.21	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.62	k star (bias corrected MLE)	3.02
Theta hat (MLE)	142.1	Theta star (bias corrected MLE)	170.3
nu hat (MLE)	123.1	nu star (bias corrected)	102.7
MLE Mean (bias corrected)	514.3	MLE Sd (bias corrected)	295.9
		Approximate Chi Square Value (0.05)	80.3
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	78.23

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	657.6	95% Adjusted Gamma UCL (use when n<50)	675.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.953	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.892	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.205	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.215	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.03	Mean of logged Data	6.098
Maximum of Logged Data	7.107	SD of logged Data	0.569

Assuming Lognormal Distribution

95% H-UCL	705.9	90% Chebyshev (MVUE) UCL	740.7
95% Chebyshev (MVUE) UCL	841.7	97.5% Chebyshev (MVUE) UCL	982
99% Chebyshev (MVUE) UCL	1257		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	625.9	95% Jackknife UCL	632.8
95% Standard Bootstrap UCL	624.5	95% Bootstrap-t UCL	649.5
95% Hall's Bootstrap UCL	658.4	95% Percentile Bootstrap UCL	627.8
95% BCA Bootstrap UCL	637.7		
90% Chebyshev(Mean, Sd) UCL	717.9	95% Chebyshev(Mean, Sd) UCL	810.1
97.5% Chebyshev(Mean, Sd) UCL	938.1	99% Chebyshev(Mean, Sd) UCL	1190

Suggested UCL to Use

95% Student's-t UCL	632.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Mn in the Animas River above of the confluence with mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 14:09
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	18	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	416	Mean	1031
Maximum	2380	Median	843
SD	527.2	Std. Error of Mean	124.3
Coefficient of Variation	0.511	Skewness	1.035

Normal GOF Test

Shapiro Wilk Test Statistic	0.902	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.183	Lilliefors GOF Test
5% Lilliefors Critical Value	0.209	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1247	95% Adjusted-CLT UCL (Chen-1995)	1268
		95% Modified-t UCL (Johnson-1978)	1252

Gamma GOF Test

A-D Test Statistic	0.396	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.142	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.204	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.412	k star (bias corrected MLE)	3.714
Theta hat (MLE)	233.6	Theta star (bias corrected MLE)	277.6
nu hat (MLE)	158.8	nu star (bias corrected)	133.7
MLE Mean (bias corrected)	1031	MLE Sd (bias corrected)	534.9
		Approximate Chi Square Value (0.05)	108
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	105.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1276	95% Adjusted Gamma UCL (use when n<50)	1303

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.961	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.152	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.031	Mean of logged Data	6.82
Maximum of Logged Data	7.775	SD of logged Data	0.498

Assuming Lognormal Distribution

95% H-UCL	1324	90% Chebyshev (MVUE) UCL	1404
95% Chebyshev (MVUE) UCL	1574	97.5% Chebyshev (MVUE) UCL	1810
99% Chebyshev (MVUE) UCL	2273		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1235	95% Jackknife UCL	1247
95% Standard Bootstrap UCL	1227	95% Bootstrap-t UCL	1295
95% Hall's Bootstrap UCL	1311	95% Percentile Bootstrap UCL	1224
95% BCA Bootstrap UCL	1274		
90% Chebyshev(Mean, Sd) UCL	1404	95% Chebyshev(Mean, Sd) UCL	1572
97.5% Chebyshev(Mean, Sd) UCL	1807	99% Chebyshev(Mean, Sd) UCL	2267

Suggested UCL to Use

95% Student's-t UCL	1247

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Mn at sampling location A72 in the Animas River below the confluence with mainstem Mineral Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 14:34
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1770	Mean	2435
Maximum	2920	Median	2525
SD	504	Std. Error of Mean	252
Coefficient of Variation	0.207	Skewness	-0.833

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.953	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.207	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3028	95% Adjusted-CLT UCL (Chen-1995)	2737
		95% Modified-t UCL (Johnson-1978)	3011
Gamma GOF Test			
A-D Test Statistic	0.297	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.241	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	28.69	k star (bias corrected MLE)	7.338
Theta hat (MLE)	84.88	Theta star (bias corrected MLE)	331.8
nu hat (MLE)	229.5	nu star (bias corrected)	58.71
MLE Mean (bias corrected)	2435	MLE Sd (bias corrected)	898.9
		Approximate Chi Square Value (0.05)	42.09
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	3396	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.927	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.213	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	7.479	Mean of logged Data	7.78
Maximum of Logged Data	7.979	SD of logged Data	0.221
Assuming Lognormal Distribution			
95% H-UCL	3383	90% Chebyshev (MVUE) UCL	3242
95% Chebyshev (MVUE) UCL	3606	97.5% Chebyshev (MVUE) UCL	4112
99% Chebyshev (MVUE) UCL	5106		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	2850	95% Jackknife UCL	3028
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	3191	95% Chebyshev(Mean, Sd) UCL	3533
97.5% Chebyshev(Mean, Sd) UCL	4009	99% Chebyshev(Mean, Sd) UCL	4942

Suggested UCL to Use

95% Student's-t UCL	3028

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Mn at sampling location A72 in the Animas River below the confluence with mainstem Mineral Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 14:34
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	219	Mean	426.7
Maximum	823	Median	450
SD	206	Std. Error of Mean	77.86
Coefficient of Variation	0.483	Skewness	1.209

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.873	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.259	Lilliefors GOF Test
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	578	95% Adjusted-CLT UCL (Chen-1995)	592.8
		95% Modified-t UCL (Johnson-1978)	583.9

Gamma GOF Test

A-D Test Statistic	0.348	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.71	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.197	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.313	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.53	k star (bias corrected MLE)	3.255
Theta hat (MLE)	77.17	Theta star (bias corrected MLE)	131.1
nu hat (MLE)	77.42	nu star (bias corrected)	45.57
MLE Mean (bias corrected)	426.7	MLE Sd (bias corrected)	236.5
		Approximate Chi Square Value (0.05)	31.08
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	27.52

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	625.6	95% Adjusted Gamma UCL (use when n<50)	706.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.196	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.389	Mean of logged Data	5.963
Maximum of Logged Data	6.713	SD of logged Data	0.462

Assuming Lognormal Distribution

95% H-UCL	677.8	90% Chebyshev (MVUE) UCL	649.4
95% Chebyshev (MVUE) UCL	750.8	97.5% Chebyshev (MVUE) UCL	891.6
99% Chebyshev (MVUE) UCL	1168		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	554.8	95% Jackknife UCL	578
95% Standard Bootstrap UCL	544.2	95% Bootstrap-t UCL	643.6
95% Hall's Bootstrap UCL	690.9	95% Percentile Bootstrap UCL	549.9
95% BCA Bootstrap UCL	582.9		
90% Chebyshev(Mean, Sd) UCL	660.3	95% Chebyshev(Mean, Sd) UCL	766.1
97.5% Chebyshev(Mean, Sd) UCL	913	99% Chebyshev(Mean, Sd) UCL	1201

Suggested UCL to Use

95% Student's-t UCL	578

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Mn at sampling location A72 in the Animas River below the confluence with mainstem Mineral Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 14:34
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	405	Mean	1242
Maximum	2490	Median	1290
SD	552.1	Std. Error of Mean	153.1
Coefficient of Variation	0.445	Skewness	0.622

Normal GOF Test

Shapiro Wilk Test Statistic	0.958	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.131	Lilliefors GOF Test
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1514	95% Adjusted-CLT UCL (Chen-1995)	1522
		95% Modified-t UCL (Johnson-1978)	1519

Gamma GOF Test

A-D Test Statistic	0.231	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.736	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.131	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.113	k star (bias corrected MLE)	3.985
Theta hat (MLE)	242.8	Theta star (bias corrected MLE)	311.6
nu hat (MLE)	132.9	nu star (bias corrected)	103.6
MLE Mean (bias corrected)	1242	MLE Sd (bias corrected)	622
		Approximate Chi Square Value (0.05)	81.11
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	78.28

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1586	95% Adjusted Gamma UCL (use when n<50)	1643

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.961	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.156	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.004	Mean of logged Data	7.023
Maximum of Logged Data	7.82	SD of logged Data	0.489

Assuming Lognormal Distribution

95% H-UCL	1701	90% Chebyshev (MVUE) UCL	1774
95% Chebyshev (MVUE) UCL	2011	97.5% Chebyshev (MVUE) UCL	2339
99% Chebyshev (MVUE) UCL	2984		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1493	95% Jackknife UCL	1514
95% Standard Bootstrap UCL	1480	95% Bootstrap-t UCL	1544
95% Hall's Bootstrap UCL	1606	95% Percentile Bootstrap UCL	1491
95% BCA Bootstrap UCL	1500		
90% Chebyshev(Mean, Sd) UCL	1701	95% Chebyshev(Mean, Sd) UCL	1909
97.5% Chebyshev(Mean, Sd) UCL	2198	99% Chebyshev(Mean, Sd) UCL	2765

Suggested UCL to Use

95% Student's-t UCL	1514

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Mn at sampling location A73 in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	341	Mean	1009
Maximum	1830	Median	811
SD	611	Std. Error of Mean	273.3
Coefficient of Variation	0.605	Skewness	0.492

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.943	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.227	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1592	95% Adjusted-CLT UCL (Chen-1995)	1523
		95% Modified-t UCL (Johnson-1978)	1602
Gamma GOF Test			
A-D Test Statistic	0.224	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.682	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.204	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.359	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	3.155	k star (bias corrected MLE)	1.395
Theta hat (MLE)	319.9	Theta star (bias corrected MLE)	723.2
nu hat (MLE)	31.55	nu star (bias corrected)	13.95
MLE Mean (bias corrected)	1009	MLE Sd (bias corrected)	854.3
		Approximate Chi Square Value (0.05)	6.54
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	4.501
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	2153	95% Adjusted Gamma UCL (use when n<50)	3129
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.967	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.182	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.832	Mean of logged Data	6.75
Maximum of Logged Data	7.512	SD of logged Data	0.67
Assuming Lognormal Distribution			
95% H-UCL	3512	90% Chebyshev (MVUE) UCL	1917
95% Chebyshev (MVUE) UCL	2324	97.5% Chebyshev (MVUE) UCL	2889
99% Chebyshev (MVUE) UCL	4000		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1459	95% Jackknife UCL	1592
95% Standard Bootstrap UCL	1414	95% Bootstrap-t UCL	2149
95% Hall's Bootstrap UCL	5349	95% Percentile Bootstrap UCL	1433
95% BCA Bootstrap UCL	1433		
90% Chebyshev(Mean, Sd) UCL	1829	95% Chebyshev(Mean, Sd) UCL	2200
97.5% Chebyshev(Mean, Sd) UCL	2716	99% Chebyshev(Mean, Sd) UCL	3728

Suggested UCL to Use

95% Student's-t UCL	1592

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Mn at sampling location A73B in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	109	Mean	508
Maximum	1210	Median	356.5
SD	485	Std. Error of Mean	242.5
Coefficient of Variation	0.955	Skewness	1.589

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.857	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.323	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1079	95% Adjusted-CLT UCL (Chen-1995)	1113
		95% Modified-t UCL (Johnson-1978)	1111

Gamma GOF Test

A-D Test Statistic	0.253	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.662	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.234	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.399	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.564	k star (bias corrected MLE)	0.558
Theta hat (MLE)	324.9	Theta star (bias corrected MLE)	911.1
nu hat (MLE)	12.51	nu star (bias corrected)	4.46
MLE Mean (bias corrected)	508	MLE Sd (bias corrected)	680.3
		Approximate Chi Square Value (0.05)	0.912
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2486	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.992	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.186	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.691	Mean of logged Data	5.878
Maximum of Logged Data	7.098	SD of logged Data	0.993

Assuming Lognormal Distribution

95% H-UCL	26175	90% Chebyshev (MVUE) UCL	1204
95% Chebyshev (MVUE) UCL	1520	97.5% Chebyshev (MVUE) UCL	1960
99% Chebyshev (MVUE) UCL	2823		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	906.9	95% Jackknife UCL	1079
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1236	95% Chebyshev(Mean, Sd) UCL	1565
97.5% Chebyshev(Mean, Sd) UCL	2022	99% Chebyshev(Mean, Sd) UCL	2921

Suggested UCL to Use

95% Student's-t UCL	1079

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Mn at sampling location A75D in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/23/2015 14:38		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics			
Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	232	Mean	589.6
Maximum	1090	Median	408
SD	362.4	Std. Error of Mean	162.1
Coefficient of Variation	0.615	Skewness	0.702

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.893	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.292	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	935.1	95% Adjusted-CLT UCL (Chen-1995)	910.5
		95% Modified-t UCL (Johnson-1978)	943.6

Gamma GOF Test			
A-D Test Statistic	0.336	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.682	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.272	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.359	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	3.333	k star (bias corrected MLE)	1.466
Theta hat (MLE)	176.9	Theta star (bias corrected MLE)	402.1
nu hat (MLE)	33.33	nu star (bias corrected)	14.66
MLE Mean (bias corrected)	589.6	MLE Sd (bias corrected)	486.9
		Approximate Chi Square Value (0.05)	7.028
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	4.895
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1230	95% Adjusted Gamma UCL (use when n<50)	1766

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.939	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.23	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.447	Mean of logged Data	6.222
Maximum of Logged Data	6.994	SD of logged Data	0.633
Assuming Lognormal Distribution			
95% H-UCL	1812	90% Chebyshev (MVUE) UCL	1082
95% Chebyshev (MVUE) UCL	1305	97.5% Chebyshev (MVUE) UCL	1615
99% Chebyshev (MVUE) UCL	2224		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	856.2	95% Jackknife UCL	935.1
95% Standard Bootstrap UCL	826.3	95% Bootstrap-t UCL	1737
95% Hall's Bootstrap UCL	4124	95% Percentile Bootstrap UCL	849
95% BCA Bootstrap UCL	849		
90% Chebyshev(Mean, Sd) UCL	1076	95% Chebyshev(Mean, Sd) UCL	1296
97.5% Chebyshev(Mean, Sd) UCL	1602	99% Chebyshev(Mean, Sd) UCL	2202

Suggested UCL to Use

95% Student's-t UCL	935.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Mn at sampling location A75B in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	233	Mean	461.5
Maximum	856	Median	378.5
SD	272.1	Std. Error of Mean	136
Coefficient of Variation	0.59	Skewness	1.595

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.845	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.348	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	781.7	95% Adjusted-CLT UCL (Chen-1995)	801.2
		95% Modified-t UCL (Johnson-1978)	799.8

Gamma GOF Test

A-D Test Statistic	0.373	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.316	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.472	k star (bias corrected MLE)	1.285
Theta hat (MLE)	103.2	Theta star (bias corrected MLE)	359.3
nu hat (MLE)	35.77	nu star (bias corrected)	10.28
MLE Mean (bias corrected)	461.5	MLE Sd (bias corrected)	407.2
		Approximate Chi Square Value (0.05)	4.115
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1152	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.939	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.281	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.451	Mean of logged Data	6.019
Maximum of Logged Data	6.752	SD of logged Data	0.541

Assuming Lognormal Distribution

95% H-UCL	1595	90% Chebyshev (MVUE) UCL	820.7
95% Chebyshev (MVUE) UCL	985.2	97.5% Chebyshev (MVUE) UCL	1214
99% Chebyshev (MVUE) UCL	1662		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	685.3	95% Jackknife UCL	781.7
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	869.6	95% Chebyshev(Mean, Sd) UCL	1055
97.5% Chebyshev(Mean, Sd) UCL	1311	99% Chebyshev(Mean, Sd) UCL	1815

Suggested UCL to Use

95% Student's-t UCL	781.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Mn at Bakers Bridge in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	149	Mean	355.8
Maximum	584	Median	254
SD	195.9	Std. Error of Mean	87.59
Coefficient of Variation	0.55	Skewness	0.418

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.852	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.298	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	542.5	95% Adjusted-CLT UCL (Chen-1995)	517.4
		95% Modified-t UCL (Johnson-1978)	545.3

Gamma GOF Test

A-D Test Statistic	0.44	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.279	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.989	k star (bias corrected MLE)	1.729
Theta hat (MLE)	89.19	Theta star (bias corrected MLE)	205.8
nu hat (MLE)	39.89	nu star (bias corrected)	17.29
MLE Mean (bias corrected)	355.8	MLE Sd (bias corrected)	270.6
		Approximate Chi Square Value (0.05)	8.88
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	6.417

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	692.8	95% Adjusted Gamma UCL (use when n<50)	958.7

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.896	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.239	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.004	Mean of logged Data	5.744
Maximum of Logged Data	6.37	SD of logged Data	0.581

Assuming Lognormal Distribution

95% H-UCL	942.3	90% Chebyshev (MVUE) UCL	630.8
95% Chebyshev (MVUE) UCL	755.1	97.5% Chebyshev (MVUE) UCL	927.7
99% Chebyshev (MVUE) UCL	1267		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	499.9	95% Jackknife UCL	542.5
95% Standard Bootstrap UCL	485.8	95% Bootstrap-t UCL	883.2
95% Hall's Bootstrap UCL	2996	95% Percentile Bootstrap UCL	501.2
95% BCA Bootstrap UCL	493.6		
90% Chebyshev(Mean, Sd) UCL	618.6	95% Chebyshev(Mean, Sd) UCL	737.6
97.5% Chebyshev(Mean, Sd) UCL	902.8	99% Chebyshev(Mean, Sd) UCL	1227

Suggested UCL to Use

95% Student's-t UCL	542.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn in mainstem Mineral Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/24/2015 8:52
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	292	Mean	357.8
Maximum	499	Median	320
SD	95.31	Std. Error of Mean	47.66
Coefficient of Variation	0.266	Skewness	1.857

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.771	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.373	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	469.9	95% Adjusted-CLT UCL (Chen-1995)	483.4
		95% Modified-t UCL (Johnson-1978)	477.3

Gamma GOF Test

A-D Test Statistic	0.59	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.377	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	21.45	k star (bias corrected MLE)	5.529
Theta hat (MLE)	16.68	Theta star (bias corrected MLE)	64.7
nu hat (MLE)	171.6	nu star (bias corrected)	44.23
MLE Mean (bias corrected)	357.8	MLE Sd (bias corrected)	152.1
		Approximate Chi Square Value (0.05)	29.98
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	527.8	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.806	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.353	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.677	Mean of logged Data	5.856
Maximum of Logged Data	6.213	SD of logged Data	0.242

Assuming Lognormal Distribution

95% H-UCL	516.7	90% Chebyshev (MVUE) UCL	486.4
95% Chebyshev (MVUE) UCL	544.9	97.5% Chebyshev (MVUE) UCL	626.2
99% Chebyshev (MVUE) UCL	785.7		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	436.1	95% Jackknife UCL	469.9
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	500.7	95% Chebyshev(Mean, Sd) UCL	565.5
97.5% Chebyshev(Mean, Sd) UCL	655.4	99% Chebyshev(Mean, Sd) UCL	831.9

Suggested UCL to Use

95% Student's-t UCL	469.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn in mainstem Mineral Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/24/2015 8:53
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
Number of Detects	6	Number of Non-Detects	1
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	48.1	Minimum Non-Detect	50
Maximum Detect	146	Maximum Non-Detect	50
Variance Detects	1202	Percent Non-Detects	14.29%
Mean Detects	83.9	SD Detects	34.66
Median Detects	70.55	CV Detects	0.413
Skewness Detects	1.36	Kurtosis Detects	1.854
Mean of Logged Detects	4.366	SD of Logged Detects	0.382

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.868	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.296	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.362	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	78.79	Standard Error of Mean	13.19
SD	31.86	95% KM (BCA) UCL	99.61
95% KM (t) UCL	104.4	95% KM (Percentile Bootstrap) UCL	100.4
95% KM (z) UCL	100.5	95% KM Bootstrap t UCL	133.3
90% KM Chebyshev UCL	118.4	95% KM Chebyshev UCL	136.3
97.5% KM Chebyshev UCL	161.2	99% KM Chebyshev UCL	210

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.387	Anderson-Darling GOF Test
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.279	Kolmogrov-Smirnoff GOF
5% K-S Critical Value	0.333	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	8.029	k star (bias corrected MLE)	4.126
Theta hat (MLE)	10.45	Theta star (bias corrected MLE)	20.34
nu hat (MLE)	96.35	nu star (bias corrected)	49.51
MLE Mean (bias corrected)	83.9	MLE Sd (bias corrected)	41.31

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	6.114	nu hat (KM)	85.6
Approximate Chi Square Value (85.60, α)	65.27	Adjusted Chi Square Value (85.60, β)	59.94
95% Gamma Approximate KM-UCL (use when n>=50)	103.3	95% Gamma Adjusted KM-UCL (use when n<50)	112.5

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	36.76	Mean	77.17
Maximum	146	Median	68.6
SD	36.31	CV	0.471
k hat (MLE)	5.799	k star (bias corrected MLE)	3.409
Theta hat (MLE)	13.31	Theta star (bias corrected MLE)	22.64
nu hat (MLE)	81.19	nu star (bias corrected)	47.73
MLE Mean (bias corrected)	77.17	MLE Sd (bias corrected)	41.79
		Adjusted Level of Significance (β)	0.0158
Approximate Chi Square Value (47.73, α)	32.87	Adjusted Chi Square Value (47.73, β)	29.2
95% Gamma Approximate UCL (use when n>=50)	112	95% Gamma Adjusted UCL (use when n<50)	126.1

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.938	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.252	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.362	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	78.26	Mean in Log Scale	4.284
SD in Original Scale	34.99	SD in Log Scale	0.41
95% t UCL (assumes normality of ROS data)	104	95% Percentile Bootstrap UCL	99.34
95% BCA Bootstrap UCL	104.4	95% Bootstrap t UCL	130.5
95% H-UCL (Log ROS)	115.9		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	4.296	95% H-UCL (KM -Log)	110.2
KM SD (logged)	0.366	95% Critical H Value (KM-Log)	2.277
KM Standard Error of Mean (logged)	0.151		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	75.49	Mean in Log Scale	4.202
SD in Original Scale	38.69	SD in Log Scale	0.556
95% t UCL (Assumes normality)	103.9	95% H-Stat UCL	140.1

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	104.4	95% KM (Percentile Bootstrap) UCL	100.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn in mainstem Mineral Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/24/2015 8:53
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	54.4	Mean	159.5
Maximum	317	Median	170
SD	69.3	Std. Error of Mean	19.22
Coefficient of Variation	0.434	Skewness	0.772

Normal GOF Test

Shapiro Wilk Test Statistic	0.953	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.153	Lilliefors GOF Test
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	193.8	95% Adjusted-CLT UCL (Chen-1995)	195.5
		95% Modified-t UCL (Johnson-1978)	194.5

Gamma GOF Test

A-D Test Statistic	0.213	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.736	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.591	k star (bias corrected MLE)	4.352
Theta hat (MLE)	28.53	Theta star (bias corrected MLE)	36.66
nu hat (MLE)	145.4	nu star (bias corrected)	113.2
MLE Mean (bias corrected)	159.5	MLE Sd (bias corrected)	76.47
		Approximate Chi Square Value (0.05)	89.6
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	86.62

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	201.5	95% Adjusted Gamma UCL (use when n<50)	208.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.97	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.17	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.996	Mean of logged Data	4.98
Maximum of Logged Data	5.759	SD of logged Data	0.462

Assuming Lognormal Distribution

95% H-UCL	213.3	90% Chebyshev (MVUE) UCL	223.5
95% Chebyshev (MVUE) UCL	252.1	97.5% Chebyshev (MVUE) UCL	291.8
99% Chebyshev (MVUE) UCL	369.7		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	191.1	95% Jackknife UCL	193.8
95% Standard Bootstrap UCL	189.8	95% Bootstrap-t UCL	201.5
95% Hall's Bootstrap UCL	205.3	95% Percentile Bootstrap UCL	188.3
95% BCA Bootstrap UCL	194.1		
90% Chebyshev(Mean, Sd) UCL	217.2	95% Chebyshev(Mean, Sd) UCL	243.3
97.5% Chebyshev(Mean, Sd) UCL	279.6	99% Chebyshev(Mean, Sd) UCL	350.8

Suggested UCL to Use

95% Student's-t UCL	193.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn in mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/24/2015 9:02
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1600	Mean	2303
Maximum	2670	Median	2470
SD	489.4	Std. Error of Mean	244.7
Coefficient of Variation	0.213	Skewness	-1.54

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.844	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.281	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2878	95% Adjusted-CLT UCL (Chen-1995)	2504
		95% Modified-t UCL (Johnson-1978)	2847

Gamma GOF Test			
A-D Test Statistic	0.51	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.309	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics			
k hat (MLE)	25.73	k star (bias corrected MLE)	6.599
Theta hat (MLE)	89.49	Theta star (bias corrected MLE)	348.9
nu hat (MLE)	205.8	nu star (bias corrected)	52.79
MLE Mean (bias corrected)	2303	MLE Sd (bias corrected)	896.3
		Approximate Chi Square Value (0.05)	37.1
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	3276	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.813	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.31	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics			
Minimum of Logged Data	7.378	Mean of logged Data	7.722
Maximum of Logged Data	7.89	SD of logged Data	0.237

Assuming Lognormal Distribution			
95% H-UCL	3298	90% Chebyshev (MVUE) UCL	3120
95% Chebyshev (MVUE) UCL	3489	97.5% Chebyshev (MVUE) UCL	4002
99% Chebyshev (MVUE) UCL	5008		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	2705	95% Jackknife UCL	2878
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	3037	95% Chebyshev(Mean, Sd) UCL	3369
97.5% Chebyshev(Mean, Sd) UCL	3831	99% Chebyshev(Mean, Sd) UCL	4737

Suggested UCL to Use

95% Student's-t UCL	2878

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Zn in mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/24/2015 9:03
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	611	Mean	929.3
Maximum	1310	Median	1070
SD	292.7	Std. Error of Mean	110.6
Coefficient of Variation	0.315	Skewness	-0.0879

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.848	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.256	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1144	95% Adjusted-CLT UCL (Chen-1995)	1107
		95% Modified-t UCL (Johnson-1978)	1144

Gamma GOF Test

A-D Test Statistic	0.674	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.291	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.12	k star (bias corrected MLE)	6.449
Theta hat (MLE)	83.58	Theta star (bias corrected MLE)	144.1
nu hat (MLE)	155.7	nu star (bias corrected)	90.28
MLE Mean (bias corrected)	929.3	MLE Sd (bias corrected)	365.9
		Approximate Chi Square Value (0.05)	69.38
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	63.86

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1209	95% Adjusted Gamma UCL (use when n<50)	1314

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.824	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.285	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.415	Mean of logged Data	6.789
Maximum of Logged Data	7.178	SD of logged Data	0.332

Assuming Lognormal Distribution

95% H-UCL	1272	90% Chebyshev (MVUE) UCL	1281
95% Chebyshev (MVUE) UCL	1440	97.5% Chebyshev (MVUE) UCL	1660
99% Chebyshev (MVUE) UCL	2094		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1111	95% Jackknife UCL	1144
95% Standard Bootstrap UCL	1096	95% Bootstrap-t UCL	1154
95% Hall's Bootstrap UCL	1058	95% Percentile Bootstrap UCL	1100
95% BCA Bootstrap UCL	1096		
90% Chebyshev(Mean, Sd) UCL	1261	95% Chebyshev(Mean, Sd) UCL	1411
97.5% Chebyshev(Mean, Sd) UCL	1620	99% Chebyshev(Mean, Sd) UCL	2030

Suggested UCL to Use

95% Student's-t UCL	1144

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Zn in mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/24/2015 9:03
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	14	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	394	Mean	2190
Maximum	2890	Median	2500
SD	723	Std. Error of Mean	193.2
Coefficient of Variation	0.33	Skewness	-1.519

Normal GOF Test

Shapiro Wilk Test Statistic	0.817	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.257	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.237	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2533	95% Adjusted-CLT UCL (Chen-1995)	2424
		95% Modified-t UCL (Johnson-1978)	2519

Gamma GOF Test

A-D Test Statistic	1.553	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.738	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.283	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.229	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	5.464	k star (bias corrected MLE)	4.341
Theta hat (MLE)	400.9	Theta star (bias corrected MLE)	504.6
nu hat (MLE)	153	nu star (bias corrected)	121.5
MLE Mean (bias corrected)	2190	MLE Sd (bias corrected)	1051
		Approximate Chi Square Value (0.05)	97.08
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	94.18

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2742	95% Adjusted Gamma UCL (use when n<50)	2826

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.666	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.278	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.237	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	5.976	Mean of logged Data	7.597
Maximum of Logged Data	7.969	SD of logged Data	0.537

Assuming Lognormal Distribution

95% H-UCL	3130	90% Chebyshev (MVUE) UCL	3288
95% Chebyshev (MVUE) UCL	3746	97.5% Chebyshev (MVUE) UCL	4382
99% Chebyshev (MVUE) UCL	5632		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	2508	95% Jackknife UCL	2533
95% Standard Bootstrap UCL	2495	95% Bootstrap-t UCL	2477
95% Hall's Bootstrap UCL	2424	95% Percentile Bootstrap UCL	2472
95% BCA Bootstrap UCL	2435		
90% Chebyshev(Mean, Sd) UCL	2770	95% Chebyshev(Mean, Sd) UCL	3033
97.5% Chebyshev(Mean, Sd) UCL	3397	99% Chebyshev(Mean, Sd) UCL	4113

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	3033

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Zn in the Animas River above of the confluence with mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/24/2015 9:05
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	610	Mean	840.2
Maximum	1030	Median	874
SD	180.4	Std. Error of Mean	80.69
Coefficient of Variation	0.215	Skewness	-0.349

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.927	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.189	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1012	95% Adjusted-CLT UCL (Chen-1995)	959.5
		95% Modified-t UCL (Johnson-1978)	1010
Gamma GOF Test			
A-D Test Statistic	0.32	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.214	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	25.74	k star (bias corrected MLE)	10.43
Theta hat (MLE)	32.65	Theta star (bias corrected MLE)	80.58
nu hat (MLE)	257.4	nu star (bias corrected)	104.3
MLE Mean (bias corrected)	840.2	MLE Sd (bias corrected)	260.2
		Approximate Chi Square Value (0.05)	81.71
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	73.01
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1072	95% Adjusted Gamma UCL (use when n<50)	1200
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.918	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.204	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.413	Mean of logged Data	6.714
Maximum of Logged Data	6.937	SD of logged Data	0.224
Assuming Lognormal Distribution			
95% H-UCL	1087	90% Chebyshev (MVUE) UCL	1093
95% Chebyshev (MVUE) UCL	1208	97.5% Chebyshev (MVUE) UCL	1366
99% Chebyshev (MVUE) UCL	1678		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	972.9	95% Jackknife UCL	1012
95% Standard Bootstrap UCL	956.1	95% Bootstrap-t UCL	984.1
95% Hall's Bootstrap UCL	934.8	95% Percentile Bootstrap UCL	955.4
95% BCA Bootstrap UCL	946.4		
90% Chebyshev(Mean, Sd) UCL	1082	95% Chebyshev(Mean, Sd) UCL	1192
97.5% Chebyshev(Mean, Sd) UCL	1344	99% Chebyshev(Mean, Sd) UCL	1643

Suggested UCL to Use

95% Student's-t UCL	1012

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for dissolved Zn in the Animas River above of the confluence with mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/24/2015 9:05
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	242	Mean	344.2
Maximum	509	Median	296
SD	85.41	Std. Error of Mean	20.71
Coefficient of Variation	0.248	Skewness	0.771

Normal GOF Test

Shapiro Wilk Test Statistic	0.84	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.892	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.265	Lilliefors GOF Test
5% Lilliefors Critical Value	0.215	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	380.3	95% Adjusted-CLT UCL (Chen-1995)	382.4
		95% Modified-t UCL (Johnson-1978)	381

Gamma GOF Test

A-D Test Statistic	1.192	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.738	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.256	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.209	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	18.64	k star (bias corrected MLE)	15.39
Theta hat (MLE)	18.46	Theta star (bias corrected MLE)	22.36
nu hat (MLE)	633.8	nu star (bias corrected)	523.3
MLE Mean (bias corrected)	344.2	MLE Sd (bias corrected)	87.73
		Approximate Chi Square Value (0.05)	471.3
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	466.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	382.2	95% Adjusted Gamma UCL (use when n<50)	386.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.868	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.892	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.243	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.215	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.489	Mean of logged Data	5.814
Maximum of Logged Data	6.232	SD of logged Data	0.236

Assuming Lognormal Distribution

95% H-UCL	383.3	90% Chebyshev (MVUE) UCL	403.3
95% Chebyshev (MVUE) UCL	430.2	97.5% Chebyshev (MVUE) UCL	467.5
99% Chebyshev (MVUE) UCL	540.9		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	378.2	95% Jackknife UCL	380.3
95% Standard Bootstrap UCL	376.9	95% Bootstrap-t UCL	382.6
95% Hall's Bootstrap UCL	376.1	95% Percentile Bootstrap UCL	377.8
95% BCA Bootstrap UCL	380.2		
90% Chebyshev(Mean, Sd) UCL	406.3	95% Chebyshev(Mean, Sd) UCL	434.5
97.5% Chebyshev(Mean, Sd) UCL	473.5	99% Chebyshev(Mean, Sd) UCL	550.3

Suggested UCL to Use

95% Student's-t UCL	380.3	or 95% Modified-t UCL	381

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn in the Animas River above of the confluence with mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/24/2015 9:05
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	237	Mean	327.1
Maximum	567	Median	296.5
SD	85.54	Std. Error of Mean	20.16
Coefficient of Variation	0.262	Skewness	1.478

Normal GOF Test

Shapiro Wilk Test Statistic	0.845	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.186	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.209	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	362.1	95% Adjusted-CLT UCL (Chen-1995)	367.7
		95% Modified-t UCL (Johnson-1978)	363.3

Gamma GOF Test

A-D Test Statistic	0.78	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.739	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.167	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.203	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	18.05	k star (bias corrected MLE)	15.08
Theta hat (MLE)	18.12	Theta star (bias corrected MLE)	21.69
nu hat (MLE)	649.7	nu star (bias corrected)	542.7
MLE Mean (bias corrected)	327.1	MLE Sd (bias corrected)	84.23
		Approximate Chi Square Value (0.05)	489.7
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	484.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	362.5	95% Adjusted Gamma UCL (use when n<50)	366.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.904	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.153	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.468	Mean of logged Data	5.762
Maximum of Logged Data	6.34	SD of logged Data	0.235

Assuming Lognormal Distribution

95% H-UCL	362.6	90% Chebyshev (MVUE) UCL	381.2
95% Chebyshev (MVUE) UCL	406.1	97.5% Chebyshev (MVUE) UCL	440.5
99% Chebyshev (MVUE) UCL	508.2		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	360.2	95% Jackknife UCL	362.1
95% Standard Bootstrap UCL	358.4	95% Bootstrap-t UCL	373.3
95% Hall's Bootstrap UCL	374.7	95% Percentile Bootstrap UCL	361.7
95% BCA Bootstrap UCL	368.7		
90% Chebyshev(Mean, Sd) UCL	387.5	95% Chebyshev(Mean, Sd) UCL	414.9
97.5% Chebyshev(Mean, Sd) UCL	453	99% Chebyshev(Mean, Sd) UCL	527.7

Suggested UCL to Use

95% Student's-t UCL	362.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn at sampling location A72 in the Animas River below the confluence with mainstem Mineral Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/24/2015 9:44
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	864	Mean	1044
Maximum	1230	Median	1041
SD	159.7	Std. Error of Mean	79.86
Coefficient of Variation	0.153	Skewness	0.0846

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.986	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.174	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1232	95% Adjusted-CLT UCL (Chen-1995)	1179
		95% Modified-t UCL (Johnson-1978)	1233
Gamma GOF Test			
A-D Test Statistic	0.215	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.656	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.195	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	56.59	k star (bias corrected MLE)	14.31
Theta hat (MLE)	18.45	Theta star (bias corrected MLE)	72.93
nu hat (MLE)	452.7	nu star (bias corrected)	114.5
MLE Mean (bias corrected)	1044	MLE Sd (bias corrected)	275.9
		Approximate Chi Square Value (0.05)	90.81
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1317	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.986	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.176	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.762	Mean of logged Data	6.942
Maximum of Logged Data	7.115	SD of logged Data	0.154
Assuming Lognormal Distribution			
95% H-UCL	1290	90% Chebyshev (MVUE) UCL	1285
95% Chebyshev (MVUE) UCL	1394	97.5% Chebyshev (MVUE) UCL	1546
99% Chebyshev (MVUE) UCL	1843		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1175	95% Jackknife UCL	1232
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1284	95% Chebyshev(Mean, Sd) UCL	1392
97.5% Chebyshev(Mean, Sd) UCL	1543	99% Chebyshev(Mean, Sd) UCL	1839

Suggested UCL to Use

95% Student's-t UCL	1232

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn at sampling location A72 in the Animas River below the confluence with mainstem Mineral Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/24/2015 9:44
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	133	Mean	273
Maximum	453	Median	249
SD	107.7	Std. Error of Mean	40.69
Coefficient of Variation	0.394	Skewness	0.652

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.959	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.174	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	352.1	95% Adjusted-CLT UCL (Chen-1995)	350.6
		95% Modified-t UCL (Johnson-1978)	353.7

Gamma GOF Test

A-D Test Statistic	0.181	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.709	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.127	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.53	k star (bias corrected MLE)	4.398
Theta hat (MLE)	36.25	Theta star (bias corrected MLE)	62.07
nu hat (MLE)	105.4	nu star (bias corrected)	61.57
MLE Mean (bias corrected)	273	MLE Sd (bias corrected)	130.2
		Approximate Chi Square Value (0.05)	44.53
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	40.19

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	377.5	95% Adjusted Gamma UCL (use when n<50)	418.3

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.982	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.155	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.89	Mean of logged Data	5.542
Maximum of Logged Data	6.116	SD of logged Data	0.403

Assuming Lognormal Distribution

95% H-UCL	402.9	90% Chebyshev (MVUE) UCL	398.6
95% Chebyshev (MVUE) UCL	455.4	97.5% Chebyshev (MVUE) UCL	534.2
99% Chebyshev (MVUE) UCL	688.9		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	339.9	95% Jackknife UCL	352.1
95% Standard Bootstrap UCL	336.5	95% Bootstrap-t UCL	399.2
95% Hall's Bootstrap UCL	435.4	95% Percentile Bootstrap UCL	337.4
95% BCA Bootstrap UCL	344.4		
90% Chebyshev(Mean, Sd) UCL	395.1	95% Chebyshev(Mean, Sd) UCL	450.4
97.5% Chebyshev(Mean, Sd) UCL	527.1	99% Chebyshev(Mean, Sd) UCL	677.9

Suggested UCL to Use

95% Student's-t UCL	352.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn at sampling location A72 in the Animas River below the confluence with mainstem Mineral Creek during the post-runoff period

User Selected Options			
Date/Time of Computation	2/24/2015 9:44		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
General Statistics			
Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	228	Mean	578.7
Maximum	1120	Median	590
SD	237.1	Std. Error of Mean	65.77
Coefficient of Variation	0.41	Skewness	0.695
Normal GOF Test			
Shapiro Wilk Test Statistic	0.954	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.143	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	695.9	95% Adjusted-CLT UCL (Chen-1995)	700.4
		95% Modified-t UCL (Johnson-1978)	698
Gamma GOF Test			
A-D Test Statistic	0.203	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.735	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.12	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	6.309	k star (bias corrected MLE)	4.905
Theta hat (MLE)	91.72	Theta star (bias corrected MLE)	118
nu hat (MLE)	164	nu star (bias corrected)	127.5
MLE Mean (bias corrected)	578.7	MLE Sd (bias corrected)	261.3
		Approximate Chi Square Value (0.05)	102.4
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	99.24
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	720.4	95% Adjusted Gamma UCL (use when n<50)	743.6
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.972	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.142	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.429	Mean of logged Data	6.279
Maximum of Logged Data	7.021	SD of logged Data	0.431
Assuming Lognormal Distribution			
95% H-UCL	754.2	90% Chebyshev (MVUE) UCL	793.5
95% Chebyshev (MVUE) UCL	889.8	97.5% Chebyshev (MVUE) UCL	1023
99% Chebyshev (MVUE) UCL	1286		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	686.9	95% Jackknife UCL	695.9
95% Standard Bootstrap UCL	682.8	95% Bootstrap-t UCL	710.5
95% Hall's Bootstrap UCL	724.6	95% Percentile Bootstrap UCL	680.2
95% BCA Bootstrap UCL	699.7		
90% Chebyshev(Mean, Sd) UCL	776	95% Chebyshev(Mean, Sd) UCL	865.4
97.5% Chebyshev(Mean, Sd) UCL	989.4	99% Chebyshev(Mean, Sd) UCL	1233

Suggested UCL to Use

95% Student's-t UCL	695.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn at sampling location A73 in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/24/2015 9:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	242	Mean	463.2
Maximum	701	Median	364
SD	213.2	Std. Error of Mean	95.33
Coefficient of Variation	0.46	Skewness	0.413

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.84	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.279	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	666.4	95% Adjusted-CLT UCL (Chen-1995)	638.8
		95% Modified-t UCL (Johnson-1978)	669.4

Gamma GOF Test

A-D Test Statistic	0.458	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.272	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.88	k star (bias corrected MLE)	2.485
Theta hat (MLE)	78.78	Theta star (bias corrected MLE)	186.4
nu hat (MLE)	58.8	nu star (bias corrected)	24.85
MLE Mean (bias corrected)	463.2	MLE Sd (bias corrected)	293.8
		Approximate Chi Square Value (0.05)	14.5
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	11.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	794	95% Adjusted Gamma UCL (use when n<50)	1028

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.885	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.244	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.489	Mean of logged Data	6.051
Maximum of Logged Data	6.553	SD of logged Data	0.47

Assuming Lognormal Distribution

95% H-UCL	927	90% Chebyshev (MVUE) UCL	752.8
95% Chebyshev (MVUE) UCL	884	97.5% Chebyshev (MVUE) UCL	1066
99% Chebyshev (MVUE) UCL	1424		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	620	95% Jackknife UCL	666.4
95% Standard Bootstrap UCL	603	95% Bootstrap-t UCL	1055
95% Hall's Bootstrap UCL	3148	95% Percentile Bootstrap UCL	614.8
95% BCA Bootstrap UCL	614.8		
90% Chebyshev(Mean, Sd) UCL	749.2	95% Chebyshev(Mean, Sd) UCL	878.7
97.5% Chebyshev(Mean, Sd) UCL	1059	99% Chebyshev(Mean, Sd) UCL	1412

Suggested UCL to Use

95% Student's-t UCL	666.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn at sampling location A73B in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/24/2015 9:54
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	79	Mean	249.5
Maximum	561	Median	179
SD	213	Std. Error of Mean	106.5
Coefficient of Variation	0.854	Skewness	1.696

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.808	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.378	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	500.1	95% Adjusted-CLT UCL (Chen-1995)	521.1
		95% Modified-t UCL (Johnson-1978)	515.1

Gamma GOF Test

A-D Test Statistic	0.405	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.336	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.144	k star (bias corrected MLE)	0.703
Theta hat (MLE)	116.4	Theta star (bias corrected MLE)	355.1
nu hat (MLE)	17.15	nu star (bias corrected)	5.621
MLE Mean (bias corrected)	249.5	MLE Sd (bias corrected)	297.6
		Approximate Chi Square Value (0.05)	1.449
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	967.6	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.287	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.369	Mean of logged Data	5.268
Maximum of Logged Data	6.33	SD of logged Data	0.806

Assuming Lognormal Distribution

95% H-UCL	3389	90% Chebyshev (MVUE) UCL	527
95% Chebyshev (MVUE) UCL	654.8	97.5% Chebyshev (MVUE) UCL	832.1
99% Chebyshev (MVUE) UCL	1180		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	424.6	95% Jackknife UCL	500.1
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	568.9	95% Chebyshev(Mean, Sd) UCL	713.6
97.5% Chebyshev(Mean, Sd) UCL	914.4	99% Chebyshev(Mean, Sd) UCL	1309

Suggested UCL to Use

95% Student's-t UCL	500.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn at sampling location A75D in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/24/2015 9:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	140	Mean	260.6
Maximum	427	Median	217
SD	129.7	Std. Error of Mean	57.99
Coefficient of Variation	0.498	Skewness	0.515

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.875	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.232	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	384.2	95% Adjusted-CLT UCL (Chen-1995)	370.2
		95% Modified-t UCL (Johnson-1978)	386.4

Gamma GOF Test

A-D Test Statistic	0.394	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.232	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.088	k star (bias corrected MLE)	2.169
Theta hat (MLE)	51.22	Theta star (bias corrected MLE)	120.2
nu hat (MLE)	50.88	nu star (bias corrected)	21.69
MLE Mean (bias corrected)	260.6	MLE Sd (bias corrected)	177
		Approximate Chi Square Value (0.05)	12.1
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	9.135

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	466.9	95% Adjusted Gamma UCL (use when n<50)	618.7

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.892	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.21	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.942	Mean of logged Data	5.462
Maximum of Logged Data	6.057	SD of logged Data	0.505

Assuming Lognormal Distribution

95% H-UCL	565.1	90% Chebyshev (MVUE) UCL	435
95% Chebyshev (MVUE) UCL	514.1	97.5% Chebyshev (MVUE) UCL	624
99% Chebyshev (MVUE) UCL	839.7		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	356	95% Jackknife UCL	384.2
95% Standard Bootstrap UCL	345	95% Bootstrap-t UCL	541.9
95% Hall's Bootstrap UCL	530.7	95% Percentile Bootstrap UCL	348
95% BCA Bootstrap UCL	357.6		
90% Chebyshev(Mean, Sd) UCL	434.6	95% Chebyshev(Mean, Sd) UCL	513.4
97.5% Chebyshev(Mean, Sd) UCL	622.7	99% Chebyshev(Mean, Sd) UCL	837.6

Suggested UCL to Use

95% Student's-t UCL	384.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn at sampling location A75B in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/24/2015 9:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	140	Mean	235.3
Maximum	442	Median	179.5
SD	141.3	Std. Error of Mean	70.65
Coefficient of Variation	0.601	Skewness	1.729

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.792	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.321	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	401.5	95% Adjusted-CLT UCL (Chen-1995)	416.7
		95% Modified-t UCL (Johnson-1978)	411.7
Gamma GOF Test			
A-D Test Statistic	0.48	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.281	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	4.521	k star (bias corrected MLE)	1.297
Theta hat (MLE)	52.03	Theta star (bias corrected MLE)	181.4
nu hat (MLE)	36.17	nu star (bias corrected)	10.38
MLE Mean (bias corrected)	235.3	MLE Sd (bias corrected)	206.6
		Approximate Chi Square Value (0.05)	4.178
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	584.2	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.859	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.249	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.942	Mean of logged Data	5.346
Maximum of Logged Data	6.091	SD of logged Data	0.528
Assuming Lognormal Distribution			
95% H-UCL	768.9	90% Chebyshev (MVUE) UCL	412.6
95% Chebyshev (MVUE) UCL	494.2	97.5% Chebyshev (MVUE) UCL	607.5
99% Chebyshev (MVUE) UCL	830.1		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	351.5	95% Jackknife UCL	401.5
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	447.2	95% Chebyshev(Mean, Sd) UCL	543.2
97.5% Chebyshev(Mean, Sd) UCL	676.5	99% Chebyshev(Mean, Sd) UCL	938.2

Suggested UCL to Use

95% Student's-t UCL	401.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn at Bakers Bridge in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/24/2015 9:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	66.5	Mean	136
Maximum	241	Median	111
SD	71.16	Std. Error of Mean	31.83
Coefficient of Variation	0.523	Skewness	0.863

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.924	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.238	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	203.9	95% Adjusted-CLT UCL (Chen-1995)	201.5
		95% Modified-t UCL (Johnson-1978)	205.9

Gamma GOF Test

A-D Test Statistic	0.244	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.208	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.788	k star (bias corrected MLE)	2.049
Theta hat (MLE)	28.41	Theta star (bias corrected MLE)	66.41
nu hat (MLE)	47.88	nu star (bias corrected)	20.49
MLE Mean (bias corrected)	136	MLE Sd (bias corrected)	95.05
		Approximate Chi Square Value (0.05)	11.21
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	8.374

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	248.6	95% Adjusted Gamma UCL (use when n<50)	332.8

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.969	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.173	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.197	Mean of logged Data	4.805
Maximum of Logged Data	5.485	SD of logged Data	0.519

Assuming Lognormal Distribution

95% H-UCL	304.6	90% Chebyshev (MVUE) UCL	229.2
95% Chebyshev (MVUE) UCL	271.6	97.5% Chebyshev (MVUE) UCL	330.4
99% Chebyshev (MVUE) UCL	445.8		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	188.4	95% Jackknife UCL	203.9
95% Standard Bootstrap UCL	182.8	95% Bootstrap-t UCL	287.9
95% Hall's Bootstrap UCL	613.6	95% Percentile Bootstrap UCL	183.5
95% BCA Bootstrap UCL	188.2		
90% Chebyshev(Mean, Sd) UCL	231.5	95% Chebyshev(Mean, Sd) UCL	274.8
97.5% Chebyshev(Mean, Sd) UCL	334.8	99% Chebyshev(Mean, Sd) UCL	452.7

Suggested UCL to Use

95% Student's-t UCL	203.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hardness in mainstem Mineral Creek during the Pre-runoff period

User Selected Options		
Date/Time of Computation	3/4/2015 11:50	
From File	WorkSheet.xls	
Full Precision	OFF	
Confidence Coefficient	95%	
Number of Bootstrap Operations	2000	

Hardness Mineral Creek

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	150	Mean	253.5
Maximum	309	Median	277.5
SD	74.84	Std. Error of Mean	37.42
Coefficient of Variation	0.295	Skewness	-1.234

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.85	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.267	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	341.6	95% Adjusted-CLT UCL (Chen-1995)	290.4
		95% Modified-t UCL (Johnson-1978)	337.7

Gamma GOF Test

A-D Test Statistic	0.487	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.292	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	12.82	k star (bias corrected MLE)	3.373
Theta hat (MLE)	19.77	Theta star (bias corrected MLE)	75.17
nu hat (MLE)	102.6	nu star (bias corrected)	26.98
MLE Mean (bias corrected)	253.5	MLE Sd (bias corrected)	138
		Approximate Chi Square Value (0.05)	16.14
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	423.9	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.821	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.266	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.011	Mean of logged Data	5.496
Maximum of Logged Data	5.733	SD of logged Data	0.34

Assuming Lognormal Distribution

95% H-UCL	458.6	90% Chebyshev (MVUE) UCL	383
95% Chebyshev (MVUE) UCL	441.3	97.5% Chebyshev (MVUE) UCL	522.2
99% Chebyshev (MVUE) UCL	681		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	315.1	95% Jackknife UCL	341.6
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	365.8	95% Chebyshev(Mean, Sd) UCL	416.6
97.5% Chebyshev(Mean, Sd) UCL	487.2	99% Chebyshev(Mean, Sd) UCL	625.8

Suggested UCL to Use

95% Student's-t UCL	341.6

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Hardness in mainstem Cement Creek during the Pre-runoff period

User Selected Options
Date/Time of Computation 3/4/2015 11:50
From File WorkSheet.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

Hardness Cement Creek

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	301	Mean	476.5
Maximum	571	Median	517
SD	121.3	Std. Error of Mean	60.67
Coefficient of Variation	0.255	Skewness	-1.601

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.849	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.304	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	619.3	95% Adjusted-CLT UCL (Chen-1995)	524.4
		95% Modified-t UCL (Johnson-1978)	611.2

Gamma GOF Test

A-D Test Statistic	0.526	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.338	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	17.19	k star (bias corrected MLE)	4.465
Theta hat (MLE)	27.71	Theta star (bias corrected MLE)	106.7
nu hat (MLE)	137.6	nu star (bias corrected)	35.72
MLE Mean (bias corrected)	476.5	MLE Sd (bias corrected)	225.5
		Approximate Chi Square Value (0.05)	23.05
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	738.6	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.806	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.336	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.707	Mean of logged Data	6.137
Maximum of Logged Data	6.347	SD of logged Data	0.293

Assuming Lognormal Distribution

95% H-UCL	769.5	90% Chebyshev (MVUE) UCL	686.4
95% Chebyshev (MVUE) UCL	780.9	97.5% Chebyshev (MVUE) UCL	912.1
99% Chebyshev (MVUE) UCL	1170		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	576.3	95% Jackknife UCL	619.3
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	658.5	95% Chebyshev(Mean, Sd) UCL	740.9
97.5% Chebyshev(Mean, Sd) UCL	855.4	99% Chebyshev(Mean, Sd) UCL	1080

Suggested UCL to Use

95% Student's-t UCL	619.3

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Hardness in the Animas River above the confluence with mainstem Mineral Creek during the Pre-runoff period

User Selected Options

Date/Time of Computation	3/4/2015 11:50
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness Above Min Creek

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	148	Mean	170.4
Maximum	202	Median	172
SD	22.1	Std. Error of Mean	9.882
Coefficient of Variation	0.13	Skewness	0.527

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.931	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.21	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	191.5	95% Adjusted-CLT UCL (Chen-1995)	189.1
		95% Modified-t UCL (Johnson-1978)	191.9

Gamma GOF Test

A-D Test Statistic	0.292	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.678	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.239	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	75.69	k star (bias corrected MLE)	30.41
Theta hat (MLE)	2.251	Theta star (bias corrected MLE)	5.604
nu hat (MLE)	756.9	nu star (bias corrected)	304.1
MLE Mean (bias corrected)	170.4	MLE Sd (bias corrected)	30.9
		Approximate Chi Square Value (0.05)	264.7
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	248.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	195.8	95% Adjusted Gamma UCL (use when n<50)	208.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.214	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.997	Mean of logged Data	5.132
Maximum of Logged Data	5.308	SD of logged Data	0.128

Assuming Lognormal Distribution

95% H-UCL	195	90% Chebyshev (MVUE) UCL	199.7
95% Chebyshev (MVUE) UCL	212.9	97.5% Chebyshev (MVUE) UCL	231.3
99% Chebyshev (MVUE) UCL	267.5		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	186.7	95% Jackknife UCL	191.5
95% Standard Bootstrap UCL	185.1	95% Bootstrap-t UCL	195.4
95% Hall's Bootstrap UCL	188.8	95% Percentile Bootstrap UCL	185.8
95% BCA Bootstrap UCL	186.8		
90% Chebyshev(Mean, Sd) UCL	200	95% Chebyshev(Mean, Sd) UCL	213.5
97.5% Chebyshev(Mean, Sd) UCL	232.1	99% Chebyshev(Mean, Sd) UCL	268.7

Suggested UCL to Use

95% Student's-t UCL	191.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hardness in the Animas River at sampling location A72 below the confluence with mainstem Mineral Creek during the Pre-runoff period

User Selected Options

Date/Time of Computation	3/4/2015 11:51
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness A72

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	177	Mean	284.8
Maximum	352	Median	305
SD	79.58	Std. Error of Mean	39.79
Coefficient of Variation	0.279	Skewness	-1.066

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.903	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.244	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	378.4	95% Adjusted-CLT UCL (Chen-1995)	327.5
		95% Modified-t UCL (Johnson-1978)	374.9

Gamma GOF Test

A-D Test Statistic	0.394	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.274	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	14.75	k star (bias corrected MLE)	3.855
Theta hat (MLE)	19.3	Theta star (bias corrected MLE)	73.87
nu hat (MLE)	118	nu star (bias corrected)	30.84
MLE Mean (bias corrected)	284.8	MLE Sd (bias corrected)	145
		Approximate Chi Square Value (0.05)	19.15
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	458.5	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.87	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.241	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.176	Mean of logged Data	5.617
Maximum of Logged Data	5.864	SD of logged Data	0.314

Assuming Lognormal Distribution

95% H-UCL	483.1	90% Chebyshev (MVUE) UCL	419.1
95% Chebyshev (MVUE) UCL	479.6	97.5% Chebyshev (MVUE) UCL	563.6
99% Chebyshev (MVUE) UCL	728.6		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	350.2	95% Jackknife UCL	378.4
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	404.1	95% Chebyshev(Mean, Sd) UCL	458.2
97.5% Chebyshev(Mean, Sd) UCL	533.3	99% Chebyshev(Mean, Sd) UCL	680.7

Suggested UCL to Use

95% Student's-t UCL	378.4

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets. For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Hardness in mainstem Mineral Creek during the Runoff period

User Selected Options

Date/Time of Computation	3/4/2015 12:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness Mineral Creek

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	49	Mean	67.71
Maximum	92	Median	72
SD	16.51	Std. Error of Mean	6.24
Coefficient of Variation	0.244	Skewness	0.157

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.899	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.242	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	79.84	95% Adjusted-CLT UCL (Chen-1995)	78.37
		95% Modified-t UCL (Johnson-1978)	79.9

Gamma GOF Test

A-D Test Statistic	0.473	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.707	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.26	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.311	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	19.39	k star (bias corrected MLE)	11.18
Theta hat (MLE)	3.491	Theta star (bias corrected MLE)	6.058
nu hat (MLE)	271.5	nu star (bias corrected)	156.5
MLE Mean (bias corrected)	67.71	MLE Sd (bias corrected)	20.25
		Approximate Chi Square Value (0.05)	128.6
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	120.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	82.42	95% Adjusted Gamma UCL (use when n<50)	87.63

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.889	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.24	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.892	Mean of logged Data	4.189
Maximum of Logged Data	4.522	SD of logged Data	0.248

Assuming Lognormal Distribution

95% H-UCL	83.97	90% Chebyshev (MVUE) UCL	86.76
95% Chebyshev (MVUE) UCL	95.39	97.5% Chebyshev (MVUE) UCL	107.4
99% Chebyshev (MVUE) UCL	130.9		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	77.98	95% Jackknife UCL	79.84
95% Standard Bootstrap UCL	77.18	95% Bootstrap-t UCL	80.38
95% Hall's Bootstrap UCL	76.14	95% Percentile Bootstrap UCL	77.29
95% BCA Bootstrap UCL	77.14		
90% Chebyshev(Mean, Sd) UCL	86.43	95% Chebyshev(Mean, Sd) UCL	94.91
97.5% Chebyshev(Mean, Sd) UCL	106.7	99% Chebyshev(Mean, Sd) UCL	129.8

Suggested UCL to Use

95% Student's-t UCL	79.84

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets. For additional insight the user may want to consult a statistician.

ProUCL calculations for Hardness in mainstem Cement Creek during the Runoff period

User Selected Options	
Date/Time of Computation	3/4/2015 12:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness Cement Creek

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	76	**Mean**	**123.7**
Maximum	189	Median	126
SD	45.66	Std. Error of Mean	17.26
Coefficient of Variation	0.369	Skewness	0.484

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.886	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.211	Lilliefors GOF Test
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	157.3	95% Adjusted-CLT UCL (Chen-1995)	155.5
		95% Modified-t UCL (Johnson-1978)	157.8

Gamma GOF Test

A-D Test Statistic	0.403	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.709	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.227	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.714	k star (bias corrected MLE)	5.075
Theta hat (MLE)	14.2	Theta star (bias corrected MLE)	24.38
nu hat (MLE)	122	nu star (bias corrected)	71.05
MLE Mean (bias corrected)	123.7	MLE Sd (bias corrected)	54.92
		Approximate Chi Square Value (0.05)	52.64
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	47.89

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	167	95% Adjusted Gamma UCL (use when n<50)	183.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.206	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.331	Mean of logged Data	4.76
Maximum of Logged Data	5.242	SD of logged Data	0.369

Assuming Lognormal Distribution

95% H-UCL	176.1	90% Chebyshev (MVUE) UCL	175.6
95% Chebyshev (MVUE) UCL	199.2	97.5% Chebyshev (MVUE) UCL	231.8
99% Chebyshev (MVUE) UCL	296		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	152.1	95% Jackknife UCL	157.3
95% Standard Bootstrap UCL	149.2	95% Bootstrap-t UCL	165.4
95% Hall's Bootstrap UCL	163.4	95% Percentile Bootstrap UCL	151.6
95% BCA Bootstrap UCL	152.3		
90% Chebyshev(Mean, Sd) UCL	175.5	95% Chebyshev(Mean, Sd) UCL	198.9
97.5% Chebyshev(Mean, Sd) UCL	231.5	99% Chebyshev(Mean, Sd) UCL	295.4

Suggested UCL to Use

95% Student's-t UCL	157.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hardness in the Animas River Above the confluence with mainstem Mineral Creek during the Runoff period

User Selected Options

Date/Time of Computation	3/4/2015 12:50
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness Above Min Creek

General Statistics

Total Number of Observations	17	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	49	Mean	69.29
Maximum	87	Median	71
SD	11.25	Std. Error of Mean	2.728
Coefficient of Variation	0.162	Skewness	-0.489

Normal GOF Test

Shapiro Wilk Test Statistic	0.931	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.892	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.136	Lilliefors GOF Test
5% Lilliefors Critical Value	0.215	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	74.06	95% Adjusted-CLT UCL (Chen-1995)	73.44
		95% Modified-t UCL (Johnson-1978)	74

Gamma GOF Test

A-D Test Statistic	0.609	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.737	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.148	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.209	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	37.57	k star (bias corrected MLE)	30.98
Theta hat (MLE)	1.844	Theta star (bias corrected MLE)	2.237
nu hat (MLE)	1277	nu star (bias corrected)	1053
MLE Mean (bias corrected)	69.29	MLE Sd (bias corrected)	12.45
		Approximate Chi Square Value (0.05)	979
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	971.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	74.56	95% Adjusted Gamma UCL (use when n<50)	75.13

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.905	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.892	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.148	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.215	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.892	Mean of logged Data	4.225
Maximum of Logged Data	4.466	SD of logged Data	0.172

Assuming Lognormal Distribution

95% H-UCL	74.9	90% Chebyshev (MVUE) UCL	78.04
95% Chebyshev (MVUE) UCL	81.99	97.5% Chebyshev (MVUE) UCL	87.46
99% Chebyshev (MVUE) UCL	98.22		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	73.78	95% Jackknife UCL	74.06
95% Standard Bootstrap UCL	73.58	95% Bootstrap-t UCL	73.61
95% Hall's Bootstrap UCL	73.47	95% Percentile Bootstrap UCL	73.41
95% BCA Bootstrap UCL	73.29		
90% Chebyshev(Mean, Sd) UCL	77.48	95% Chebyshev(Mean, Sd) UCL	81.18
97.5% Chebyshev(Mean, Sd) UCL	86.33	99% Chebyshev(Mean, Sd) UCL	96.43

Suggested UCL to Use

95% Student's-t UCL	74.06

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Hardness in the Animas River from sampling location A72 below the confluence with mainstem Mineral Creek during the Runoff period

User Selected Options	
Date/Time of Computation	3/4/2015 12:50
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness A72

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	45	Mean	71.86
Maximum	103	Median	78
SD	20.96	Std. Error of Mean	7.921
Coefficient of Variation	0.292	Skewness	0.113

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.935	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.218	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	87.25	95% Adjusted-CLT UCL (Chen-1995)	85.25
		95% Modified-t UCL (Johnson-1978)	87.3

Gamma GOF Test

A-D Test Statistic	0.365	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.228	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	13.26	k star (bias corrected MLE)	7.672
Theta hat (MLE)	5.419	Theta star (bias corrected MLE)	9.366
nu hat (MLE)	185.6	nu star (bias corrected)	107.4
MLE Mean (bias corrected)	71.86	MLE Sd (bias corrected)	25.94
		Approximate Chi Square Value (0.05)	84.49
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	78.37

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	91.35	95% Adjusted Gamma UCL (use when n<50)	98.49

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.226	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.807	Mean of logged Data	4.236
Maximum of Logged Data	4.635	SD of logged Data	0.302

Assuming Lognormal Distribution

95% H-UCL	95.19	90% Chebyshev (MVUE) UCL	96.61
95% Chebyshev (MVUE) UCL	107.8	97.5% Chebyshev (MVUE) UCL	123.3
99% Chebyshev (MVUE) UCL	153.8		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	84.89	95% Jackknife UCL	87.25
95% Standard Bootstrap UCL	83.62	95% Bootstrap-t UCL	87.9
95% Hall's Bootstrap UCL	83.18	95% Percentile Bootstrap UCL	84
95% BCA Bootstrap UCL	83.86		
90% Chebyshev(Mean, Sd) UCL	95.62	95% Chebyshev(Mean, Sd) UCL	106.4
97.5% Chebyshev(Mean, Sd) UCL	121.3	99% Chebyshev(Mean, Sd) UCL	150.7

Suggested UCL to Use

95% Student's-t UCL	87.25

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hardness in mainstem Mineral Creek during the Post-runoff period

User Selected Options
Date/Time of Computation 3/4/2015 12:56
From File WorkSheet_a.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

Hardness Mineral Creek

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	65	Mean	161
Maximum	238	Median	156
SD	53.3	Std. Error of Mean	14.78
Coefficient of Variation	0.331	Skewness	-0.305

Normal GOF Test

Shapiro Wilk Test Statistic	0.964	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.142	Lilliefors GOF Test
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	187.3	95% Adjusted-CLT UCL (Chen-1995)	184
		95% Modified-t UCL (Johnson-1978)	187.1

Gamma GOF Test

A-D Test Statistic	0.328	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.168	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.364	k star (bias corrected MLE)	6.485
Theta hat (MLE)	19.25	Theta star (bias corrected MLE)	24.82
nu hat (MLE)	217.5	nu star (bias corrected)	168.6
MLE Mean (bias corrected)	161	MLE Sd (bias corrected)	63.22
		Approximate Chi Square Value (0.05)	139.6
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	135.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	194.5	95% Adjusted Gamma UCL (use when n<50)	199.9

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.921	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.165	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.174	Mean of logged Data	5.02
Maximum of Logged Data	5.472	SD of logged Data	0.384

Assuming Lognormal Distribution

95% H-UCL	203.1	90% Chebyshev (MVUE) UCL	214.6
95% Chebyshev (MVUE) UCL	238.4	97.5% Chebyshev (MVUE) UCL	271.4
99% Chebyshev (MVUE) UCL	336.3		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	185.3	95% Jackknife UCL	187.3
95% Standard Bootstrap UCL	183.9	95% Bootstrap-t UCL	186
95% Hall's Bootstrap UCL	184.2	95% Percentile Bootstrap UCL	183.3
95% BCA Bootstrap UCL	182.8		
90% Chebyshev(Mean, Sd) UCL	205.4	95% Chebyshev(Mean, Sd) UCL	225.4
97.5% Chebyshev(Mean, Sd) UCL	253.3	99% Chebyshev(Mean, Sd) UCL	308.1

Suggested UCL to Use

95% Student's-t UCL	187.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Hardness in mainstem Cement Creek during the Post-runoff period

User Selected Options	
Date/Time of Computation	3/4/2015 12:56
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness Cement Creek

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	67	Mean	408.6
Maximum	545	Median	468.5
SD	139.5	Std. Error of Mean	37.28
Coefficient of Variation	0.341	Skewness	-1.475

Normal GOF Test

Shapiro Wilk Test Statistic	0.83	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.234	Lilliefors GOF Test
5% Lilliefors Critical Value	0.237	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	474.7	95% Adjusted-CLT UCL (Chen-1995)	454.3
		95% Modified-t UCL (Johnson-1978)	472.2

Gamma GOF Test

A-D Test Statistic	1.504	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.738	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.257	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.229	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.998	k star (bias corrected MLE)	3.975
Theta hat (MLE)	81.76	Theta star (bias corrected MLE)	102.8
nu hat (MLE)	139.9	nu star (bias corrected)	111.3
MLE Mean (bias corrected)	408.6	MLE Sd (bias corrected)	205
		Approximate Chi Square Value (0.05)	87.94
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	85.19

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	517.2	95% Adjusted Gamma UCL (use when n<50)	533.9

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.67	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.268	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.237	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.205	Mean of logged Data	5.909
Maximum of Logged Data	6.301	SD of logged Data	0.567

Assuming Lognormal Distribution

95% H-UCL	604.1	90% Chebyshev (MVUE) UCL	628.2
95% Chebyshev (MVUE) UCL	719.3	97.5% Chebyshev (MVUE) UCL	845.7
99% Chebyshev (MVUE) UCL	1094		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	470	95% Jackknife UCL	474.7
95% Standard Bootstrap UCL	468.8	95% Bootstrap-t UCL	464.7
95% Hall's Bootstrap UCL	456.6	95% Percentile Bootstrap UCL	464.5
95% BCA Bootstrap UCL	457.2		
90% Chebyshev(Mean, Sd) UCL	520.5	95% Chebyshev(Mean, Sd) UCL	571.1
97.5% Chebyshev(Mean, Sd) UCL	641.5	99% Chebyshev(Mean, Sd) UCL	779.6

Suggested UCL to Use

95% Student's-t UCL	474.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Hardness in the Animas River above the confluence with mainstem Mineral Creek during the Post-runoff period

User Selected Options

Date/Time of Computation	3/4/2015 12:56
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness Above Mineral Creek

General Statistics

Total Number of Observations	18	Number of Distinct Observations	16
		Number of Missing Observations	0
Minimum	66	Mean	124.3
Maximum	174	Median	118.5
SD	27.56	Std. Error of Mean	6.497
Coefficient of Variation	0.222	Skewness	-0.138

Normal GOF Test

Shapiro Wilk Test Statistic	0.973	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.148	Lilliefors GOF Test
5% Lilliefors Critical Value	0.209	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	135.6	95% Adjusted-CLT UCL (Chen-1995)	134.8
		95% Modified-t UCL (Johnson-1978)	135.6

Gamma GOF Test

A-D Test Statistic	0.348	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.171	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.203	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	19.83	k star (bias corrected MLE)	16.56
Theta hat (MLE)	6.272	Theta star (bias corrected MLE)	7.509
nu hat (MLE)	713.7	nu star (bias corrected)	596.1
MLE Mean (bias corrected)	124.3	MLE Sd (bias corrected)	30.56
		Approximate Chi Square Value (0.05)	540.5
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	535.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	137.1	95% Adjusted Gamma UCL (use when n<50)	138.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.94	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.19	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.19	Mean of logged Data	4.798
Maximum of Logged Data	5.159	SD of logged Data	0.239

Assuming Lognormal Distribution

95% H-UCL	138.5	90% Chebyshev (MVUE) UCL	145.7
95% Chebyshev (MVUE) UCL	155.3	97.5% Chebyshev (MVUE) UCL	168.7
99% Chebyshev (MVUE) UCL	194.9		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	135	95% Jackknife UCL	135.6
95% Standard Bootstrap UCL	134.3	95% Bootstrap-t UCL	135.7
95% Hall's Bootstrap UCL	134.9	95% Percentile Bootstrap UCL	134.4
95% BCA Bootstrap UCL	134.8		
90% Chebyshev(Mean, Sd) UCL	143.8	95% Chebyshev(Mean, Sd) UCL	152.7
97.5% Chebyshev(Mean, Sd) UCL	164.9	99% Chebyshev(Mean, Sd) UCL	189

Suggested UCL to Use

95% Student's-t UCL	135.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Hardness in the Animas River from sampling location A72 below the confluence with mainstem Mineral Creek during the Post-runoff period

User Selected Options	
Date/Time of Computation	3/4/2015 12:57
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness A72

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	75	**Mean**	**189.4**
Maximum	296	Median	199
SD	63.04	Std. Error of Mean	17.48
Coefficient of Variation	0.333	Skewness	-0.172

Normal GOF Test

Shapiro Wilk Test Statistic	0.99	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0991	Lilliefors GOF Test
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	220.5	95% Adjusted-CLT UCL (Chen-1995)	217.3
		95% Modified-t UCL (Johnson-1978)	220.4

Gamma GOF Test

A-D Test Statistic	0.233	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.141	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.372	k star (bias corrected MLE)	6.492
Theta hat (MLE)	22.62	Theta star (bias corrected MLE)	29.17
nu hat (MLE)	217.7	nu star (bias corrected)	168.8
MLE Mean (bias corrected)	189.4	MLE Sd (bias corrected)	74.33
		Approximate Chi Square Value (0.05)	139.7
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	136

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	228.7	95% Adjusted Gamma UCL (use when n<50)	235.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.94	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.152	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.317	Mean of logged Data	5.183
Maximum of Logged Data	5.69	SD of logged Data	0.383

Assuming Lognormal Distribution

95% H-UCL	238.9	90% Chebyshev (MVUE) UCL	252.4
95% Chebyshev (MVUE) UCL	280.3	97.5% Chebyshev (MVUE) UCL	319.2
99% Chebyshev (MVUE) UCL	395.4		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	218.1	95% Jackknife UCL	220.5
95% Standard Bootstrap UCL	216.4	95% Bootstrap-t UCL	219.9
95% Hall's Bootstrap UCL	219.6	95% Percentile Bootstrap UCL	215.5
95% BCA Bootstrap UCL	215.7		
90% Chebyshev(Mean, Sd) UCL	241.8	95% Chebyshev(Mean, Sd) UCL	265.6
97.5% Chebyshev(Mean, Sd) UCL	298.6	99% Chebyshev(Mean, Sd) UCL	363.4

Suggested UCL to Use

95% Student's-t UCL	220.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Hardness in the Animas River from sampling location A73 below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/4/2015 13:14
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness A73

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	71	Mean	146.8
Maximum	251	Median	142
SD	73.01	Std. Error of Mean	32.65
Coefficient of Variation	0.497	Skewness	0.574

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.95	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.19	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	216.4	95% Adjusted-CLT UCL (Chen-1995)	209.5
		95% Modified-t UCL (Johnson-1978)	217.8

Gamma GOF Test

A-D Test Statistic	0.229	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.215	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.968	k star (bias corrected MLE)	2.12
Theta hat (MLE)	29.55	Theta star (bias corrected MLE)	69.23
nu hat (MLE)	49.68	nu star (bias corrected)	21.2
MLE Mean (bias corrected)	146.8	MLE Sd (bias corrected)	100.8
		Approximate Chi Square Value (0.05)	11.74
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	8.828

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	265.1	95% Adjusted Gamma UCL (use when n<50)	352.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.962	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.185	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.263	Mean of logged Data	4.885
Maximum of Logged Data	5.525	SD of logged Data	0.517

Assuming Lognormal Distribution

95% H-UCL	328.8	90% Chebyshev (MVUE) UCL	248
95% Chebyshev (MVUE) UCL	293.7	97.5% Chebyshev (MVUE) UCL	357.3
99% Chebyshev (MVUE) UCL	482		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	200.5	95% Jackknife UCL	216.4
95% Standard Bootstrap UCL	195.6	95% Bootstrap-t UCL	234.9
95% Hall's Bootstrap UCL	236.6	95% Percentile Bootstrap UCL	196.6
95% BCA Bootstrap UCL	196.6		
90% Chebyshev(Mean, Sd) UCL	244.8	95% Chebyshev(Mean, Sd) UCL	289.1
97.5% Chebyshev(Mean, Sd) UCL	350.7	99% Chebyshev(Mean, Sd) UCL	471.7

Suggested UCL to Use

95% Student's-t UCL	216.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hardness in the Animas River from sampling location A73B below the confluence with mainstem Mineral Creek

User Selected Options

Date/Time of Computation	3/4/2015 13:14
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness A73B

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	37	Mean	97.75
Maximum	217	Median	68.5
SD	81.74	Std. Error of Mean	40.87
Coefficient of Variation	0.836	Skewness	1.69

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.825	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.322	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	193.9	95% Adjusted-CLT UCL (Chen-1995)	201.9
		95% Modified-t UCL (Johnson-1978)	199.7

Gamma GOF Test

A-D Test Statistic	0.344	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.257	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.301	k star (bias corrected MLE)	0.742
Theta hat (MLE)	42.48	Theta star (bias corrected MLE)	131.7
nu hat (MLE)	18.41	nu star (bias corrected)	5.935
MLE Mean (bias corrected)	97.75	MLE Sd (bias corrected)	113.5
		Approximate Chi Square Value (0.05)	1.607
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	361	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.952	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.214	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.611	Mean of logged Data	4.35
Maximum of Logged Data	5.38	SD of logged Data	0.762

Assuming Lognormal Distribution

95% H-UCL	1011	90% Chebyshev (MVUE) UCL	199.9
95% Chebyshev (MVUE) UCL	247.3	97.5% Chebyshev (MVUE) UCL	312.9
99% Chebyshev (MVUE) UCL	442		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	165	95% Jackknife UCL	193.9
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	220.4	95% Chebyshev(Mean, Sd) UCL	275.9
97.5% Chebyshev(Mean, Sd) UCL	353	99% Chebyshev(Mean, Sd) UCL	504.4

Suggested UCL to Use

95% Student's-t UCL	193.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hardness in the Animas River from sampling location A75D below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/4/2015 13:14
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness A75D

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	60	Mean	110.4
Maximum	191	Median	92
SD	52.61	Std. Error of Mean	23.53
Coefficient of Variation	0.476	Skewness	1.031

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.918	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.237	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	160.6	95% Adjusted-CLT UCL (Chen-1995)	160.7
		95% Modified-t UCL (Johnson-1978)	162.4

Gamma GOF Test

A-D Test Statistic	0.244	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.215	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.961	k star (bias corrected MLE)	2.518
Theta hat (MLE)	18.52	Theta star (bias corrected MLE)	43.85
nu hat (MLE)	59.61	nu star (bias corrected)	25.18
MLE Mean (bias corrected)	110.4	MLE Sd (bias corrected)	69.57
		Approximate Chi Square Value (0.05)	14.75
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	11.41

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	188.5	95% Adjusted Gamma UCL (use when n<50)	243.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.971	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.183	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.094	Mean of logged Data	4.618
Maximum of Logged Data	5.252	SD of logged Data	0.459

Assuming Lognormal Distribution

95% H-UCL	214.9	90% Chebyshev (MVUE) UCL	177.3
95% Chebyshev (MVUE) UCL	207.8	97.5% Chebyshev (MVUE) UCL	250.1
99% Chebyshev (MVUE) UCL	333.1		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	149.1	95% Jackknife UCL	160.6
95% Standard Bootstrap UCL	145	95% Bootstrap-t UCL	233
95% Hall's Bootstrap UCL	428.5	95% Percentile Bootstrap UCL	144.8
95% BCA Bootstrap UCL	148		
90% Chebyshev(Mean, Sd) UCL	181	95% Chebyshev(Mean, Sd) UCL	212.9
97.5% Chebyshev(Mean, Sd) UCL	257.3	99% Chebyshev(Mean, Sd) UCL	344.5

Suggested UCL to Use

95% Student's-t UCL	160.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hardness in the Animas River from sampling location A75B below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/4/2015 13:14
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Hardness A75B

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	61	Mean	102.3
Maximum	193	Median	77.5
SD	61.3	Std. Error of Mean	30.65
Coefficient of Variation	0.6	Skewness	1.848

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.771	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.361	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	174.4	95% Adjusted-CLT UCL (Chen-1995)	182.9
		95% Modified-t UCL (Johnson-1978)	179.1

Gamma GOF Test

A-D Test Statistic	0.523	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.341	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.655	k star (bias corrected MLE)	1.33
Theta hat (MLE)	21.97	Theta star (bias corrected MLE)	76.86
nu hat (MLE)	37.24	nu star (bias corrected)	10.64
MLE Mean (bias corrected)	102.3	MLE Sd (bias corrected)	88.65
		Approximate Chi Square Value (0.05)	4.348
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	250.3	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.85	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.307	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.111	Mean of logged Data	4.516
Maximum of Logged Data	5.263	SD of logged Data	0.516

Assuming Lognormal Distribution

95% H-UCL	318.5	90% Chebyshev (MVUE) UCL	177.4
95% Chebyshev (MVUE) UCL	212.1	97.5% Chebyshev (MVUE) UCL	260.2
99% Chebyshev (MVUE) UCL	354.8		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	152.7	95% Jackknife UCL	174.4
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	194.2	95% Chebyshev(Mean, Sd) UCL	235.9
97.5% Chebyshev(Mean, Sd) UCL	293.7	99% Chebyshev(Mean, Sd) UCL	407.2

Suggested UCL to Use

95% Student's-t UCL	174.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hardness in the Animas River from sampling location Bakers Bridge below the confluence with mainstem Mineral Creek

User Selected Options
Date/Time of Computation 3/4/2015 13:15
From File WorkSheet_b.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

Hardness Baker Bridge

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	58	Mean	108
Maximum	183	Median	99
SD	49.48	Std. Error of Mean	22.13
Coefficient of Variation	0.458	Skewness	0.895

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.943	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.172	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	155.2	95% Adjusted-CLT UCL (Chen-1995)	153.9
		95% Modified-t UCL (Johnson-1978)	156.6

Gamma GOF Test

A-D Test Statistic	0.199	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.183	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.245	k star (bias corrected MLE)	2.631
Theta hat (MLE)	17.29	Theta star (bias corrected MLE)	41.04
nu hat (MLE)	62.45	nu star (bias corrected)	26.31
MLE Mean (bias corrected)	108	MLE Sd (bias corrected)	66.58
		Approximate Chi Square Value (0.05)	15.62
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	12.17

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	181.9	95% Adjusted Gamma UCL (use when n<50)	233.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.984	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.153	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.06	Mean of logged Data	4.6
Maximum of Logged Data	5.209	SD of logged Data	0.452

Assuming Lognormal Distribution

95% H-UCL	207.5	90% Chebyshev (MVUE) UCL	172.8
95% Chebyshev (MVUE) UCL	202.2	97.5% Chebyshev (MVUE) UCL	243.1
99% Chebyshev (MVUE) UCL	323.3		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	144.4	95% Jackknife UCL	155.2
95% Standard Bootstrap UCL	140.8	95% Bootstrap-t UCL	183.7
95% Hall's Bootstrap UCL	180.4	95% Percentile Bootstrap UCL	141.2
95% BCA Bootstrap UCL	144.2		
90% Chebyshev(Mean, Sd) UCL	174.4	95% Chebyshev(Mean, Sd) UCL	204.4
97.5% Chebyshev(Mean, Sd) UCL	246.2	99% Chebyshev(Mean, Sd) UCL	328.2

Suggested UCL to Use

95% Student's-t UCL	155.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Appendix 13

ProUCL calculations to derive EPCs for total metals in surface water for wildlife receptors

ProUCL calculations for total Al in mainstem Mineral Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 9:50
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2160	Mean	4575
Maximum	5950	Median	5095
SD	1674	Std. Error of Mean	836.9
Coefficient of Variation	0.366	Skewness	-1.562

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.863	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.311	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6544	95% Adjusted-CLT UCL (Chen-1995)	5253
		95% Modified-t UCL (Johnson-1978)	6436

Gamma GOF Test

A-D Test Statistic	0.541	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.658	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.357	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.432	k star (bias corrected MLE)	2.025
Theta hat (MLE)	615.6	Theta star (bias corrected MLE)	2260
nu hat (MLE)	59.46	nu star (bias corrected)	16.2
MLE Mean (bias corrected)	4575	MLE Sd (bias corrected)	3215
		Approximate Chi Square Value (0.05)	8.102
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	9147	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.794	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.355	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.678	Mean of logged Data	8.36
Maximum of Logged Data	8.691	SD of logged Data	0.462

Assuming Lognormal Distribution

95% H-UCL	11990	90% Chebyshev (MVUE) UCL	7776
95% Chebyshev (MVUE) UCL	9205	97.5% Chebyshev (MVUE) UCL	11188
99% Chebyshev (MVUE) UCL	15084		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5952	95% Jackknife UCL	6544
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	7086	95% Chebyshev(Mean, Sd) UCL	8223
97.5% Chebyshev(Mean, Sd) UCL	9801	99% Chebyshev(Mean, Sd) UCL	12902

Suggested UCL to Use

95% Student's-t UCL	6544

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Al in mainstem Mineral Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 9:50
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	665	Mean	1353
Maximum	2610	Median	1130
SD	757.6	Std. Error of Mean	286.3
Coefficient of Variation	0.56	Skewness	1.026

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.846	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.258	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1910	95% Adjusted-CLT UCL (Chen-1995)	1943
		95% Modified-t UCL (Johnson-1978)	1928
Gamma GOF Test			
A-D Test Statistic	0.432	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.71	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.208	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.313	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	4.196	k star (bias corrected MLE)	2.493
Theta hat (MLE)	322.5	Theta star (bias corrected MLE)	542.7
nu hat (MLE)	58.75	nu star (bias corrected)	34.9
MLE Mean (bias corrected)	1353	MLE Sd (bias corrected)	857
		Approximate Chi Square Value (0.05)	22.39
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	19.42
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	2110	95% Adjusted Gamma UCL (use when n<50)	2432
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.911	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.189	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.5	Mean of logged Data	7.086
Maximum of Logged Data	7.867	SD of logged Data	0.526
Assuming Lognormal Distribution			
95% H-UCL	2358	90% Chebyshev (MVUE) UCL	2150
95% Chebyshev (MVUE) UCL	2515	97.5% Chebyshev (MVUE) UCL	3021
99% Chebyshev (MVUE) UCL	4017		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1824	95% Jackknife UCL	1910
95% Standard Bootstrap UCL	1788	95% Bootstrap-t UCL	2658
95% Hall's Bootstrap UCL	5097	95% Percentile Bootstrap UCL	1848
95% BCA Bootstrap UCL	1871		
90% Chebyshev(Mean, Sd) UCL	2212	95% Chebyshev(Mean, Sd) UCL	2601
97.5% Chebyshev(Mean, Sd) UCL	3141	99% Chebyshev(Mean, Sd) UCL	4202

Suggested UCL to Use

95% Student's-t UCL	1910

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Al in mainstem Mineral Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 9:51
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	563	Mean	2267
Maximum	4590	Median	2480
SD	1132	Std. Error of Mean	314
Coefficient of Variation	0.5	Skewness	0.345

Normal GOF Test

Shapiro Wilk Test Statistic	0.966	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.121	Lilliefors GOF Test
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2826	95% Adjusted-CLT UCL (Chen-1995)	2815
		95% Modified-t UCL (Johnson-1978)	2831

Gamma GOF Test

A-D Test Statistic	0.304	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.175	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.238	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.703	k star (bias corrected MLE)	2.899
Theta hat (MLE)	612.2	Theta star (bias corrected MLE)	781.7
nu hat (MLE)	96.27	nu star (bias corrected)	75.39
MLE Mean (bias corrected)	2267	MLE Sd (bias corrected)	1331
		Approximate Chi Square Value (0.05)	56.39
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	54.05

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3030	95% Adjusted Gamma UCL (use when n<50)	3161

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.94	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.19	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.333	Mean of logged Data	7.585
Maximum of Logged Data	8.432	SD of logged Data	0.593

Assuming Lognormal Distribution

95% H-UCL	3434	90% Chebyshev (MVUE) UCL	3490
95% Chebyshev (MVUE) UCL	4025	97.5% Chebyshev (MVUE) UCL	4767
99% Chebyshev (MVUE) UCL	6224		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2783	95% Jackknife UCL	2826
95% Standard Bootstrap UCL	2761	95% Bootstrap-t UCL	2846
95% Hall's Bootstrap UCL	2891	95% Percentile Bootstrap UCL	2789
95% BCA Bootstrap UCL	2776		
90% Chebyshev(Mean, Sd) UCL	3209	95% Chebyshev(Mean, Sd) UCL	3635
97.5% Chebyshev(Mean, Sd) UCL	4228	99% Chebyshev(Mean, Sd) UCL	5391

Suggested UCL to Use

95% Student's-t UCL	2826

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Al in mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 10:21
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	5020	Mean	7318
Maximum	8610	Median	7820
SD	1593	Std. Error of Mean	796.4
Coefficient of Variation	0.218	Skewness	-1.564

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.862	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.306	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	9192	95% Adjusted-CLT UCL (Chen-1995)	7962
		95% Modified-t UCL (Johnson-1978)	9088

Gamma GOF Test

A-D Test Statistic	0.498	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.336	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	24.37	k star (bias corrected MLE)	6.259
Theta hat (MLE)	300.3	Theta star (bias corrected MLE)	1169
nu hat (MLE)	194.9	nu star (bias corrected)	50.07
MLE Mean (bias corrected)	7318	MLE Sd (bias corrected)	2925
		Approximate Chi Square Value (0.05)	34.82
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	10521	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.823	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.332	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.521	Mean of logged Data	8.877
Maximum of Logged Data	9.061	SD of logged Data	0.244

Assuming Lognormal Distribution

95% H-UCL	10629	90% Chebyshev (MVUE) UCL	9994
95% Chebyshev (MVUE) UCL	11201	97.5% Chebyshev (MVUE) UCL	12877
99% Chebyshev (MVUE) UCL	16169		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	8627	95% Jackknife UCL	9192
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	9707	95% Chebyshev(Mean, Sd) UCL	10789
97.5% Chebyshev(Mean, Sd) UCL	12291	99% Chebyshev(Mean, Sd) UCL	15241

Suggested UCL to Use

95% Student's-t UCL	9192

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Al in mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 10:21
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	1610	Mean	2389
Maximum	3280	Median	2690
SD	663.7	Std. Error of Mean	250.9
Coefficient of Variation	0.278	Skewness	-0.0355

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.878	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.249	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2876	95% Adjusted-CLT UCL (Chen-1995)	2798
		95% Modified-t UCL (Johnson-1978)	2875

Gamma GOF Test

A-D Test Statistic	0.573	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.28	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	14.52	k star (bias corrected MLE)	8.39
Theta hat (MLE)	164.6	Theta star (bias corrected MLE)	284.7
nu hat (MLE)	203.2	nu star (bias corrected)	117.5
MLE Mean (bias corrected)	2389	MLE Sd (bias corrected)	824.6
		Approximate Chi Square Value (0.05)	93.43
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	86.97

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3003	95% Adjusted Gamma UCL (use when n<50)	3226

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.863	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.274	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.384	Mean of logged Data	7.744
Maximum of Logged Data	8.096	SD of logged Data	0.289

Assuming Lognormal Distribution

95% H-UCL	3110	90% Chebyshev (MVUE) UCL	3174
95% Chebyshev (MVUE) UCL	3529	97.5% Chebyshev (MVUE) UCL	4021
99% Chebyshev (MVUE) UCL	4989		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2801	95% Jackknife UCL	2876
95% Standard Bootstrap UCL	2776	95% Bootstrap-t UCL	2870
95% Hall's Bootstrap UCL	2698	95% Percentile Bootstrap UCL	2770
95% BCA Bootstrap UCL	2757		
90% Chebyshev(Mean, Sd) UCL	3141	95% Chebyshev(Mean, Sd) UCL	3482
97.5% Chebyshev(Mean, Sd) UCL	3955	99% Chebyshev(Mean, Sd) UCL	4885

Suggested UCL to Use

95% Student's-t UCL	2876

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Al in mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 10:21
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	2710	Mean	6360
Maximum	7930	Median	6930
SD	1584	Std. Error of Mean	423.3
Coefficient of Variation	0.249	Skewness	-1.141

Normal GOF Test			
Shapiro Wilk Test Statistic	0.871	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.245	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.237	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	7110	95% Adjusted-CLT UCL (Chen-1995)	6918
		95% Modified-t UCL (Johnson-1978)	7088

Gamma GOF Test			
A-D Test Statistic	0.926	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.734	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.269	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.229	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics			
k hat (MLE)	13.39	k star (bias corrected MLE)	10.57
Theta hat (MLE)	474.8	Theta star (bias corrected MLE)	601.6
nu hat (MLE)	375.1	nu star (bias corrected)	296
MLE Mean (bias corrected)	6360	MLE Sd (bias corrected)	1956
		Approximate Chi Square Value (0.05)	257.2
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	252.4

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	7321	95% Adjusted Gamma UCL (use when n<50)	7460

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.801	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.271	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.237	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			

Lognormal Statistics			
Minimum of Logged Data	7.905	Mean of logged Data	8.72
Maximum of Logged Data	8.978	SD of logged Data	0.307

Assuming Lognormal Distribution			
95% H-UCL	7547	90% Chebyshev (MVUE) UCL	7990
95% Chebyshev (MVUE) UCL	8712	97.5% Chebyshev (MVUE) UCL	9713
99% Chebyshev (MVUE) UCL	11681		

Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			

Nonparametric Distribution Free UCLs			
95% CLT UCL	7056	95% Jackknife UCL	7110
95% Standard Bootstrap UCL	7053	95% Bootstrap-t UCL	6994
95% Hall's Bootstrap UCL	6953	95% Percentile Bootstrap UCL	6996
95% BCA Bootstrap UCL	6899		
90% Chebyshev(Mean, Sd) UCL	7630	95% Chebyshev(Mean, Sd) UCL	8205
97.5% Chebyshev(Mean, Sd) UCL	9003	99% Chebyshev(Mean, Sd) UCL	10572

Suggested UCL to Use

95% Student's-t UCL	7110	or 95% Modified-t UCL	7088

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Al in Animas River above mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 10:28
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	177	Mean	305.4
Maximum	438	Median	275
SD	100.3	Std. Error of Mean	44.85
Coefficient of Variation	0.328	Skewness	0.158

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.968	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.219	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	401	95% Adjusted-CLT UCL (Chen-1995)	382.6
		95% Modified-t UCL (Johnson-1978)	401.6

Gamma GOF Test

A-D Test Statistic	0.246	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.195	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.03	k star (bias corrected MLE)	4.543
Theta hat (MLE)	27.7	Theta star (bias corrected MLE)	67.22
nu hat (MLE)	110.3	nu star (bias corrected)	45.43
MLE Mean (bias corrected)	305.4	MLE Sd (bias corrected)	143.3
		Approximate Chi Square Value (0.05)	30.97
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	25.86

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	448	95% Adjusted Gamma UCL (use when n<50)	536.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.959	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.208	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.176	Mean of logged Data	5.676
Maximum of Logged Data	6.082	SD of logged Data	0.346

Assuming Lognormal Distribution

95% H-UCL	478.1	90% Chebyshev (MVUE) UCL	447.2
95% Chebyshev (MVUE) UCL	511.3	97.5% Chebyshev (MVUE) UCL	600.2
99% Chebyshev (MVUE) UCL	774.8		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	379.2	95% Jackknife UCL	401
95% Standard Bootstrap UCL	371.6	95% Bootstrap-t UCL	440.3
95% Hall's Bootstrap UCL	501.9	95% Percentile Bootstrap UCL	371.8
95% BCA Bootstrap UCL	363.4		
90% Chebyshev(Mean, Sd) UCL	440	95% Chebyshev(Mean, Sd) UCL	500.9
97.5% Chebyshev(Mean, Sd) UCL	585.5	99% Chebyshev(Mean, Sd) UCL	751.7

Suggested UCL to Use

95% Student's-t UCL	401

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Al in Animas River above mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 10:28
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	154	Mean	480.1
Maximum	1010	Median	508
SD	202.5	Std. Error of Mean	49.12
Coefficient of Variation	0.422	Skewness	0.761

Normal GOF Test

Shapiro Wilk Test Statistic	0.932	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.892	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.19	Lilliefors GOF Test
5% Lilliefors Critical Value	0.215	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	565.8	95% Adjusted-CLT UCL (Chen-1995)	570.5
		95% Modified-t UCL (Johnson-1978)	567.3

Gamma GOF Test

A-D Test Statistic	0.505	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.149	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.21	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.477	k star (bias corrected MLE)	4.55
Theta hat (MLE)	87.65	Theta star (bias corrected MLE)	105.5
nu hat (MLE)	186.2	nu star (bias corrected)	154.7
MLE Mean (bias corrected)	480.1	MLE Sd (bias corrected)	225.1
		Approximate Chi Square Value (0.05)	126.9
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	124.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	585	95% Adjusted Gamma UCL (use when n<50)	597.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.91	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.892	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.176	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.215	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.037	Mean of logged Data	6.08
Maximum of Logged Data	6.918	SD of logged Data	0.474

Assuming Lognormal Distribution

95% H-UCL	620.1	90% Chebyshev (MVUE) UCL	657.6
95% Chebyshev (MVUE) UCL	735.6	97.5% Chebyshev (MVUE) UCL	843.9
99% Chebyshev (MVUE) UCL	1057		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	560.9	95% Jackknife UCL	565.8
95% Standard Bootstrap UCL	557.9	95% Bootstrap-t UCL	570.7
95% Hall's Bootstrap UCL	595.3	95% Percentile Bootstrap UCL	561.4
95% BCA Bootstrap UCL	568.4		
90% Chebyshev(Mean, Sd) UCL	627.4	95% Chebyshev(Mean, Sd) UCL	694.2
97.5% Chebyshev(Mean, Sd) UCL	786.8	99% Chebyshev(Mean, Sd) UCL	968.8

Suggested UCL to Use

95% Student's-t UCL	565.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Al in Animas River above mainstem Cement Creek during the post- runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 10:28
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	18	Number of Distinct Observations	13
Number of Detects	13	Number of Non-Detects	5
Number of Distinct Detects	12	Number of Distinct Non-Detects	1
Minimum Detect	101	Minimum Non-Detect	100
Maximum Detect	217	Maximum Non-Detect	100
Variance Detects	1081	Percent Non-Detects	27.78%
Mean Detects	153.2	SD Detects	32.87
Median Detects	160	CV Detects	0.215
Skewness Detects	0.191	Kurtosis Detects	-0.402
Mean of Logged Detects	5.01	SD of Logged Detects	0.219

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.97	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.121	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.246	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	138.4	Standard Error of Mean	8.808
SD	35.9	95% KM (BCA) UCL	152.8
95% KM (t) UCL	153.8	95% KM (Percentile Bootstrap) UCL	151.9
95% KM (z) UCL	152.9	95% KM Bootstrap t UCL	155.5
90% KM Chebyshev UCL	164.9	95% KM Chebyshev UCL	176.8
97.5% KM Chebyshev UCL	193.4	99% KM Chebyshev UCL	226.1

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.267	Anderson-Darling GOF Test	
5% A-D Critical Value	0.733	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.148	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.236	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	23.13	k star (bias corrected MLE)	17.85
Theta hat (MLE)	6.623	Theta star (bias corrected MLE)	8.586
nu hat (MLE)	601.5	nu star (bias corrected)	464
MLE Mean (bias corrected)	153.2	MLE Sd (bias corrected)	36.27

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	14.87	nu hat (KM)	535.3
Approximate Chi Square Value (535.34, α)	482.7	Adjusted Chi Square Value (535.34, β)	477.9
95% Gamma Approximate KM-UCL (use when n>=50)	153.5	95% Gamma Adjusted KM-UCL (use when n<50)	155.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	60.29	Mean	133.2
Maximum	217	Median	129
SD	43.74	CV	0.328
k hat (MLE)	9.094	k star (bias corrected MLE)	7.616
Theta hat (MLE)	14.65	Theta star (bias corrected MLE)	17.5
nu hat (MLE)	327.4	nu star (bias corrected)	274.2
MLE Mean (bias corrected)	133.2	MLE Sd (bias corrected)	48.29
		Adjusted Level of Significance (β)	0.0357
Approximate Chi Square Value (274.16, α)	236.8	Adjusted Chi Square Value (274.16, β)	233.5
95% Gamma Approximate UCL (use when n>=50)	154.3	95% Gamma Adjusted UCL (use when n<50)	156.5

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.968	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.155	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.246	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	135.3	Mean in Log Scale	4.863
SD in Original Scale	40.94	SD in Log Scale	0.312
95% t UCL (assumes normality of ROS data)	152.1	95% Percentile Bootstrap UCL	152.3
95% BCA Bootstrap UCL	150.2	95% Bootstrap t UCL	152.8
95% H-UCL (Log ROS)	156.4		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	4.898	95% H-UCL (KM -Log)	154.9
KM SD (logged)	0.255	95% Critical H Value (KM-Log)	1.822
KM Standard Error of Mean (logged)	0.0625		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	124.6	Mean in Log Scale	4.705
SD in Original Scale	55.01	SD in Log Scale	0.539
95% t UCL (Assumes normality)	147.1	95% H-Stat UCL	167.2

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	153.8	95% KM (Percentile Bootstrap) UCL	151.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Al at sampling location A72 in the Animas River below mainstem Mineral Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 10:40
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1980	Mean	3455
Maximum	4440	Median	3700
SD	1091	Std. Error of Mean	545.4
Coefficient of Variation	0.316	Skewness	-1.027

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.929	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.22	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4739	95% Adjusted-CLT UCL (Chen-1995)	4053
		95% Modified-t UCL (Johnson-1978)	4692

Gamma GOF Test

A-D Test Statistic	0.365	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.252	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.27	k star (bias corrected MLE)	2.985
Theta hat (MLE)	306.5	Theta star (bias corrected MLE)	1158
nu hat (MLE)	90.18	nu star (bias corrected)	23.88
MLE Mean (bias corrected)	3455	MLE Sd (bias corrected)	2000
		Approximate Chi Square Value (0.05)	13.76
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5997	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.882	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.252	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.591	Mean of logged Data	8.103
Maximum of Logged Data	8.398	SD of logged Data	0.363

Assuming Lognormal Distribution

95% H-UCL	6638	90% Chebyshev (MVUE) UCL	5338
95% Chebyshev (MVUE) UCL	6185	97.5% Chebyshev (MVUE) UCL	7360
99% Chebyshev (MVUE) UCL	9669		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4352	95% Jackknife UCL	4739
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5091	95% Chebyshev(Mean, Sd) UCL	5833
97.5% Chebyshev(Mean, Sd) UCL	6861	99% Chebyshev(Mean, Sd) UCL	8882

Suggested UCL to Use

95% Student's-t UCL	4739

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Al at sampling location A72 in the Animas River below mainstem Mineral Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 10:41
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	585	Mean	1359
Maximum	3060	Median	938
SD	960.6	Std. Error of Mean	363.1
Coefficient of Variation	0.707	Skewness	1.246

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.807	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.28	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2065	95% Adjusted-CLT UCL (Chen-1995)	2139
		95% Modified-t UCL (Johnson-1978)	2093

Gamma GOF Test

A-D Test Statistic	0.53	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.713	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.219	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.314	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.8	k star (bias corrected MLE)	1.695
Theta hat (MLE)	485.4	Theta star (bias corrected MLE)	801.8
nu hat (MLE)	39.2	nu star (bias corrected)	23.74
MLE Mean (bias corrected)	1359	MLE Sd (bias corrected)	1044
		Approximate Chi Square Value (0.05)	13.65
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	11.41

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2364	95% Adjusted Gamma UCL (use when n<50)	2828

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.888	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.19	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.372	Mean of logged Data	7.026
Maximum of Logged Data	8.026	SD of logged Data	0.641

Assuming Lognormal Distribution

95% H-UCL	2849	90% Chebyshev (MVUE) UCL	2315
95% Chebyshev (MVUE) UCL	2758	97.5% Chebyshev (MVUE) UCL	3372
99% Chebyshev (MVUE) UCL	4580		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1957	95% Jackknife UCL	2065
95% Standard Bootstrap UCL	1910	95% Bootstrap-t UCL	3483
95% Hall's Bootstrap UCL	5705	95% Percentile Bootstrap UCL	1908
95% BCA Bootstrap UCL	2053		
90% Chebyshev(Mean, Sd) UCL	2449	95% Chebyshev(Mean, Sd) UCL	2942
97.5% Chebyshev(Mean, Sd) UCL	3627	99% Chebyshev(Mean, Sd) UCL	4972

Suggested UCL to Use

95% Student's-t UCL	2065

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Al at sampling location A72 in the Animas River below mainstem Mineral Creek during the post-runoff period

User Selected Options			
Date/Time of Computation	2/23/2015 10:41		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	13	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	597	Mean	1777
Maximum	2750	Median	2070
SD	711.7	Std. Error of Mean	197.4
Coefficient of Variation	0.401	Skewness	-0.305

Normal GOF Test			
Shapiro Wilk Test Statistic	0.932	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.198	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2129	95% Adjusted-CLT UCL (Chen-1995)	2084
		95% Modified-t UCL (Johnson-1978)	2126

Gamma GOF Test			
A-D Test Statistic	0.538	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.736	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.233	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics			
k hat (MLE)	5.466	k star (bias corrected MLE)	4.256
Theta hat (MLE)	325.1	Theta star (bias corrected MLE)	417.5
nu hat (MLE)	142.1	nu star (bias corrected)	110.7
MLE Mean (bias corrected)	1777	MLE Sd (bias corrected)	861.3
		Approximate Chi Square Value (0.05)	87.37
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	84.43

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	2250	95% Adjusted Gamma UCL (use when n<50)	2329

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.234	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics			
Minimum of Logged Data	6.392	Mean of logged Data	7.388
Maximum of Logged Data	7.919	SD of logged Data	0.483

Assuming Lognormal Distribution			
95% H-UCL	2433	90% Chebyshev (MVUE) UCL	2540
95% Chebyshev (MVUE) UCL	2876	97.5% Chebyshev (MVUE) UCL	3341
99% Chebyshev (MVUE) UCL	4256		

Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			

Nonparametric Distribution Free UCLs			
95% CLT UCL	2102	95% Jackknife UCL	2129
95% Standard Bootstrap UCL	2087	95% Bootstrap-t UCL	2094
95% Hall's Bootstrap UCL	2065	95% Percentile Bootstrap UCL	2077
95% BCA Bootstrap UCL	2069		
90% Chebyshev(Mean, Sd) UCL	2369	95% Chebyshev(Mean, Sd) UCL	2637
97.5% Chebyshev(Mean, Sd) UCL	3010	99% Chebyshev(Mean, Sd) UCL	3741

Suggested UCL to Use

95% Student's-t UCL	2129

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Al at sampling location A73 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 10:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	933	Mean	1461
Maximum	2420	Median	1280
SD	597	Std. Error of Mean	267
Coefficient of Variation	0.409	Skewness	1.303

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.889	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.219	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2030	95% Adjusted-CLT UCL (Chen-1995)	2066
		95% Modified-t UCL (Johnson-1978)	2056

Gamma GOF Test

A-D Test Statistic	0.289	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.202	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.448	k star (bias corrected MLE)	3.513
Theta hat (MLE)	172.9	Theta star (bias corrected MLE)	415.8
nu hat (MLE)	84.48	nu star (bias corrected)	35.13
MLE Mean (bias corrected)	1461	MLE Sd (bias corrected)	779.3
		Approximate Chi Square Value (0.05)	22.57
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	18.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2274	95% Adjusted Gamma UCL (use when n<50)	2804

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.175	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.838	Mean of logged Data	7.226
Maximum of Logged Data	7.792	SD of logged Data	0.379

Assuming Lognormal Distribution

95% H-UCL	2416	90% Chebyshev (MVUE) UCL	2192
95% Chebyshev (MVUE) UCL	2526	97.5% Chebyshev (MVUE) UCL	2989
99% Chebyshev (MVUE) UCL	3898		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1900	95% Jackknife UCL	2030
95% Standard Bootstrap UCL	1860	95% Bootstrap-t UCL	2776
95% Hall's Bootstrap UCL	4080	95% Percentile Bootstrap UCL	1872
95% BCA Bootstrap UCL	1986		
90% Chebyshev(Mean, Sd) UCL	2262	95% Chebyshev(Mean, Sd) UCL	2624
97.5% Chebyshev(Mean, Sd) UCL	3128	99% Chebyshev(Mean, Sd) UCL	4117

Suggested UCL to Use

95% Student's-t UCL	2030

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Al at sampling location A73B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 10:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	612	Mean	974.5
Maximum	1980	Median	653
SD	670.7	Std. Error of Mean	335.3
Coefficient of Variation	0.688	Skewness	1.994

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.661	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.427	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1764	95% Adjusted-CLT UCL (Chen-1995)	1883
		95% Modified-t UCL (Johnson-1978)	1819
Gamma GOF Test			
A-D Test Statistic	0.849	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.447	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	3.747	k star (bias corrected MLE)	1.103
Theta hat (MLE)	260.1	Theta star (bias corrected MLE)	883.2
nu hat (MLE)	29.98	nu star (bias corrected)	8.827
MLE Mean (bias corrected)	974.5	MLE Sd (bias corrected)	927.7
		Approximate Chi Square Value (0.05)	3.223
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	2669	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.687	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.415	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.417	Mean of logged Data	6.743
Maximum of Logged Data	7.591	SD of logged Data	0.567
Assuming Lognormal Distribution			
95% H-UCL	3704	90% Chebyshev (MVUE) UCL	1745
95% Chebyshev (MVUE) UCL	2103	97.5% Chebyshev (MVUE) UCL	2600
99% Chebyshev (MVUE) UCL	3577		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1526	95% Jackknife UCL	1764
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1981	95% Chebyshev(Mean, Sd) UCL	2436
97.5% Chebyshev(Mean, Sd) UCL	3069	99% Chebyshev(Mean, Sd) UCL	4311

Suggested UCL to Use

95% Student's-t UCL	1764

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Al at sampling location A75D in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 10:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	534	Mean	1255
Maximum	1790	Median	1260
SD	496.2	Std. Error of Mean	221.9
Coefficient of Variation	0.395	Skewness	-0.6

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.96	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.175	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1728	95% Adjusted-CLT UCL (Chen-1995)	1556
		95% Modified-t UCL (Johnson-1978)	1718

Gamma GOF Test

A-D Test Statistic	0.308	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.194	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.38	k star (bias corrected MLE)	2.685
Theta hat (MLE)	196.7	Theta star (bias corrected MLE)	467.3
nu hat (MLE)	63.8	nu star (bias corrected)	26.85
MLE Mean (bias corrected)	1255	MLE Sd (bias corrected)	765.7
		Approximate Chi Square Value (0.05)	16.04
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	12.53

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2101	95% Adjusted Gamma UCL (use when n<50)	2688

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.895	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.227	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.28	Mean of logged Data	7.054
Maximum of Logged Data	7.49	SD of logged Data	0.48

Assuming Lognormal Distribution

95% H-UCL	2594	90% Chebyshev (MVUE) UCL	2077
95% Chebyshev (MVUE) UCL	2444	97.5% Chebyshev (MVUE) UCL	2952
99% Chebyshev (MVUE) UCL	3952		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1620	95% Jackknife UCL	1728
95% Standard Bootstrap UCL	1583	95% Bootstrap-t UCL	1729
95% Hall's Bootstrap UCL	1611	95% Percentile Bootstrap UCL	1580
95% BCA Bootstrap UCL	1507		
90% Chebyshev(Mean, Sd) UCL	1920	95% Chebyshev(Mean, Sd) UCL	2222
97.5% Chebyshev(Mean, Sd) UCL	2641	99% Chebyshev(Mean, Sd) UCL	3463

Suggested UCL to Use

95% Student's-t UCL	1728

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Al at sampling location A75B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 10:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	562	Mean	1021
Maximum	1650	Median	935
SD	463	Std. Error of Mean	231.5
Coefficient of Variation	0.454	Skewness	0.982

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.953	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.233	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1565	95% Adjusted-CLT UCL (Chen-1995)	1523
		95% Modified-t UCL (Johnson-1978)	1584

Gamma GOF Test

A-D Test Statistic	0.214	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.658	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.181	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.746	k star (bias corrected MLE)	1.853
Theta hat (MLE)	151.3	Theta star (bias corrected MLE)	550.6
nu hat (MLE)	53.97	nu star (bias corrected)	14.83
MLE Mean (bias corrected)	1021	MLE Sd (bias corrected)	749.6
		Approximate Chi Square Value (0.05)	7.141
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2119	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.998	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.166	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.332	Mean of logged Data	6.852
Maximum of Logged Data	7.409	SD of logged Data	0.45

Assuming Lognormal Distribution

95% H-UCL	2533	90% Chebyshev (MVUE) UCL	1696
95% Chebyshev (MVUE) UCL	2003	97.5% Chebyshev (MVUE) UCL	2429
99% Chebyshev (MVUE) UCL	3265		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1401	95% Jackknife UCL	1565
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1715	95% Chebyshev(Mean, Sd) UCL	2030
97.5% Chebyshev(Mean, Sd) UCL	2466	99% Chebyshev(Mean, Sd) UCL	3324

Suggested UCL to Use

95% Student's-t UCL	1565

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Al at Bakers Bridge in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 10:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	234	Mean	704
Maximum	1310	Median	734
SD	418.7	Std. Error of Mean	187.3
Coefficient of Variation	0.595	Skewness	0.528

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.964	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.17	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1103	95% Adjusted-CLT UCL (Chen-1995)	1059
		95% Modified-t UCL (Johnson-1978)	1111

Gamma GOF Test

A-D Test Statistic	0.214	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.682	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.203	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.359	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.182	k star (bias corrected MLE)	1.406
Theta hat (MLE)	221.2	Theta star (bias corrected MLE)	500.6
nu hat (MLE)	31.82	nu star (bias corrected)	14.06
MLE Mean (bias corrected)	704	MLE Sd (bias corrected)	593.7
		Approximate Chi Square Value (0.05)	6.614
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	4.56

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1497	95% Adjusted Gamma UCL (use when n<50)	2171

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.966	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.221	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.455	Mean of logged Data	6.392
Maximum of Logged Data	7.178	SD of logged Data	0.674

Assuming Lognormal Distribution

95% H-UCL	2490	90% Chebyshev (MVUE) UCL	1345
95% Chebyshev (MVUE) UCL	1632	97.5% Chebyshev (MVUE) UCL	2030
99% Chebyshev (MVUE) UCL	2812		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1012	95% Jackknife UCL	1103
95% Standard Bootstrap UCL	973.5	95% Bootstrap-t UCL	1161
95% Hall's Bootstrap UCL	1029	95% Percentile Bootstrap UCL	986.2
95% BCA Bootstrap UCL	986.2		
90% Chebyshev(Mean, Sd) UCL	1266	95% Chebyshev(Mean, Sd) UCL	1520
97.5% Chebyshev(Mean, Sd) UCL	1873	99% Chebyshev(Mean, Sd) UCL	2567

Suggested UCL to Use

95% Student's-t UCL	1103

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe in mainstem Mineral Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:18
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	4180	Mean	5868
Maximum	6830	Median	6230
SD	1166	Std. Error of Mean	583.2
Coefficient of Variation	0.199	Skewness	-1.583

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.858	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.322	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	7240	95% Adjusted-CLT UCL (Chen-1995)	6333
		95% Modified-t UCL (Johnson-1978)	7163

Gamma GOF Test

A-D Test Statistic	0.508	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.351	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	29.62	k star (bias corrected MLE)	7.571
Theta hat (MLE)	198.1	Theta star (bias corrected MLE)	775
nu hat (MLE)	236.9	nu star (bias corrected)	60.57
MLE Mean (bias corrected)	5868	MLE Sd (bias corrected)	2132
		Approximate Chi Square Value (0.05)	43.67
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	8138	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.822	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.344	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.338	Mean of logged Data	8.66
Maximum of Logged Data	8.829	SD of logged Data	0.22

Assuming Lognormal Distribution

95% H-UCL	8139	90% Chebyshev (MVUE) UCL	7805
95% Chebyshev (MVUE) UCL	8680	97.5% Chebyshev (MVUE) UCL	9895
99% Chebyshev (MVUE) UCL	12280		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	6827	95% Jackknife UCL	7240
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	7617	95% Chebyshev(Mean, Sd) UCL	8410
97.5% Chebyshev(Mean, Sd) UCL	9510	99% Chebyshev(Mean, Sd) UCL	11671

Suggested UCL to Use

95% Student's-t UCL	7240

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Fe in mainstem Mineral Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:18
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	1040	Mean	2664
Maximum	6330	Median	2130
SD	1980	Std. Error of Mean	748.5
Coefficient of Variation	0.743	Skewness	1.231

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.848	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.206	Lilliefors GOF Test
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4119	95% Adjusted-CLT UCL (Chen-1995)	4268
		95% Modified-t UCL (Johnson-1978)	4177

Gamma GOF Test

A-D Test Statistic	0.399	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.714	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.242	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.315	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.386	k star (bias corrected MLE)	1.458
Theta hat (MLE)	1117	Theta star (bias corrected MLE)	1827
nu hat (MLE)	33.4	nu star (bias corrected)	20.42
MLE Mean (bias corrected)	2664	MLE Sd (bias corrected)	2206
		Approximate Chi Square Value (0.05)	11.16
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	9.166

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4875	95% Adjusted Gamma UCL (use when n<50)	5935

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.227	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.947	Mean of logged Data	7.664
Maximum of Logged Data	8.753	SD of logged Data	0.715

Assuming Lognormal Distribution

95% H-UCL	6487	90% Chebyshev (MVUE) UCL	4788
95% Chebyshev (MVUE) UCL	5762	97.5% Chebyshev (MVUE) UCL	7115
99% Chebyshev (MVUE) UCL	9772		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3895	95% Jackknife UCL	4119
95% Standard Bootstrap UCL	3780	95% Bootstrap-t UCL	5341
95% Hall's Bootstrap UCL	10257	95% Percentile Bootstrap UCL	3946
95% BCA Bootstrap UCL	4149		
90% Chebyshev(Mean, Sd) UCL	4910	95% Chebyshev(Mean, Sd) UCL	5927
97.5% Chebyshev(Mean, Sd) UCL	7339	99% Chebyshev(Mean, Sd) UCL	10112

Suggested UCL to Use

95% Student's-t UCL	4119

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe in mainstem Mineral Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:18
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	754	Mean	3339
Maximum	8290	Median	3340
SD	1976	Std. Error of Mean	548.1
Coefficient of Variation	0.592	Skewness	1.176

Normal GOF Test

Shapiro Wilk Test Statistic	0.913	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.148	Lilliefors GOF Test
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4316	95% Adjusted-CLT UCL (Chen-1995)	4431
		95% Modified-t UCL (Johnson-1978)	4345

Gamma GOF Test

A-D Test Statistic	0.226	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.141	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.238	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.063	k star (bias corrected MLE)	2.407
Theta hat (MLE)	1090	Theta star (bias corrected MLE)	1387
nu hat (MLE)	79.63	nu star (bias corrected)	62.59
MLE Mean (bias corrected)	3339	MLE Sd (bias corrected)	2152
		Approximate Chi Square Value (0.05)	45.39
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	43.31

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4604	95% Adjusted Gamma UCL (use when n<50)	4825

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.965	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.176	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.625	Mean of logged Data	7.941
Maximum of Logged Data	9.023	SD of logged Data	0.642

Assuming Lognormal Distribution

95% H-UCL	5279	90% Chebyshev (MVUE) UCL	5274
95% Chebyshev (MVUE) UCL	6127	97.5% Chebyshev (MVUE) UCL	7311
99% Chebyshev (MVUE) UCL	9637		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4240	95% Jackknife UCL	4316
95% Standard Bootstrap UCL	4198	95% Bootstrap-t UCL	4585
95% Hall's Bootstrap UCL	5081	95% Percentile Bootstrap UCL	4242
95% BCA Bootstrap UCL	4385		
90% Chebyshev(Mean, Sd) UCL	4983	95% Chebyshev(Mean, Sd) UCL	5728
97.5% Chebyshev(Mean, Sd) UCL	6761	99% Chebyshev(Mean, Sd) UCL	8792

Suggested UCL to Use

95% Student's-t UCL	4316

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe in mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:26
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	12700	Mean	17150
Maximum	21700	Median	17100
SD	4127	Std. Error of Mean	2063
Coefficient of Variation	0.241	Skewness	0.0426

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.947	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.215	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	22006	95% Adjusted-CLT UCL (Chen-1995)	20591
		95% Modified-t UCL (Johnson-1978)	22013

Gamma GOF Test

A-D Test Statistic	0.289	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.248	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	22.59	k star (bias corrected MLE)	5.815
Theta hat (MLE)	759.1	Theta star (bias corrected MLE)	2949
nu hat (MLE)	180.7	nu star (bias corrected)	46.52
MLE Mean (bias corrected)	17150	MLE Sd (bias corrected)	7112
		Approximate Chi Square Value (0.05)	31.87
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	25034	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.947	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.224	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.449	Mean of logged Data	9.727
Maximum of Logged Data	9.985	SD of logged Data	0.245

Assuming Lognormal Distribution

95% H-UCL	24966	90% Chebyshev (MVUE) UCL	23436
95% Chebyshev (MVUE) UCL	26282	97.5% Chebyshev (MVUE) UCL	30233
99% Chebyshev (MVUE) UCL	37993		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	20544	95% Jackknife UCL	22006
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	23340	95% Chebyshev(Mean, Sd) UCL	26144
97.5% Chebyshev(Mean, Sd) UCL	30036	99% Chebyshev(Mean, Sd) UCL	37680

Suggested UCL to Use

95% Student's-t UCL	22006

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe in mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:26
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	3610	Mean	8067
Maximum	17200	Median	4440
SD	6108	Std. Error of Mean	2309
Coefficient of Variation	0.757	Skewness	1.14

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.713	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.315	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	12554	95% Adjusted-CLT UCL (Chen-1995)	12928
		95% Modified-t UCL (Johnson-1978)	12719

Gamma GOF Test

A-D Test Statistic	0.897	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.714	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.307	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.314	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.467	k star (bias corrected MLE)	1.505
Theta hat (MLE)	3271	Theta star (bias corrected MLE)	5361
nu hat (MLE)	34.53	nu star (bias corrected)	21.07
MLE Mean (bias corrected)	8067	MLE Sd (bias corrected)	6576
		Approximate Chi Square Value (0.05)	11.64
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	9.597

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	14599	95% Adjusted Gamma UCL (use when n<50)	17708

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.783	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.284	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.191	Mean of logged Data	8.779
Maximum of Logged Data	9.753	SD of logged Data	0.679

Assuming Lognormal Distribution

95% H-UCL	18040	90% Chebyshev (MVUE) UCL	13986
95% Chebyshev (MVUE) UCL	16752	97.5% Chebyshev (MVUE) UCL	20591
99% Chebyshev (MVUE) UCL	28131		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	11865	95% Jackknife UCL	12554
95% Standard Bootstrap UCL	11654	95% Bootstrap-t UCL	25139
95% Hall's Bootstrap UCL	44220	95% Percentile Bootstrap UCL	11697
95% BCA Bootstrap UCL	11856		
90% Chebyshev(Mean, Sd) UCL	14994	95% Chebyshev(Mean, Sd) UCL	18131
97.5% Chebyshev(Mean, Sd) UCL	22486	99% Chebyshev(Mean, Sd) UCL	31039

Suggested UCL to Use

95% Student's-t UCL	12554

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe in mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:26
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	5230	Mean	10801
Maximum	18600	Median	11150
SD	4066	Std. Error of Mean	1087
Coefficient of Variation	0.376	Skewness	0.219

Normal GOF Test

Shapiro Wilk Test Statistic	0.956	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.111	Lilliefors GOF Test
5% Lilliefors Critical Value	0.237	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	12725	95% Adjusted-CLT UCL (Chen-1995)	12656
		95% Modified-t UCL (Johnson-1978)	12736

Gamma GOF Test

A-D Test Statistic	0.306	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.737	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.121	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.229	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.117	k star (bias corrected MLE)	5.64
Theta hat (MLE)	1517	Theta star (bias corrected MLE)	1915
nu hat (MLE)	199.3	nu star (bias corrected)	157.9
MLE Mean (bias corrected)	10801	MLE Sd (bias corrected)	4548
		Approximate Chi Square Value (0.05)	129.9
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	126.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	13134	95% Adjusted Gamma UCL (use when n<50)	13484

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.941	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.142	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.237	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.562	Mean of logged Data	9.215
Maximum of Logged Data	9.831	SD of logged Data	0.404

Assuming Lognormal Distribution

95% H-UCL	13628	90% Chebyshev (MVUE) UCL	14420
95% Chebyshev (MVUE) UCL	16041	97.5% Chebyshev (MVUE) UCL	18292
99% Chebyshev (MVUE) UCL	22714		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	12588	95% Jackknife UCL	12725
95% Standard Bootstrap UCL	12493	95% Bootstrap-t UCL	12842
95% Hall's Bootstrap UCL	12530	95% Percentile Bootstrap UCL	12559
95% BCA Bootstrap UCL	12601		
90% Chebyshev(Mean, Sd) UCL	14061	95% Chebyshev(Mean, Sd) UCL	15538
97.5% Chebyshev(Mean, Sd) UCL	17588	99% Chebyshev(Mean, Sd) UCL	21614

Suggested UCL to Use

95% Student's-t UCL	12725

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe in the Animas River above of the confluence with mainstem Cement Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:28
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	208	Mean	259
Maximum	334	Median	235
SD	52.71	Std. Error of Mean	23.57
Coefficient of Variation	0.204	Skewness	0.783

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.902	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.276	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	309.3	95% Adjusted-CLT UCL (Chen-1995)	306.6
		95% Modified-t UCL (Johnson-1978)	310.6
Gamma GOF Test			
A-D Test Statistic	0.359	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.284	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	31.57	k star (bias corrected MLE)	12.76
Theta hat (MLE)	8.204	Theta star (bias corrected MLE)	20.29
nu hat (MLE)	315.7	nu star (bias corrected)	127.6
MLE Mean (bias corrected)	259	MLE Sd (bias corrected)	72.5
		Approximate Chi Square Value (0.05)	102.5
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	92.69
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	322.4	95% Adjusted Gamma UCL (use when n<50)	356.6
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.918	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.26	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.338	Mean of logged Data	5.541
Maximum of Logged Data	5.811	SD of logged Data	0.197
Assuming Lognormal Distribution			
95% H-UCL	322.8	90% Chebyshev (MVUE) UCL	327.4
95% Chebyshev (MVUE) UCL	358.4	97.5% Chebyshev (MVUE) UCL	401.5
99% Chebyshev (MVUE) UCL	486.1		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	297.8	95% Jackknife UCL	309.3
95% Standard Bootstrap UCL	294.5	95% Bootstrap-t UCL	402.3
95% Hall's Bootstrap UCL	700	95% Percentile Bootstrap UCL	295.8
95% BCA Bootstrap UCL	297.8		
90% Chebyshev(Mean, Sd) UCL	329.7	95% Chebyshev(Mean, Sd) UCL	361.8
97.5% Chebyshev(Mean, Sd) UCL	406.2	99% Chebyshev(Mean, Sd) UCL	493.6

Suggested UCL to Use

95% Student's-t UCL	309.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe in the Animas River above of the confluence with mainstem Cement Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:28
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
Number of Detects	16	Number of Non-Detects	1
Number of Distinct Detects	16	Number of Distinct Non-Detects	1
Minimum Detect	111	Minimum Non-Detect	100
Maximum Detect	1100	Maximum Non-Detect	100
Variance Detects	60866	Percent Non-Detects	5.88%
Mean Detects	469	SD Detects	246.7
Median Detects	432	CV Detects	0.526
Skewness Detects	0.86	Kurtosis Detects	1.684
Mean of Logged Detects	6	SD of Logged Detects	0.61

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.936	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.131	Lilliefors GOF Test
5% Lilliefors Critical Value	0.222	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	447.3	Standard Error of Mean	61.99
SD	247.5	95% KM (BCA) UCL	548.5
95% KM (t) UCL	555.5	95% KM (Percentile Bootstrap) UCL	541.9
95% KM (z) UCL	549.3	95% KM Bootstrap t UCL	567.6
90% KM Chebyshev UCL	633.3	95% KM Chebyshev UCL	717.5
97.5% KM Chebyshev UCL	834.4	99% KM Chebyshev UCL	1064

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.367	Anderson-Darling GOF Test
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.165	Kolmogrov-Smirnoff GOF
5% K-S Critical Value	0.216	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.469	k star (bias corrected MLE)	2.86
Theta hat (MLE)	135.2	Theta star (bias corrected MLE)	164
nu hat (MLE)	111	nu star (bias corrected)	91.52
MLE Mean (bias corrected)	469	MLE Sd (bias corrected)	277.3

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	3.267	nu hat (KM)	111.1
Approximate Chi Square Value (111.07, α)	87.75	Adjusted Chi Square Value (111.07, β)	85.57
95% Gamma Approximate KM-UCL (use when n>=50)	566.2	95% Gamma Adjusted KM-UCL (use when n<50)	580.6

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	52.46	Mean	444.5
Maximum	1100	Median	427
SD	259.4	CV	0.583
k hat (MLE)	2.454	k star (bias corrected MLE)	2.061
Theta hat (MLE)	181.1	Theta star (bias corrected MLE)	215.7
nu hat (MLE)	83.45	nu star (bias corrected)	70.06
MLE Mean (bias corrected)	444.5	MLE Sd (bias corrected)	309.7
		Adjusted Level of Significance (β)	0.0346
Approximate Chi Square Value (70.06, α)	51.79	Adjusted Chi Square Value (70.06, β)	50.14
95% Gamma Approximate UCL (use when n>=50)	601.3	95% Gamma Adjusted UCL (use when n<50)	621

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.926	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.204	Lilliefors GOF Test
5% Lilliefors Critical Value	0.222	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	447	Mean in Log Scale	5.915
SD in Original Scale	255.5	SD in Log Scale	0.686
95% t UCL (assumes normality of ROS data)	555.2	95% Percentile Bootstrap UCL	545.8
95% BCA Bootstrap UCL	553.8	95% Bootstrap t UCL	571.6
95% H-UCL (Log ROS)	689		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	5.918	95% H-UCL (KM -Log)	665.7
KM SD (logged)	0.661	95% Critical H Value (KM-Log)	2.211
KM Standard Error of Mean (logged)	0.165		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	444.4	Mean in Log Scale	5.877
SD in Original Scale	259.6	SD in Log Scale	0.778
95% t UCL (Assumes normality)	554.3	95% H-Stat UCL	760.6

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	555.5	95% KM (Percentile Bootstrap) UCL	541.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe in the Animas River above of the confluence with mainstem Cement Creek during the post-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:28
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	18	Number of Distinct Observations	11
Number of Detects	10	Number of Non-Detects	8
Number of Distinct Detects	9	Number of Distinct Non-Detects	2
Minimum Detect	111	Minimum Non-Detect	100
Maximum Detect	234	Maximum Non-Detect	500
Variance Detects	1504	Percent Non-Detects	44.44%
Mean Detects	154.1	SD Detects	38.79
Median Detects	154.5	CV Detects	0.252
Skewness Detects	0.829	Kurtosis Detects	0.544
Mean of Logged Detects	5.01	SD of Logged Detects	0.243

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.918	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.15	Lilliefors GOF Test
5% Lilliefors Critical Value	0.28	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	131.8	Standard Error of Mean	9.919
SD	38.8	95% KM (BCA) UCL	147.2
95% KM (t) UCL	149.1	95% KM (Percentile Bootstrap) UCL	149.3
95% KM (z) UCL	148.1	95% KM Bootstrap t UCL	154
90% KM Chebyshev UCL	161.6	95% KM Chebyshev UCL	175.1
97.5% KM Chebyshev UCL	193.8	99% KM Chebyshev UCL	230.5

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.317	Anderson-Darling GOF Test
5% A-D Critical Value	0.725	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.162	Kolmogrov-Smirnoff GOF
5% K-S Critical Value	0.266	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	18.59	k star (bias corrected MLE)	13.08
Theta hat (MLE)	8.291	Theta star (bias corrected MLE)	11.78
nu hat (MLE)	371.7	nu star (bias corrected)	261.6
MLE Mean (bias corrected)	154.1	MLE Sd (bias corrected)	42.61

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	11.54	nu hat (KM)	415.6
Approximate Chi Square Value (415.58, α)	369.3	Adjusted Chi Square Value (415.58, β)	365.1
95% Gamma Approximate KM-UCL (use when n>=50)	148.3	95% Gamma Adjusted KM-UCL (use when n<50)	150

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	22.74	Mean	115.6
Maximum	234	Median	113.6
SD	55.65	CV	0.482
k hat (MLE)	3.768	k star (bias corrected MLE)	3.177
Theta hat (MLE)	30.67	Theta star (bias corrected MLE)	36.38
nu hat (MLE)	135.6	nu star (bias corrected)	114.4
MLE Mean (bias corrected)	115.6	MLE Sd (bias corrected)	64.84
		Adjusted Level of Significance (β)	0.0357
Approximate Chi Square Value (114.37, α)	90.68	Adjusted Chi Square Value (114.37, β)	88.66
95% Gamma Approximate UCL (use when n>=50)	145.8	95% Gamma Adjusted UCL (use when n<50)	149.1

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.939	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.155	Lilliefors GOF Test
5% Lilliefors Critical Value	0.28	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	122.5	Mean in Log Scale	4.738
SD in Original Scale	47.52	SD in Log Scale	0.389
95% t UCL (assumes normality of ROS data)	142	95% Percentile Bootstrap UCL	141.1
95% BCA Bootstrap UCL	143.1	95% Bootstrap t UCL	145.7
95% H-UCL (Log ROS)	147.6		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	4.844	95% H-UCL (KM -Log)	148
KM SD (logged)	0.267	95% Critical H Value (KM-Log)	1.83
KM Standard Error of Mean (logged)	0.0682		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	118.9	Mean in Log Scale	4.612
SD in Original Scale	67.01	SD in Log Scale	0.612
95% t UCL (Assumes normality)	146.4	95% H-Stat UCL	166.8

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	149.1	95% KM (Percentile Bootstrap) UCL	149.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe at sampling location A72 in the Animas River below the confluence with mainstem Mineral Creek during the pre-runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:42
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	4190	Mean	6018
Maximum	7710	Median	6085
SD	1657	Std. Error of Mean	828.3
Coefficient of Variation	0.275	Skewness	-0.124

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.923	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.241	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	7967	95% Adjusted-CLT UCL (Chen-1995)	7325
		95% Modified-t UCL (Johnson-1978)	7958
Gamma GOF Test			
A-D Test Statistic	0.334	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.28	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	16.91	k star (bias corrected MLE)	4.393
Theta hat (MLE)	356	Theta star (bias corrected MLE)	1370
nu hat (MLE)	135.2	nu star (bias corrected)	35.14
MLE Mean (bias corrected)	6018	MLE Sd (bias corrected)	2871
		Approximate Chi Square Value (0.05)	22.58
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	9365	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.923	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.251	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	8.34	Mean of logged Data	8.673
Maximum of Logged Data	8.95	SD of logged Data	0.285
Assuming Lognormal Distribution			
95% H-UCL	9535	90% Chebyshev (MVUE) UCL	8583
95% Chebyshev (MVUE) UCL	9743	97.5% Chebyshev (MVUE) UCL	11354
99% Chebyshev (MVUE) UCL	14519		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	7380	95% Jackknife UCL	7967
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	8502	95% Chebyshev(Mean, Sd) UCL	9628
97.5% Chebyshev(Mean, Sd) UCL	11190	99% Chebyshev(Mean, Sd) UCL	14259

Suggested UCL to Use

95% Student's-t UCL	7967

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Fe at sampling location A72 in the Animas River below the confluence with mainstem Mineral Creek during the runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:42
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	948	Mean	2905
Maximum	7200	Median	1950
SD	2427	Std. Error of Mean	917.2
Coefficient of Variation	0.835	Skewness	1.195

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.826	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.251	Lilliefors GOF Test
5% Lilliefors Critical Value	0.335	Data appear Normal at 5% Significance Level
Data appear Normal at 5% Significance Level		

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4687	95% Adjusted-CLT UCL (Chen-1995)	4856
		95% Modified-t UCL (Johnson-1978)	4756

Gamma GOF Test

A-D Test Statistic	0.419	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.716	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.201	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.315	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics

k hat (MLE)	1.902	k star (bias corrected MLE)	1.182
Theta hat (MLE)	1527	Theta star (bias corrected MLE)	2458
nu hat (MLE)	26.62	nu star (bias corrected)	16.55
MLE Mean (bias corrected)	2905	MLE Sd (bias corrected)	2672
		Approximate Chi Square Value (0.05)	8.35
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	6.669

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5757	95% Adjusted Gamma UCL (use when n<50)	7208

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.908	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.178	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.335	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics

Minimum of Logged Data	6.854	Mean of logged Data	7.689
Maximum of Logged Data	8.882	SD of logged Data	0.805

Assuming Lognormal Distribution

95% H-UCL	8547	90% Chebyshev (MVUE) UCL	5481
95% Chebyshev (MVUE) UCL	6670	97.5% Chebyshev (MVUE) UCL	8319
99% Chebyshev (MVUE) UCL	11560		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4413	95% Jackknife UCL	4687
95% Standard Bootstrap UCL	4291	95% Bootstrap-t UCL	7615
95% Hall's Bootstrap UCL	13393	95% Percentile Bootstrap UCL	4449
95% BCA Bootstrap UCL	4605		
90% Chebyshev(Mean, Sd) UCL	5656	95% Chebyshev(Mean, Sd) UCL	6903
97.5% Chebyshev(Mean, Sd) UCL	8633	99% Chebyshev(Mean, Sd) UCL	12031

Suggested UCL to Use

95% Student's-t UCL	4687

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe at sampling location A72 in the Animas River below the confluence with mainstem Mineral Creek during the post- runoff period

User Selected Options	
Date/Time of Computation	2/23/2015 13:42
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	787	Mean	2701
Maximum	5490	Median	2740
SD	1432	Std. Error of Mean	397.3
Coefficient of Variation	0.53	Skewness	0.424

Normal GOF Test

Shapiro Wilk Test Statistic	0.952	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.137	Lilliefors GOF Test
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3409	95% Adjusted-CLT UCL (Chen-1995)	3404
		95% Modified-t UCL (Johnson-1978)	3416

Gamma GOF Test

A-D Test Statistic	0.282	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.145	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.238	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.477	k star (bias corrected MLE)	2.726
Theta hat (MLE)	776.6	Theta star (bias corrected MLE)	990.6
nu hat (MLE)	90.41	nu star (bias corrected)	70.88
MLE Mean (bias corrected)	2701	MLE Sd (bias corrected)	1636
		Approximate Chi Square Value (0.05)	52.5
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	50.25

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3646	95% Adjusted Gamma UCL (use when n<50)	3809

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.164	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.668	Mean of logged Data	7.751
Maximum of Logged Data	8.611	SD of logged Data	0.6

Assuming Lognormal Distribution

95% H-UCL	4093	90% Chebyshev (MVUE) UCL	4151
95% Chebyshev (MVUE) UCL	4792	97.5% Chebyshev (MVUE) UCL	5681
99% Chebyshev (MVUE) UCL	7428		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3354	95% Jackknife UCL	3409
95% Standard Bootstrap UCL	3337	95% Bootstrap-t UCL	3461
95% Hall's Bootstrap UCL	3466	95% Percentile Bootstrap UCL	3337
95% BCA Bootstrap UCL	3378		
90% Chebyshev(Mean, Sd) UCL	3892	95% Chebyshev(Mean, Sd) UCL	4432
97.5% Chebyshev(Mean, Sd) UCL	5182	99% Chebyshev(Mean, Sd) UCL	6653

Suggested UCL to Use

95% Student's-t UCL	3409

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe at sampling location A73 in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 13:47
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	1080	Mean	2986
Maximum	4210	Median	3210
SD	1234	Std. Error of Mean	551.9
Coefficient of Variation	0.413	Skewness	-0.998

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.935	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.172	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4163	95% Adjusted-CLT UCL (Chen-1995)	3631
		95% Modified-t UCL (Johnson-1978)	4122
Gamma GOF Test			
A-D Test Statistic	0.418	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.229	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	5.231	k star (bias corrected MLE)	2.226
Theta hat (MLE)	570.9	Theta star (bias corrected MLE)	1342
nu hat (MLE)	52.31	nu star (bias corrected)	22.26
MLE Mean (bias corrected)	2986	MLE Sd (bias corrected)	2002
		Approximate Chi Square Value (0.05)	12.53
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	9.5
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	5304	95% Adjusted Gamma UCL (use when n<50)	6995
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.838	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.265	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.985	Mean of logged Data	7.903
Maximum of Logged Data	8.345	SD of logged Data	0.547
Assuming Lognormal Distribution			
95% H-UCL	7328	90% Chebyshev (MVUE) UCL	5248
95% Chebyshev (MVUE) UCL	6247	97.5% Chebyshev (MVUE) UCL	7634
99% Chebyshev (MVUE) UCL	10359		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	3894	95% Jackknife UCL	4163
95% Standard Bootstrap UCL	3794	95% Bootstrap-t UCL	3892
95% Hall's Bootstrap UCL	3695	95% Percentile Bootstrap UCL	3740
95% BCA Bootstrap UCL	3666		
90% Chebyshev(Mean, Sd) UCL	4642	95% Chebyshev(Mean, Sd) UCL	5392
97.5% Chebyshev(Mean, Sd) UCL	6433	99% Chebyshev(Mean, Sd) UCL	8478

Suggested UCL to Use

95% Student's-t UCL	4163

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Fe at sampling location A73B in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 13:48
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	569	Mean	1570
Maximum	2790	Median	1460
SD	916.8	Std. Error of Mean	458.4
Coefficient of Variation	0.584	Skewness	0.7

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.948	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.272	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2649	95% Adjusted-CLT UCL (Chen-1995)	2495
		95% Modified-t UCL (Johnson-1978)	2675

Gamma GOF Test

A-D Test Statistic	0.28	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.237	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.569	k star (bias corrected MLE)	1.059
Theta hat (MLE)	439.8	Theta star (bias corrected MLE)	1482
nu hat (MLE)	28.55	nu star (bias corrected)	8.472
MLE Mean (bias corrected)	1570	MLE Sd (bias corrected)	1525
		Approximate Chi Square Value (0.05)	3.011
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4416	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.95	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.27	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.344	Mean of logged Data	7.212
Maximum of Logged Data	7.934	SD of logged Data	0.655

Assuming Lognormal Distribution

95% H-UCL	9338	90% Chebyshev (MVUE) UCL	3094
95% Chebyshev (MVUE) UCL	3777	97.5% Chebyshev (MVUE) UCL	4726
99% Chebyshev (MVUE) UCL	6589		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2324	95% Jackknife UCL	2649
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	2945	95% Chebyshev(Mean, Sd) UCL	3568
97.5% Chebyshev(Mean, Sd) UCL	4433	99% Chebyshev(Mean, Sd) UCL	6131

Suggested UCL to Use

95% Student's-t UCL	2649

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe at sampling location A75D in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 13:48
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	580	Mean	2556
Maximum	4610	Median	2530
SD	1432	Std. Error of Mean	640.5
Coefficient of Variation	0.56	Skewness	0.134

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.938	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.252	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3922	95% Adjusted-CLT UCL (Chen-1995)	3651
		95% Modified-t UCL (Johnson-1978)	3928

Gamma GOF Test

A-D Test Statistic	0.453	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.683	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.319	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.36	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.843	k star (bias corrected MLE)	1.271
Theta hat (MLE)	899.1	Theta star (bias corrected MLE)	2012
nu hat (MLE)	28.43	nu star (bias corrected)	12.71
MLE Mean (bias corrected)	2556	MLE Sd (bias corrected)	2268
		Approximate Chi Square Value (0.05)	5.695
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	3.826

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5702	95% Adjusted Gamma UCL (use when n<50)	8488

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.84	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.348	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.363	Mean of logged Data	7.66
Maximum of Logged Data	8.436	SD of logged Data	0.773

Assuming Lognormal Distribution

95% H-UCL	13153	90% Chebyshev (MVUE) UCL	5374
95% Chebyshev (MVUE) UCL	6599	97.5% Chebyshev (MVUE) UCL	8299
99% Chebyshev (MVUE) UCL	11638		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3610	95% Jackknife UCL	3922
95% Standard Bootstrap UCL	3499	95% Bootstrap-t UCL	3827
95% Hall's Bootstrap UCL	3998	95% Percentile Bootstrap UCL	3428
95% BCA Bootstrap UCL	3402		
90% Chebyshev(Mean, Sd) UCL	4478	95% Chebyshev(Mean, Sd) UCL	5348
97.5% Chebyshev(Mean, Sd) UCL	6556	99% Chebyshev(Mean, Sd) UCL	8929

Suggested UCL to Use

95% Student's-t UCL	3922

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe at sampling location A75B in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 13:48
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	585	Mean	2224
Maximum	4810	Median	1750
SD	1895	Std. Error of Mean	947.6
Coefficient of Variation	0.852	Skewness	1.11

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.912	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.23	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level
Data appear Normal at 5% Significance Level		

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4454	95% Adjusted-CLT UCL (Chen-1995)	4344
		95% Modified-t UCL (Johnson-1978)	4541

Gamma GOF Test

A-D Test Statistic	0.238	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.661	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.233	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.399	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics

k hat (MLE)	1.799	k star (bias corrected MLE)	0.616
Theta hat (MLE)	1236	Theta star (bias corrected MLE)	3608
nu hat (MLE)	14.39	nu star (bias corrected)	4.931
MLE Mean (bias corrected)	2224	MLE Sd (bias corrected)	2832
		Approximate Chi Square Value (0.05)	1.121
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	9786	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.182	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics

Minimum of Logged Data	6.372	Mean of logged Data	7.404
Maximum of Logged Data	8.478	SD of logged Data	0.925

Assuming Lognormal Distribution

95% H-UCL	69069	90% Chebyshev (MVUE) UCL	5119
95% Chebyshev (MVUE) UCL	6430	97.5% Chebyshev (MVUE) UCL	8251
99% Chebyshev (MVUE) UCL	11826		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3782	95% Jackknife UCL	4454
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5067	95% Chebyshev(Mean, Sd) UCL	6354
97.5% Chebyshev(Mean, Sd) UCL	8141	99% Chebyshev(Mean, Sd) UCL	11652

Suggested UCL to Use

95% Student's-t UCL	4454

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Fe at Bakers Bridge in the Animas River below the confluence with mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 13:48
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	1
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	317	Minimum Non-Detect	500
Maximum Detect	3560	Maximum Non-Detect	500
Variance Detects	1819222	Percent Non-Detects	20%
Mean Detects	1717	SD Detects	1349
Median Detects	1495	CV Detects	0.786
Skewness Detects	0.95	Kurtosis Detects	1.998
Mean of Logged Detects	7.139	SD of Logged Detects	1.007

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.92	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.305	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1437	Standard Error of Mean	612.1
SD	1185	95% KM (BCA) UCL	N/A
95% KM (t) UCL	2742	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	2444	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	3273	95% KM Chebyshev UCL	4105
97.5% KM Chebyshev UCL	5259	99% KM Chebyshev UCL	7527

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.318	Anderson-Darling GOF Test	
5% A-D Critical Value	0.661	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.269	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.399	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.765	k star (bias corrected MLE)	0.608
Theta hat (MLE)	972.7	Theta star (bias corrected MLE)	2824
nu hat (MLE)	14.12	nu star (bias corrected)	4.863
MLE Mean (bias corrected)	1717	MLE Sd (bias corrected)	2202

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.469	nu hat (KM)	14.69
Approximate Chi Square Value (14.69, α)	7.048	Adjusted Chi Square Value (14.69, β)	4.912
95% Gamma Approximate KM-UCL (use when n>=50)	2995	95% Gamma Adjusted KM-UCL (use when n<50)	4298

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	162.3	Mean	1406
Maximum	3560	Median	1460
SD	1359	CV	0.967
k hat (MLE)	1.099	k star (bias corrected MLE)	0.573
Theta hat (MLE)	1279	Theta star (bias corrected MLE)	2453
nu hat (MLE)	10.99	nu star (bias corrected)	5.731
MLE Mean (bias corrected)	1406	MLE Sd (bias corrected)	1857
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (5.73, α)	1.504	Adjusted Chi Square Value (5.73, β)	0.749
95% Gamma Approximate UCL (use when n>=50)	5357	95% Gamma Adjusted UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.917	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.308	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1441	Mean in Log Scale	6.877
SD in Original Scale	1320	SD in Log Scale	1.051
95% t UCL (assumes normality of ROS data)	2700	95% Percentile Bootstrap UCL	2314
95% BCA Bootstrap UCL	2496	95% Bootstrap t UCL	3585
95% H-UCL (Log ROS)	24854		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	6.863	95% H-UCL (KM -Log)	14357
KM SD (logged)	0.956	95% Critical H Value (KM-Log)	4.714
KM Standard Error of Mean (logged)	0.493		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1423	Mean in Log Scale	6.815
SD in Original Scale	1340	SD in Log Scale	1.133
95% t UCL (Assumes normality)	2701	95% H-Stat UCL	38709

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	2742	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Cd in the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	40	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	0.8	Mean	1.382
Maximum	4	Median	1.3
SD	0.632	Std. Error of Mean	0.1
Coefficient of Variation	0.458	Skewness	2.637

Normal GOF Test

Shapiro Wilk Test Statistic	0.719	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.238	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.55	95% Adjusted-CLT UCL (Chen-1995)	1.591
		95% Modified-t UCL (Johnson-1978)	1.557

Gamma GOF Test

A-D Test Statistic	1.681	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.75	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.175	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.14	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	7.296	k star (bias corrected MLE)	6.766
Theta hat (MLE)	0.189	Theta star (bias corrected MLE)	0.204
nu hat (MLE)	583.7	nu star (bias corrected)	541.3
MLE Mean (bias corrected)	1.382	MLE Sd (bias corrected)	0.531
		Approximate Chi Square Value (0.05)	488.3
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	486.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.532	95% Adjusted Gamma UCL (use when n<50)	1.538

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.896	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.144	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.14	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	-0.223	Mean of logged Data	0.253
Maximum of Logged Data	1.386	SD of logged Data	0.351

Assuming Lognormal Distribution

95% H-UCL	1.518	90% Chebyshev (MVUE) UCL	1.601
95% Chebyshev (MVUE) UCL	1.707	97.5% Chebyshev (MVUE) UCL	1.853
99% Chebyshev (MVUE) UCL	2.142		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	1.546	95% Jackknife UCL	1.55
95% Standard Bootstrap UCL	1.546	95% Bootstrap-t UCL	1.64
95% Hall's Bootstrap UCL	1.733	95% Percentile Bootstrap UCL	1.552
95% BCA Bootstrap UCL	1.587		
90% Chebyshev(Mean, Sd) UCL	1.682	95% Chebyshev(Mean, Sd) UCL	1.818
97.5% Chebyshev(Mean, Sd) UCL	2.006	99% Chebyshev(Mean, Sd) UCL	2.377

Suggested UCL to Use

95% Student's-t UCL	1.55	or 95% Modified-t UCL	1.557

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cu in the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	40	Number of Distinct Observations	31
Number of Detects	32	Number of Non-Detects	8
Number of Distinct Detects	29	Number of Distinct Non-Detects	3
Minimum Detect	3.9	Minimum Non-Detect	4
Maximum Detect	33.5	Maximum Non-Detect	20
Variance Detects	120.4	Percent Non-Detects	20%
Mean Detects	15.53	SD Detects	10.97
Median Detects	12.8	CV Detects	0.707
Skewness Detects	0.274	Kurtosis Detects	-1.67
Mean of Logged Detects	2.436	SD of Logged Detects	0.835

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.825	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.93	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.24	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.157	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	13.43	Standard Error of Mean	1.705
SD	10.57	95% KM (BCA) UCL	16.2
95% KM (t) UCL	16.3	95% KM (Percentile Bootstrap) UCL	16.4
95% KM (z) UCL	16.23	95% KM Bootstrap t UCL	16.41
90% KM Chebyshev UCL	18.54	95% KM Chebyshev UCL	20.86
97.5% KM Chebyshev UCL	24.07	99% KM Chebyshev UCL	30.39

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.253	Anderson-Darling GOF Test	
5% A-D Critical Value	0.761	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.225	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.158	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.78	k star (bias corrected MLE)	1.634
Theta hat (MLE)	8.72	Theta star (bias corrected MLE)	9.499
nu hat (MLE)	113.9	nu star (bias corrected)	104.6
MLE Mean (bias corrected)	15.53	MLE Sd (bias corrected)	12.14

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.613	nu hat (KM)	129.1
Approximate Chi Square Value (129.05, α)	103.8	Adjusted Chi Square Value (129.05, β)	103
95% Gamma Approximate KM-UCL (use when n>=50)	16.69	95% Gamma Adjusted KM-UCL (use when n<50)	16.83

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.632	Mean	13.49
Maximum	33.5	Median	7.958
SD	10.73	CV	0.796
k hat (MLE)	1.458	k star (bias corrected MLE)	1.366
Theta hat (MLE)	9.249	Theta star (bias corrected MLE)	9.877
nu hat (MLE)	116.7	nu star (bias corrected)	109.2
MLE Mean (bias corrected)	13.49	MLE Sd (bias corrected)	11.54
		Adjusted Level of Significance (β)	0.044
Approximate Chi Square Value (109.24, α)	86.12	Adjusted Chi Square Value (109.24, β)	85.35
95% Gamma Approximate UCL (use when n>=50)	17.11	95% Gamma Adjusted UCL (use when n<50)	17.26

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.819	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.93	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.219	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.157	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	13.43	Mean in Log Scale	2.248
SD in Original Scale	10.72	SD in Log Scale	0.87
95% t UCL (assumes normality of ROS data)	16.29	95% Percentile Bootstrap UCL	16.25
95% BCA Bootstrap UCL	16.1	95% Bootstrap t UCL	16.49
95% H-UCL (Log ROS)	18.95		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	13.77	Mean in Log Scale	2.294
SD in Original Scale	10.52	SD in Log Scale	0.852
95% t UCL (Assumes normality)	16.57	95% H-Stat UCL	19.37

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL	16.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Pb in the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	40	Number of Distinct Observations	33
		Number of Missing Observations	0
Minimum	1.4	Mean	11.57
Maximum	52.3	Median	2.85
SD	15.03	Std. Error of Mean	2.376
Coefficient of Variation	1.299	Skewness	1.732

Normal GOF Test

Shapiro Wilk Test Statistic	0.69	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.284	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	15.57	95% Adjusted-CLT UCL (Chen-1995)	16.17
		95% Modified-t UCL (Johnson-1978)	15.68

Gamma GOF Test

A-D Test Statistic	2.903	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.787	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.252	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.145	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	0.796	k star (bias corrected MLE)	0.753
Theta hat (MLE)	14.53	Theta star (bias corrected MLE)	15.36
nu hat (MLE)	63.69	nu star (bias corrected)	60.25
MLE Mean (bias corrected)	11.57	MLE Sd (bias corrected)	13.33
		Approximate Chi Square Value (0.05)	43.4
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	42.86

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	16.06	95% Adjusted Gamma UCL (use when n<50)	16.26

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.841	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.226	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.14	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	0.336	Mean of logged Data	1.703
Maximum of Logged Data	3.957	SD of logged Data	1.21

Assuming Lognormal Distribution

95% H-UCL	19.12	90% Chebyshev (MVUE) UCL	18.84
95% Chebyshev (MVUE) UCL	22.37	97.5% Chebyshev (MVUE) UCL	27.25
99% Chebyshev (MVUE) UCL	36.85		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	15.48	95% Jackknife UCL	15.57
95% Standard Bootstrap UCL	15.41	95% Bootstrap-t UCL	16.6
95% Hall's Bootstrap UCL	15.85	95% Percentile Bootstrap UCL	15.66
95% BCA Bootstrap UCL	16.02		
90% Chebyshev(Mean, Sd) UCL	18.7	95% Chebyshev(Mean, Sd) UCL	21.93
97.5% Chebyshev(Mean, Sd) UCL	26.41	99% Chebyshev(Mean, Sd) UCL	35.22

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	21.93

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn in the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	40	Number of Distinct Observations	39
		Number of Missing Observations	0
Minimum	252	Mean	432
Maximum	1180	Median	382
SD	202.5	Std. Error of Mean	32.01
Coefficient of Variation	0.469	Skewness	2.21

Normal GOF Test

Shapiro Wilk Test Statistic	0.755	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.187	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	485.9	95% Adjusted-CLT UCL (Chen-1995)	496.6
		95% Modified-t UCL (Johnson-1978)	487.8

Gamma GOF Test

A-D Test Statistic	1.516	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.75	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.144	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.14	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.606	k star (bias corrected MLE)	6.127
Theta hat (MLE)	65.4	Theta star (bias corrected MLE)	70.51
nu hat (MLE)	528.4	nu star (bias corrected)	490.1
MLE Mean (bias corrected)	432	MLE Sd (bias corrected)	174.5
		Approximate Chi Square Value (0.05)	439.8
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	438

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	481.4	95% Adjusted Gamma UCL (use when n<50)	483.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.115	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.14	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.529	Mean of logged Data	5.991
Maximum of Logged Data	7.073	SD of logged Data	0.373

Assuming Lognormal Distribution

95% H-UCL	478	90% Chebyshev (MVUE) UCL	505.4
95% Chebyshev (MVUE) UCL	540.6	97.5% Chebyshev (MVUE) UCL	589.4
99% Chebyshev (MVUE) UCL	685.4		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	484.6	95% Jackknife UCL	485.9
95% Standard Bootstrap UCL	484.3	95% Bootstrap-t UCL	507.2
95% Hall's Bootstrap UCL	511.2	95% Percentile Bootstrap UCL	483.4
95% BCA Bootstrap UCL	494.5		
90% Chebyshev(Mean, Sd) UCL	528	95% Chebyshev(Mean, Sd) UCL	571.5
97.5% Chebyshev(Mean, Sd) UCL	631.9	99% Chebyshev(Mean, Sd) UCL	750.5

Suggested UCL to Use

95% Student's-t UCL	485.9	or 95% Modified-t UCL	487.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cd from sampling location A72 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:12
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	24	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	0.8	Mean	1.648
Maximum	2.9	Median	1.675
SD	0.683	Std. Error of Mean	0.139
Coefficient of Variation	0.415	Skewness	0.494

Normal GOF Test

Shapiro Wilk Test Statistic	0.91	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.136	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.181	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.887	95% Adjusted-CLT UCL (Chen-1995)	1.892
		95% Modified-t UCL (Johnson-1978)	1.889

Gamma GOF Test

A-D Test Statistic	0.539	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.138	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.178	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.085	k star (bias corrected MLE)	5.353
Theta hat (MLE)	0.271	Theta star (bias corrected MLE)	0.308
nu hat (MLE)	292.1	nu star (bias corrected)	256.9
MLE Mean (bias corrected)	1.648	MLE Sd (bias corrected)	0.712
		Approximate Chi Square Value (0.05)	220.8
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	218.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.917	95% Adjusted Gamma UCL (use when n<50)	1.938

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.916	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.14	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.181	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.223	Mean of logged Data	0.415
Maximum of Logged Data	1.065	SD of logged Data	0.424

Assuming Lognormal Distribution

95% H-UCL	1.963	90% Chebyshev (MVUE) UCL	2.092
95% Chebyshev (MVUE) UCL	2.292	97.5% Chebyshev (MVUE) UCL	2.569
99% Chebyshev (MVUE) UCL	3.114		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.877	95% Jackknife UCL	1.887
95% Standard Bootstrap UCL	1.868	95% Bootstrap-t UCL	1.901
95% Hall's Bootstrap UCL	1.883	95% Percentile Bootstrap UCL	1.881
95% BCA Bootstrap UCL	1.898		
90% Chebyshev(Mean, Sd) UCL	2.066	95% Chebyshev(Mean, Sd) UCL	2.256
97.5% Chebyshev(Mean, Sd) UCL	2.519	99% Chebyshev(Mean, Sd) UCL	3.036

Suggested UCL to Use

95% Student's-t UCL	1.887

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cu from sampling location A72 in the Animas River below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/19/2015 9:13		
From File	WorkSheet_a.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	24	Number of Distinct Observations	24
Number of Detects	23	Number of Non-Detects	1
Number of Distinct Detects	23	Number of Distinct Non-Detects	1
Minimum Detect	10.3	Minimum Non-Detect	20
Maximum Detect	46.7	Maximum Non-Detect	20
Variance Detects	117	Percent Non-Detects	4.17%
Mean Detects	27.36	SD Detects	10.82
Median Detects	28.8	CV Detects	0.395
Skewness Detects	-0.0118	Kurtosis Detects	-1.226
Mean of Logged Detects	3.222	SD of Logged Detects	0.446

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.948	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.914	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.15	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.185	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	26.84	Standard Error of Mean	2.229
SD	10.66	95% KM (BCA) UCL	30.43
95% KM (t) UCL	30.66	95% KM (Percentile Bootstrap) UCL	30.38
95% KM (z) UCL	30.51	95% KM Bootstrap t UCL	30.67
90% KM Chebyshev UCL	33.53	95% KM Chebyshev UCL	36.56
97.5% KM Chebyshev UCL	40.76	99% KM Chebyshev UCL	49.02

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.594	Anderson-Darling GOF Test	
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.175	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.182	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.898	k star (bias corrected MLE)	5.158
Theta hat (MLE)	4.638	Theta star (bias corrected MLE)	5.304
nu hat (MLE)	271.3	nu star (bias corrected)	237.3
MLE Mean (bias corrected)	27.36	MLE Sd (bias corrected)	12.05

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	6.342	nu hat (KM)	304.4
Approximate Chi Square Value (304.43, α)	265	Adjusted Chi Square Value (304.43, β)	262.4
95% Gamma Approximate KM-UCL (use when n>=50)	30.84	95% Gamma Adjusted KM-UCL (use when n<50)	31.14

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	10.3	Mean	26.92
Maximum	46.7	Median	27.4
SD	10.79	CV	0.401
k hat (MLE)	5.867	k star (bias corrected MLE)	5.162
Theta hat (MLE)	4.588	Theta star (bias corrected MLE)	5.215
nu hat (MLE)	281.6	nu star (bias corrected)	247.8
MLE Mean (bias corrected)	26.92	MLE Sd (bias corrected)	11.85
		Adjusted Level of Significance (β)	0.0392
Approximate Chi Square Value (247.76, α)	212.3	Adjusted Chi Square Value (247.76, β)	210
95% Gamma Approximate UCL (use when n>=50)	31.41	95% Gamma Adjusted UCL (use when n<50)	31.75

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.928	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.914	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.177	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.185	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	26.89	Mean in Log Scale	3.203
SD in Original Scale	10.82	SD in Log Scale	0.445
95% t UCL (assumes normality of ROS data)	30.68	95% Percentile Bootstrap UCL	30.28
95% BCA Bootstrap UCL	30.62	95% Bootstrap t UCL	30.81
95% H-UCL (Log ROS)	32.52		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	3.2	95% H-UCL (KM -Log)	32.29
KM SD (logged)	0.441	95% Critical H Value (KM-Log)	1.93
KM Standard Error of Mean (logged)	0.0926		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	26.63	Mean in Log Scale	3.183
SD in Original Scale	11.16	SD in Log Scale	0.474
95% t UCL (Assumes normality)	30.54	95% H-Stat UCL	32.78

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	30.66	95% KM (Percentile Bootstrap) UCL	30.38

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Pb from sampling location A72 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:13
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	24	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	3.3	Mean	12.77
Maximum	99.8	Median	5.9
SD	19.88	Std. Error of Mean	4.057
Coefficient of Variation	1.556	Skewness	3.983

Normal GOF Test		
Shapiro Wilk Test Statistic	0.465	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.321	Lilliefors GOF Test
5% Lilliefors Critical Value	0.181	Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level		

Assuming Normal Distribution			
		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% Adjusted-CLT UCL (Chen-1995)	22.97
95% Student's-t UCL	19.73	95% Modified-t UCL (Johnson-1978)	20.27

Gamma GOF Test			
A-D Test Statistic	2.5	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.767	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.28	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.182	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.22	k star (bias corrected MLE)	1.095
Theta hat (MLE)	10.47	Theta star (bias corrected MLE)	11.66
nu hat (MLE)	58.56	nu star (bias corrected)	52.57
MLE Mean (bias corrected)	12.77	MLE Sd (bias corrected)	12.2
		Approximate Chi Square Value (0.05)	36.91
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	35.99
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	18.19	95% Adjusted Gamma UCL (use when n<50)	18.65

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.829	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.916	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.234	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.181	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.194	Mean of logged Data	2.084
Maximum of Logged Data	4.603	SD of logged Data	0.812

Assuming Lognormal Distribution			
95% H-UCL	16.51	90% Chebyshev (MVUE) UCL	16.97
95% Chebyshev (MVUE) UCL	19.68	97.5% Chebyshev (MVUE) UCL	23.44
99% Chebyshev (MVUE) UCL	30.82		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs			
95% CLT UCL	19.45	95% Jackknife UCL	19.73
95% Standard Bootstrap UCL	19.14	95% Bootstrap-t UCL	33.29
95% Hall's Bootstrap UCL	41.1	95% Percentile Bootstrap UCL	20.29
95% BCA Bootstrap UCL	24.4		
90% Chebyshev(Mean, Sd) UCL	24.94	95% Chebyshev(Mean, Sd) UCL	30.46
97.5% Chebyshev(Mean, Sd) UCL	38.11	99% Chebyshev(Mean, Sd) UCL	53.14

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	30.46

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Ni from sampling location A72 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:13
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	24	Number of Distinct Observations	11
Number of Detects	9	Number of Non-Detects	15
Number of Distinct Detects	8	Number of Distinct Non-Detects	4
Minimum Detect	2	Minimum Non-Detect	0.7
Maximum Detect	7	Maximum Non-Detect	4
Variance Detects	2.893	Percent Non-Detects	62.50%
Mean Detects	4.967	SD Detects	1.701
Median Detects	5.2	CV Detects	0.342
Skewness Detects	-0.416	Kurtosis Detects	-0.606
Mean of Logged Detects	1.538	SD of Logged Detects	0.407

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.952	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.117	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.295	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	2.559	Standard Error of Mean	0.519
SD	2.219	95% KM (BCA) UCL	3.864
95% KM (t) UCL	3.449	95% KM (Percentile Bootstrap) UCL	3.713
95% KM (z) UCL	3.413	95% KM Bootstrap t UCL	3.397
90% KM Chebyshev UCL	4.116	95% KM Chebyshev UCL	4.822
97.5% KM Chebyshev UCL	5.801	99% KM Chebyshev UCL	7.724

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.298	Anderson-Darling GOF Test	
5% A-D Critical Value	0.722	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.154	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.28	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.879	k star (bias corrected MLE)	5.327
Theta hat (MLE)	0.63	Theta star (bias corrected MLE)	0.932
nu hat (MLE)	141.8	nu star (bias corrected)	95.88
MLE Mean (bias corrected)	4.967	MLE Sd (bias corrected)	2.152

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.331	nu hat (KM)	63.87
Approximate Chi Square Value (63.87, α)	46.48	Adjusted Chi Square Value (63.87, β)	45.44
95% Gamma Approximate KM-UCL (use when n>=50)	3.516	95% Gamma Adjusted KM-UCL (use when n<50)	3.597

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2.633
Maximum	7	Median	2.056
SD	2.25	CV	0.854
k hat (MLE)	0.714	k star (bias corrected MLE)	0.652
Theta hat (MLE)	3.69	Theta star (bias corrected MLE)	4.038
nu hat (MLE)	34.25	nu star (bias corrected)	31.3
MLE Mean (bias corrected)	2.633	MLE Sd (bias corrected)	3.261
		Adjusted Level of Significance (β)	0.0392
Approximate Chi Square Value (31.30, α)	19.52	Adjusted Chi Square Value (31.30, β)	18.87
95% Gamma Approximate UCL (use when n>=50)	4.222	95% Gamma Adjusted UCL (use when n<50)	4.369

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.901	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.163	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.295	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.959	Mean in Log Scale	0.89
SD in Original Scale	1.945	SD in Log Scale	0.632
95% t UCL (assumes normality of ROS data)	3.639	95% Percentile Bootstrap UCL	3.589
95% BCA Bootstrap UCL	3.68	95% Bootstrap t UCL	3.771
95% H-UCL (Log ROS)	3.926		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	0.526	95% H-UCL (KM -Log)	4.152
KM SD (logged)	0.924	95% Critical H Value (KM-Log)	2.444
KM Standard Error of Mean (logged)	0.238		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.794	Mean in Log Scale	0.772
SD in Original Scale	2.035	SD in Log Scale	0.751
95% t UCL (Assumes normality)	3.506	95% H-Stat UCL	4.07

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.449	95% KM (Percentile Bootstrap) UCL	3.713

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn from sampling location A72 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:13
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	24	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	221	Mean	599.7
Maximum	1320	Median	531
SD	319.3	Std. Error of Mean	65.17
Coefficient of Variation	0.532	Skewness	0.766

Normal GOF Test

Shapiro Wilk Test Statistic	0.912	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.136	Lilliefors GOF Test
5% Lilliefors Critical Value	0.181	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	711.4	95% Adjusted-CLT UCL (Chen-1995)	717.8
		95% Modified-t UCL (Johnson-1978)	713.1

Gamma GOF Test

A-D Test Statistic	0.379	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.749	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.129	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.179	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.824	k star (bias corrected MLE)	3.373
Theta hat (MLE)	156.8	Theta star (bias corrected MLE)	177.8
nu hat (MLE)	183.5	nu star (bias corrected)	161.9
MLE Mean (bias corrected)	599.7	MLE Sd (bias corrected)	326.5
		Approximate Chi Square Value (0.05)	133.5
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	131.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	727.4	95% Adjusted Gamma UCL (use when n<50)	737.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.956	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.916	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.126	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.181	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.398	Mean of logged Data	6.26
Maximum of Logged Data	7.185	SD of logged Data	0.539

Assuming Lognormal Distribution

95% H-UCL	758.5	90% Chebyshev (MVUE) UCL	808.1
95% Chebyshev (MVUE) UCL	902	97.5% Chebyshev (MVUE) UCL	1032
99% Chebyshev (MVUE) UCL	1288		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	706.9	95% Jackknife UCL	711.4
95% Standard Bootstrap UCL	708	95% Bootstrap-t UCL	729
95% Hall's Bootstrap UCL	716.9	95% Percentile Bootstrap UCL	705.5
95% BCA Bootstrap UCL	720.9		
90% Chebyshev(Mean, Sd) UCL	795.2	95% Chebyshev(Mean, Sd) UCL	883.8
97.5% Chebyshev(Mean, Sd) UCL	1007	99% Chebyshev(Mean, Sd) UCL	1248

Suggested UCL to Use

95% Student's-t UCL	711.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cd from sampling location A73 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:09
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.97	Mean	1.524
Maximum	2.2	Median	1.27
SD	0.619	Std. Error of Mean	0.277
Coefficient of Variation	0.406	Skewness	0.458

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.792	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.259	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.114	95% Adjusted-CLT UCL (Chen-1995)	2.04
		95% Modified-t UCL (Johnson-1978)	2.124

Gamma GOF Test

A-D Test Statistic	0.579	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.28	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.731	k star (bias corrected MLE)	3.226
Theta hat (MLE)	0.197	Theta star (bias corrected MLE)	0.472
nu hat (MLE)	77.31	nu star (bias corrected)	32.26
MLE Mean (bias corrected)	1.524	MLE Sd (bias corrected)	0.849
		Approximate Chi Square Value (0.05)	20.27
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	16.26

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.425	95% Adjusted Gamma UCL (use when n<50)	3.023

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.817	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.252	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.0305	Mean of logged Data	0.355
Maximum of Logged Data	0.788	SD of logged Data	0.405

Assuming Lognormal Distribution

95% H-UCL	2.656	90% Chebyshev (MVUE) UCL	2.344
95% Chebyshev (MVUE) UCL	2.717	97.5% Chebyshev (MVUE) UCL	3.234
99% Chebyshev (MVUE) UCL	4.249		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.979	95% Jackknife UCL	2.114
95% Standard Bootstrap UCL	1.933	95% Bootstrap-t UCL	3.187
95% Hall's Bootstrap UCL	2.885	95% Percentile Bootstrap UCL	1.95
95% BCA Bootstrap UCL	1.956		
90% Chebyshev(Mean, Sd) UCL	2.355	95% Chebyshev(Mean, Sd) UCL	2.731
97.5% Chebyshev(Mean, Sd) UCL	3.253	99% Chebyshev(Mean, Sd) UCL	4.279

Suggested UCL to Use

95% Student's-t UCL	2.114

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cu from sampling location A73 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:09
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	8.3	Mean	17.76
Maximum	22.8	Median	19.3
SD	5.983	Std. Error of Mean	2.676
Coefficient of Variation	0.337	Skewness	-1.196

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.881	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.202	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	23.46	95% Adjusted-CLT UCL (Chen-1995)	20.63
		95% Modified-t UCL (Johnson-1978)	23.23
Gamma GOF Test			
A-D Test Statistic	0.483	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.24	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	8.447	k star (bias corrected MLE)	3.512
Theta hat (MLE)	2.102	Theta star (bias corrected MLE)	5.057
nu hat (MLE)	84.47	nu star (bias corrected)	35.12
MLE Mean (bias corrected)	17.76	MLE Sd (bias corrected)	9.477
		Approximate Chi Square Value (0.05)	22.56
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	18.29
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	27.65	95% Adjusted Gamma UCL (use when n<50)	34.1
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.817	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.252	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.116	Mean of logged Data	2.817
Maximum of Logged Data	3.127	SD of logged Data	0.418
Assuming Lognormal Distribution			
95% H-UCL	32.07	90% Chebyshev (MVUE) UCL	27.89
95% Chebyshev (MVUE) UCL	32.41	97.5% Chebyshev (MVUE) UCL	38.68
99% Chebyshev (MVUE) UCL	51.01		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	22.16	95% Jackknife UCL	23.46
95% Standard Bootstrap UCL	21.83	95% Bootstrap-t UCL	21.74
95% Hall's Bootstrap UCL	20.58	95% Percentile Bootstrap UCL	21.34
95% BCA Bootstrap UCL	20.66		
90% Chebyshev(Mean, Sd) UCL	25.79	95% Chebyshev(Mean, Sd) UCL	29.42
97.5% Chebyshev(Mean, Sd) UCL	34.47	99% Chebyshev(Mean, Sd) UCL	44.38

Suggested UCL to Use

95% Student's-t UCL	23.46

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Pb from sampling location A73 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:09
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	2.6	Mean	11.14
Maximum	33.7	Median	6.3
SD	12.87	Std. Error of Mean	5.756
Coefficient of Variation	1.155	Skewness	2.022

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.73	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.357	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	23.41	95% Adjusted-CLT UCL (Chen-1995)	26.17
		95% Modified-t UCL (Johnson-1978)	24.28
Gamma GOF Test			
A-D Test Statistic	0.419	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.688	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.26	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.363	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.291	k star (bias corrected MLE)	0.65
Theta hat (MLE)	8.628	Theta star (bias corrected MLE)	17.14
nu hat (MLE)	12.91	nu star (bias corrected)	6.498
MLE Mean (bias corrected)	11.14	MLE Sd (bias corrected)	13.82
		Approximate Chi Square Value (0.05)	1.899
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	1.005
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	38.11	95% Adjusted Gamma UCL (use when n<50)	72.03
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.941	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.199	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.956	Mean of logged Data	1.976
Maximum of Logged Data	3.517	SD of logged Data	0.989
Assuming Lognormal Distribution			
95% H-UCL	129.8	90% Chebyshev (MVUE) UCL	23.7
95% Chebyshev (MVUE) UCL	29.71	97.5% Chebyshev (MVUE) UCL	38.06
99% Chebyshev (MVUE) UCL	54.45		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	20.61	95% Jackknife UCL	23.41
95% Standard Bootstrap UCL	19.58	95% Bootstrap-t UCL	66.03
95% Hall's Bootstrap UCL	61.76	95% Percentile Bootstrap UCL	22
95% BCA Bootstrap UCL	22.6		
90% Chebyshev(Mean, Sd) UCL	28.41	95% Chebyshev(Mean, Sd) UCL	36.23
97.5% Chebyshev(Mean, Sd) UCL	47.08	99% Chebyshev(Mean, Sd) UCL	68.41

Suggested UCL to Use

95% Student's-t UCL	23.41

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn in surface water from A73 on the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:09
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	352	Mean	520.6
Maximum	768	Median	426
SD	192.2	Std. Error of Mean	85.93
Coefficient of Variation	0.369	Skewness	0.626

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.839	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.289	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	703.8	95% Adjusted-CLT UCL (Chen-1995)	687.7
		95% Modified-t UCL (Johnson-1978)	707.8
Gamma GOF Test			
A-D Test Statistic	0.503	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.289	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	9.607	k star (bias corrected MLE)	3.976
Theta hat (MLE)	54.19	Theta star (bias corrected MLE)	130.9
nu hat (MLE)	96.07	nu star (bias corrected)	39.76
MLE Mean (bias corrected)	520.6	MLE Sd (bias corrected)	261.1
		Approximate Chi Square Value (0.05)	26.31
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	21.66
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	786.6	95% Adjusted Gamma UCL (use when n<50)	955.8
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.854	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.259	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.864	Mean of logged Data	6.202
Maximum of Logged Data	6.644	SD of logged Data	0.36
Assuming Lognormal Distribution			
95% H-UCL	833.3	90% Chebyshev (MVUE) UCL	769.8
95% Chebyshev (MVUE) UCL	883.1	97.5% Chebyshev (MVUE) UCL	1040
99% Chebyshev (MVUE) UCL	1349		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	661.9	95% Jackknife UCL	703.8
95% Standard Bootstrap UCL	645	95% Bootstrap-t UCL	1256
95% Hall's Bootstrap UCL	2521	95% Percentile Bootstrap UCL	651.6
95% BCA Bootstrap UCL	666.4		
90% Chebyshev(Mean, Sd) UCL	778.4	95% Chebyshev(Mean, Sd) UCL	895.2
97.5% Chebyshev(Mean, Sd) UCL	1057	99% Chebyshev(Mean, Sd) UCL	1376

Suggested UCL to Use

95% Student's-t UCL	703.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cu from sampling location A73B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:23
From File	WorkSheet_c.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	4.3	Mean	9.425
Maximum	13.1	Median	10.15
SD	3.927	Std. Error of Mean	1.964
Coefficient of Variation	0.417	Skewness	-0.797

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.942	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.227	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	14.05	95% Adjusted-CLT UCL (Chen-1995)	11.82
		95% Modified-t UCL (Johnson-1978)	13.92
Gamma GOF Test			
A-D Test Statistic	0.346	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.262	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	6.149	k star (bias corrected MLE)	1.704
Theta hat (MLE)	1.533	Theta star (bias corrected MLE)	5.532
nu hat (MLE)	49.19	nu star (bias corrected)	13.63
MLE Mean (bias corrected)	9.425	MLE Sd (bias corrected)	7.221
		Approximate Chi Square Value (0.05)	6.319
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	20.33	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.889	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.234	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.459	Mean of logged Data	2.16
Maximum of Logged Data	2.573	SD of logged Data	0.502
Assuming Lognormal Distribution			
95% H-UCL	28.53	90% Chebyshev (MVUE) UCL	16.55
95% Chebyshev (MVUE) UCL	19.74	97.5% Chebyshev (MVUE) UCL	24.16
99% Chebyshev (MVUE) UCL	32.85		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	12.65	95% Jackknife UCL	14.05
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	15.32	95% Chebyshev(Mean, Sd) UCL	17.98
97.5% Chebyshev(Mean, Sd) UCL	21.69	99% Chebyshev(Mean, Sd) UCL	28.96

Suggested UCL to Use

95% Student's-t UCL	14.05

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Pb from sampling location A73B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:23
From File	WorkSheet_c.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1.7	Mean	5.45
Maximum	11.7	Median	4.2
SD	4.392	Std. Error of Mean	2.196
Coefficient of Variation	0.806	Skewness	1.428

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.889	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.282	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	10.62	95% Adjusted-CLT UCL (Chen-1995)	10.74
		95% Modified-t UCL (Johnson-1978)	10.88
Gamma GOF Test			
A-D Test Statistic	0.236	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.199	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.216	k star (bias corrected MLE)	0.721
Theta hat (MLE)	2.459	Theta star (bias corrected MLE)	7.562
nu hat (MLE)	17.73	nu star (bias corrected)	5.766
MLE Mean (bias corrected)	5.45	MLE Sd (bias corrected)	6.42
		Approximate Chi Square Value (0.05)	1.521
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	20.66	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.997	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.164	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.531	Mean of logged Data	1.453
Maximum of Logged Data	2.46	SD of logged Data	0.809
Assuming Lognormal Distribution			
95% H-UCL	76.22	90% Chebyshev (MVUE) UCL	11.65
95% Chebyshev (MVUE) UCL	14.48	97.5% Chebyshev (MVUE) UCL	18.41
99% Chebyshev (MVUE) UCL	26.12		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	9.062	95% Jackknife UCL	10.62
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	12.04	95% Chebyshev(Mean, Sd) UCL	15.02
97.5% Chebyshev(Mean, Sd) UCL	19.16	99% Chebyshev(Mean, Sd) UCL	27.3

Suggested UCL to Use

95% Student's-t UCL	10.62

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn from sampling location A73B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:23
From File	WorkSheet_c.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	119	Mean	265.3
Maximum	557	Median	192.5
SD	197.8	Std. Error of Mean	98.89
Coefficient of Variation	0.746	Skewness	1.799

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.792	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.372	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	498	95% Adjusted-CLT UCL (Chen-1995)	523
		95% Modified-t UCL (Johnson-1978)	512.8

Gamma GOF Test

A-D Test Statistic	0.446	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.344	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.996	k star (bias corrected MLE)	0.916
Theta hat (MLE)	88.55	Theta star (bias corrected MLE)	289.7
nu hat (MLE)	23.97	nu star (bias corrected)	7.325
MLE Mean (bias corrected)	265.3	MLE Sd (bias corrected)	277.2
		Approximate Chi Square Value (0.05)	2.35
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	826.6	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.91	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.303	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.779	Mean of logged Data	5.405
Maximum of Logged Data	6.323	SD of logged Data	0.654

Assuming Lognormal Distribution

95% H-UCL	1521	90% Chebyshev (MVUE) UCL	506.8
95% Chebyshev (MVUE) UCL	618.7	97.5% Chebyshev (MVUE) UCL	774
99% Chebyshev (MVUE) UCL	1079		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	427.9	95% Jackknife UCL	498
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	561.9	95% Chebyshev(Mean, Sd) UCL	696.3
97.5% Chebyshev(Mean, Sd) UCL	882.8	99% Chebyshev(Mean, Sd) UCL	1249

Suggested UCL to Use

95% Student's-t UCL	498

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cd from sampling location A75D in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:41
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.51	Mean	1.013
Maximum	1.43	Median	0.924
SD	0.364	Std. Error of Mean	0.163
Coefficient of Variation	0.359	Skewness	-0.285

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.946	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.196	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.36	95% Adjusted-CLT UCL (Chen-1995)	1.258
		95% Modified-t UCL (Johnson-1978)	1.356
Gamma GOF Test			
A-D Test Statistic	0.316	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.213	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	8.461	k star (bias corrected MLE)	3.518
Theta hat (MLE)	0.12	Theta star (bias corrected MLE)	0.288
nu hat (MLE)	84.61	nu star (bias corrected)	35.18
MLE Mean (bias corrected)	1.013	MLE Sd (bias corrected)	0.54
		Approximate Chi Square Value (0.05)	22.61
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	18.33
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.576	95% Adjusted Gamma UCL (use when n<50)	1.943
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.913	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.243	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.673	Mean of logged Data	-0.0475
Maximum of Logged Data	0.358	SD of logged Data	0.405
Assuming Lognormal Distribution			
95% H-UCL	1.776	90% Chebyshev (MVUE) UCL	1.567
95% Chebyshev (MVUE) UCL	1.816	97.5% Chebyshev (MVUE) UCL	2.162
99% Chebyshev (MVUE) UCL	2.841		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1.281	95% Jackknife UCL	1.36
95% Standard Bootstrap UCL	1.255	95% Bootstrap-t UCL	1.437
95% Hall's Bootstrap UCL	1.486	95% Percentile Bootstrap UCL	1.251
95% BCA Bootstrap UCL	1.228		
90% Chebyshev(Mean, Sd) UCL	1.501	95% Chebyshev(Mean, Sd) UCL	1.722
97.5% Chebyshev(Mean, Sd) UCL	2.029	99% Chebyshev(Mean, Sd) UCL	2.632

Suggested UCL to Use

95% Student's-t UCL	1.36

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Cu from sampling location A75D in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:41
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	4.4	Mean	13.8
Maximum	20.6	Median	13.5
SD	6.183	Std. Error of Mean	2.765
Coefficient of Variation	0.448	Skewness	-0.791

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.949	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.223	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	19.7	95% Adjusted-CLT UCL (Chen-1995)	17.3
		95% Modified-t UCL (Johnson-1978)	19.53

Gamma GOF Test

A-D Test Statistic	0.42	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.29	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.36	k star (bias corrected MLE)	1.877
Theta hat (MLE)	3.165	Theta star (bias corrected MLE)	7.352
nu hat (MLE)	43.6	nu star (bias corrected)	18.77
MLE Mean (bias corrected)	13.8	MLE Sd (bias corrected)	10.07
		Approximate Chi Square Value (0.05)	9.951
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	7.311

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	26.03	95% Adjusted Gamma UCL (use when n<50)	35.43

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.838	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.318	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.482	Mean of logged Data	2.506
Maximum of Logged Data	3.025	SD of logged Data	0.607

Assuming Lognormal Distribution

95% H-UCL	40.22	90% Chebyshev (MVUE) UCL	25.5
95% Chebyshev (MVUE) UCL	30.65	97.5% Chebyshev (MVUE) UCL	37.79
99% Chebyshev (MVUE) UCL	51.82		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	18.35	95% Jackknife UCL	19.7
95% Standard Bootstrap UCL	17.84	95% Bootstrap-t UCL	19.07
95% Hall's Bootstrap UCL	18.42	95% Percentile Bootstrap UCL	17.76
95% BCA Bootstrap UCL	17.04		
90% Chebyshev(Mean, Sd) UCL	22.1	95% Chebyshev(Mean, Sd) UCL	25.85
97.5% Chebyshev(Mean, Sd) UCL	31.07	99% Chebyshev(Mean, Sd) UCL	41.31

Suggested UCL to Use

95% Student's-t UCL	19.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Pb from sampling location A75D in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:41
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	1.6	Mean	11.22
Maximum	32.6	Median	5.5
SD	12.44	Std. Error of Mean	5.562
Coefficient of Variation	1.108	Skewness	1.837

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.786	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.301	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	23.08	95% Adjusted-CLT UCL (Chen-1995)	25.25
		95% Modified-t UCL (Johnson-1978)	23.84
Gamma GOF Test			
A-D Test Statistic	0.306	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.689	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.246	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.363	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.196	k star (bias corrected MLE)	0.612
Theta hat (MLE)	9.379	Theta star (bias corrected MLE)	18.34
nu hat (MLE)	11.96	nu star (bias corrected)	6.119
MLE Mean (bias corrected)	11.22	MLE Sd (bias corrected)	14.34
		Approximate Chi Square Value (0.05)	1.701
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	0.875
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	40.36	95% Adjusted Gamma UCL (use when n<50)	78.47
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.975	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.195	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.47	Mean of logged Data	1.945
Maximum of Logged Data	3.484	SD of logged Data	1.108
Assuming Lognormal Distribution			
95% H-UCL	253.8	90% Chebyshev (MVUE) UCL	26.6
95% Chebyshev (MVUE) UCL	33.64	97.5% Chebyshev (MVUE) UCL	43.42
99% Chebyshev (MVUE) UCL	62.64		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	20.37	95% Jackknife UCL	23.08
95% Standard Bootstrap UCL	19.31	95% Bootstrap-t UCL	58.77
95% Hall's Bootstrap UCL	76.93	95% Percentile Bootstrap UCL	20.92
95% BCA Bootstrap UCL	22.9		
90% Chebyshev(Mean, Sd) UCL	27.9	95% Chebyshev(Mean, Sd) UCL	35.46
97.5% Chebyshev(Mean, Sd) UCL	45.95	99% Chebyshev(Mean, Sd) UCL	66.56

Suggested UCL to Use

95% Student's-t UCL	23.08

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn from sampling location A75D in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:41
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	181	Mean	360.6
Maximum	545	Median	306
SD	149.6	Std. Error of Mean	66.89
Coefficient of Variation	0.415	Skewness	0.22

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.933	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.242	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	503.2	95% Adjusted-CLT UCL (Chen-1995)	477.7
		95% Modified-t UCL (Johnson-1978)	504.3
Gamma GOF Test			
A-D Test Statistic	0.292	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.224	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	6.865	k star (bias corrected MLE)	2.879
Theta hat (MLE)	52.53	Theta star (bias corrected MLE)	125.2
nu hat (MLE)	68.65	nu star (bias corrected)	28.79
MLE Mean (bias corrected)	360.6	MLE Sd (bias corrected)	212.5
		Approximate Chi Square Value (0.05)	17.55
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	13.85
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	591.7	95% Adjusted Gamma UCL (use when n<50)	749.5
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.941	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.197	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.198	Mean of logged Data	5.813
Maximum of Logged Data	6.301	SD of logged Data	0.442
Assuming Lognormal Distribution			
95% H-UCL	680.2	90% Chebyshev (MVUE) UCL	574.3
95% Chebyshev (MVUE) UCL	670.7	97.5% Chebyshev (MVUE) UCL	804.4
99% Chebyshev (MVUE) UCL	1067		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	470.6	95% Jackknife UCL	503.2
95% Standard Bootstrap UCL	458.1	95% Bootstrap-t UCL	607.3
95% Hall's Bootstrap UCL	828.2	95% Percentile Bootstrap UCL	459.8
95% BCA Bootstrap UCL	449.4		
90% Chebyshev(Mean, Sd) UCL	561.3	95% Chebyshev(Mean, Sd) UCL	652.2
97.5% Chebyshev(Mean, Sd) UCL	778.3	99% Chebyshev(Mean, Sd) UCL	1026

Suggested UCL to Use

95% Student's-t UCL	503.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cd from sampling location A75B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:47
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	0.51	Mean	0.877
Maximum	1.1	Median	0.948
SD	0.258	Std. Error of Mean	0.129
Coefficient of Variation	0.295	Skewness	-1.402

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.895	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.28	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.18	95% Adjusted-CLT UCL (Chen-1995)	0.992
		95% Modified-t UCL (Johnson-1978)	1.165
Gamma GOF Test			
A-D Test Statistic	0.455	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.318	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	12.62	k star (bias corrected MLE)	3.322
Theta hat (MLE)	0.0695	Theta star (bias corrected MLE)	0.264
nu hat (MLE)	101	nu star (bias corrected)	26.57
MLE Mean (bias corrected)	0.877	MLE Sd (bias corrected)	0.481
		Approximate Chi Square Value (0.05)	15.82
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.472	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.839	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.322	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.673	Mean of logged Data	-0.172
Maximum of Logged Data	0.0953	SD of logged Data	0.345
Assuming Lognormal Distribution			
95% H-UCL	1.605	90% Chebyshev (MVUE) UCL	1.331
95% Chebyshev (MVUE) UCL	1.535	97.5% Chebyshev (MVUE) UCL	1.819
99% Chebyshev (MVUE) UCL	2.375		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1.089	95% Jackknife UCL	1.18
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1.264	95% Chebyshev(Mean, Sd) UCL	1.439
97.5% Chebyshev(Mean, Sd) UCL	1.683	99% Chebyshev(Mean, Sd) UCL	2.161

Suggested UCL to Use

95% Student's-t UCL	1.18

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Cu from sampling location A75B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:47
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	4.1	Mean	12.18
Maximum	21.5	Median	11.55
SD	8.824	Std. Error of Mean	4.412
Coefficient of Variation	0.725	Skewness	0.129

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.85	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.285	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	22.56	95% Adjusted-CLT UCL (Chen-1995)	19.74
		95% Modified-t UCL (Johnson-1978)	22.61
Gamma GOF Test			
A-D Test Statistic	0.484	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.305	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.182	k star (bias corrected MLE)	0.712
Theta hat (MLE)	5.579	Theta star (bias corrected MLE)	17.09
nu hat (MLE)	17.46	nu star (bias corrected)	5.698
MLE Mean (bias corrected)	12.18	MLE Sd (bias corrected)	14.43
		Approximate Chi Square Value (0.05)	1.488
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	46.63	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.848	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.273	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.411	Mean of logged Data	2.253
Maximum of Logged Data	3.068	SD of logged Data	0.844
Assuming Lognormal Distribution			
95% H-UCL	217.4	90% Chebyshev (MVUE) UCL	27.01
95% Chebyshev (MVUE) UCL	33.68	97.5% Chebyshev (MVUE) UCL	42.95
99% Chebyshev (MVUE) UCL	61.15		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	19.43	95% Jackknife UCL	22.56
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	25.41	95% Chebyshev(Mean, Sd) UCL	31.41
97.5% Chebyshev(Mean, Sd) UCL	39.73	99% Chebyshev(Mean, Sd) UCL	56.07

Suggested UCL to Use

95% Student's-t UCL	22.56

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Pb from sampling location A75B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:47
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1.5	Mean	12.13
Maximum	34.5	Median	6.25
SD	15.46	Std. Error of Mean	7.73
Coefficient of Variation	1.275	Skewness	1.622

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.808	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.294	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	30.32	95% Adjusted-CLT UCL (Chen-1995)	31.54
		95% Modified-t UCL (Johnson-1978)	31.36
Gamma GOF Test			
A-D Test Statistic	0.354	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.67	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.293	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.404	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0.804	k star (bias corrected MLE)	0.368
Theta hat (MLE)	15.08	Theta star (bias corrected MLE)	32.98
nu hat (MLE)	6.432	nu star (bias corrected)	2.941
MLE Mean (bias corrected)	12.13	MLE Sd (bias corrected)	20
		Approximate Chi Square Value (0.05)	0.355
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	100.4	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.92	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.257	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.405	Mean of logged Data	1.758
Maximum of Logged Data	3.541	SD of logged Data	1.458
Assuming Lognormal Distribution			
95% H-UCL	54710	90% Chebyshev (MVUE) UCL	33.59
95% Chebyshev (MVUE) UCL	43.52	97.5% Chebyshev (MVUE) UCL	57.3
99% Chebyshev (MVUE) UCL	84.37		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	24.84	95% Jackknife UCL	30.32
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	35.31	95% Chebyshev(Mean, Sd) UCL	45.82
97.5% Chebyshev(Mean, Sd) UCL	60.4	99% Chebyshev(Mean, Sd) UCL	89.04

Suggested UCL to Use

95% Student's-t UCL	30.32

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn from sampling location A75B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:47
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	183	Mean	301.8
Maximum	445	Median	289.5
SD	108	Std. Error of Mean	54.01
Coefficient of Variation	0.358	Skewness	0.665

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.949	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.271	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	428.9	95% Adjusted-CLT UCL (Chen-1995)	409.8
		95% Modified-t UCL (Johnson-1978)	431.9
Gamma GOF Test			
A-D Test Statistic	0.281	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.233	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	10.42	k star (bias corrected MLE)	2.771
Theta hat (MLE)	28.96	Theta star (bias corrected MLE)	108.9
nu hat (MLE)	83.35	nu star (bias corrected)	22.17
MLE Mean (bias corrected)	301.8	MLE Sd (bias corrected)	181.3
		Approximate Chi Square Value (0.05)	12.47
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	536.6	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.965	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.233	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.209	Mean of logged Data	5.661
Maximum of Logged Data	6.098	SD of logged Data	0.363
Assuming Lognormal Distribution			
95% H-UCL	578.3	90% Chebyshev (MVUE) UCL	464.7
95% Chebyshev (MVUE) UCL	538.5	97.5% Chebyshev (MVUE) UCL	640.9
99% Chebyshev (MVUE) UCL	842		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	390.6	95% Jackknife UCL	428.9
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	463.8	95% Chebyshev(Mean, Sd) UCL	537.2
97.5% Chebyshev(Mean, Sd) UCL	639.1	99% Chebyshev(Mean, Sd) UCL	839.2

Suggested UCL to Use

95% Student's-t UCL	428.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cd from Baker Bridge on the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:55
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	1
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	0.601	Minimum Non-Detect	0.5
Maximum Detect	0.8	Maximum Non-Detect	0.5
Variance Detects	0.00663	Percent Non-Detects	20%
Mean Detects	0.698	SD Detects	0.0814
Median Detects	0.695	CV Detects	0.117
Skewness Detects	0.219	Kurtosis Detects	1.436
Mean of Logged Detects	-0.365	SD of Logged Detects	0.117

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.965	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.238	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	95% UCLs (Adjusted for Skewness)	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.658	Standard Error of Mean	0.0522
SD	0.101	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.769	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.744	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.815	95% KM Chebyshev UCL	0.886
97.5% KM Chebyshev UCL	0.984	99% KM Chebyshev UCL	1.177

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.275	Anderson-Darling GOF Test
5% A-D Critical Value	0.656	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.222	Kolmogrov-Smirnoff GOF
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	97.81	k star (bias corrected MLE)	24.62
Theta hat (MLE)	0.00713	Theta star (bias corrected MLE)	0.0283
nu hat (MLE)	782.5	nu star (bias corrected)	197
MLE Mean (bias corrected)	0.698	MLE Sd (bias corrected)	0.141

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	42.36	nu hat (KM)	423.6
Approximate Chi Square Value (423.63, α)	376.9	Adjusted Chi Square Value (423.63, β)	357.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.74	95% Gamma Adjusted KM-UCL (use when n<50)	0.78

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.494	Mean	0.657
Maximum	0.8	Median	0.689
SD	0.115	CV	0.175
k hat (MLE)	38.64	k star (bias corrected MLE)	15.59
Theta hat (MLE)	0.017	Theta star (bias corrected MLE)	0.0421
nu hat (MLE)	386.4	nu star (bias corrected)	155.9
MLE Mean (bias corrected)	0.657	MLE Sd (bias corrected)	0.166
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (155.89, α)	128	Adjusted Chi Square Value (155.89, β)	117
95% Gamma Approximate UCL (use when n>=50)	0.8	95% Gamma Adjusted UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.967	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.226	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.66	Mean in Log Scale	-0.427
SD in Original Scale	0.109	SD in Log Scale	0.171
95% t UCL (assumes normality of ROS data)	0.764	95% Percentile Bootstrap UCL	0.736
95% BCA Bootstrap UCL	0.72	95% Bootstrap t UCL	0.765
95% H-UCL (Log ROS)	0.795		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-0.431	95% H-UCL (KM -Log)	0.78
KM SD (logged)	0.159	95% Critical H Value (KM-Log)	2.127
KM Standard Error of Mean (logged)	0.0823		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.608	Mean in Log Scale	-0.57
SD in Original Scale	0.212	SD in Log Scale	0.468
95% t UCL (Assumes normality)	0.81	95% H-Stat UCL	1.228

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.769	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Cu from Baker Bridge on the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:55
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	1
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	2.8	Minimum Non-Detect	2.5
Maximum Detect	16.3	Maximum Non-Detect	2.5
Variance Detects	31.98	Percent Non-Detects	20%
Mean Detects	9.5	SD Detects	5.655
Median Detects	9.45	CV Detects	0.595
Skewness Detects	0.0477	Kurtosis Detects	0.0745
Mean of Logged Detects	2.071	SD of Logged Detects	0.755

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	N/A	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.145	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	95% UCLs (Adjusted for Skewness)	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	8.1	Standard Error of Mean	2.685
SD	5.199	95% KM (BCA) UCL	N/A
95% KM (t) UCL	13.82	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	12.52	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	16.15	95% KM Chebyshev UCL	19.8
97.5% KM Chebyshev UCL	24.87	99% KM Chebyshev UCL	34.81

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.244	Anderson-Darling GOF Test
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.207	Kolmogrov-Smirnoff GOF
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.935	k star (bias corrected MLE)	0.9
Theta hat (MLE)	3.236	Theta star (bias corrected MLE)	10.55
nu hat (MLE)	23.48	nu star (bias corrected)	7.204
MLE Mean (bias corrected)	9.5	MLE Sd (bias corrected)	10.01

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	2.427	nu hat (KM)	24.27
Approximate Chi Square Value (24.27, α)	14.06	Adjusted Chi Square Value (24.27, β)	10.81
95% Gamma Approximate KM-UCL (use when n>=50)	13.99	95% Gamma Adjusted KM-UCL (use when n<50)	18.18

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	7.602
Maximum	16.3	Median	7.9
SD	6.481	CV	0.852
k hat (MLE)	0.493	k star (bias corrected MLE)	0.33
Theta hat (MLE)	15.43	Theta star (bias corrected MLE)	23.01
nu hat (MLE)	4.926	nu star (bias corrected)	3.304
MLE Mean (bias corrected)	7.602	MLE Sd (bias corrected)	13.23
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (3.30, α)	0.468	Adjusted Chi Square Value (3.30, β)	0.178
95% Gamma Approximate UCL (use when n>=50)	53.68	95% Gamma Adjusted UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.937	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.248	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.829	Mean in Log Scale	1.684
SD in Original Scale	6.161	SD in Log Scale	1.086
95% t UCL (assumes normality of ROS data)	13.7	95% Percentile Bootstrap UCL	11.88
95% BCA Bootstrap UCL	11.92	95% Bootstrap t UCL	14.32
95% H-UCL (Log ROS)	170.3		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	1.84	95% H-UCL (KM -Log)	34.78
KM SD (logged)	0.745	95% Critical H Value (KM-Log)	3.84
KM Standard Error of Mean (logged)	0.385		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	7.85	Mean in Log Scale	1.702
SD in Original Scale	6.132	SD in Log Scale	1.054
95% t UCL (Assumes normality)	13.7	95% H-Stat UCL	143.2

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	13.82	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Pb from Baker Bridge on the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:55
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.6	Mean	7.78
Maximum	26	Median	5.4
SD	10.45	Std. Error of Mean	4.673
Coefficient of Variation	1.343	Skewness	1.961

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.739	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.379	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	17.74	95% Adjusted-CLT UCL (Chen-1995)	19.85
		95% Modified-t UCL (Johnson-1978)	18.43
Gamma GOF Test			
A-D Test Statistic	0.331	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.247	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.367	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0.765	k star (bias corrected MLE)	0.439
Theta hat (MLE)	10.17	Theta star (bias corrected MLE)	17.71
nu hat (MLE)	7.652	nu star (bias corrected)	4.394
MLE Mean (bias corrected)	7.78	MLE Sd (bias corrected)	11.74
		Approximate Chi Square Value (0.05)	0.883
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	0.382
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	38.7	95% Adjusted Gamma UCL (use when n<50)	89.41
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.954	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.211	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.511	Mean of logged Data	1.271
Maximum of Logged Data	3.258	SD of logged Data	1.475
Assuming Lognormal Distribution			
95% H-UCL	1856	90% Chebyshev (MVUE) UCL	21.5
95% Chebyshev (MVUE) UCL	27.75	97.5% Chebyshev (MVUE) UCL	36.42
99% Chebyshev (MVUE) UCL	53.45		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	15.47	95% Jackknife UCL	17.74
95% Standard Bootstrap UCL	14.71	95% Bootstrap-t UCL	36.7
95% Hall's Bootstrap UCL	53.89	95% Percentile Bootstrap UCL	16.08
95% BCA Bootstrap UCL	17.76		
90% Chebyshev(Mean, Sd) UCL	21.8	95% Chebyshev(Mean, Sd) UCL	28.15
97.5% Chebyshev(Mean, Sd) UCL	36.97	99% Chebyshev(Mean, Sd) UCL	54.28

Suggested UCL to Use

95% Student's-t UCL	17.74

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn from Baker Bridge on the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:55
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	126	Mean	215.8
Maximum	273	Median	221
SD	59.41	Std. Error of Mean	26.57
Coefficient of Variation	0.275	Skewness	-0.862

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.926	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.191	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	272.4	95% Adjusted-CLT UCL (Chen-1995)	248.6
		95% Modified-t UCL (Johnson-1978)	270.7
Gamma GOF Test			
A-D Test Statistic	0.35	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.208	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	14.14	k star (bias corrected MLE)	5.789
Theta hat (MLE)	15.26	Theta star (bias corrected MLE)	37.28
nu hat (MLE)	141.4	nu star (bias corrected)	57.89
MLE Mean (bias corrected)	215.8	MLE Sd (bias corrected)	89.69
		Approximate Chi Square Value (0.05)	41.4
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	35.39
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	301.8	95% Adjusted Gamma UCL (use when n<50)	353
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.884	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.217	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.836	Mean of logged Data	5.339
Maximum of Logged Data	5.609	SD of logged Data	0.312
Assuming Lognormal Distribution			
95% H-UCL	319.5	90% Chebyshev (MVUE) UCL	306.8
95% Chebyshev (MVUE) UCL	347.7	97.5% Chebyshev (MVUE) UCL	404.5
99% Chebyshev (MVUE) UCL	516.1		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	259.5	95% Jackknife UCL	272.4
95% Standard Bootstrap UCL	254.5	95% Bootstrap-t UCL	262.4
95% Hall's Bootstrap UCL	256.4	95% Percentile Bootstrap UCL	252.2
95% BCA Bootstrap UCL	245.2		
90% Chebyshev(Mean, Sd) UCL	295.5	95% Chebyshev(Mean, Sd) UCL	331.6
97.5% Chebyshev(Mean, Sd) UCL	381.7	99% Chebyshev(Mean, Sd) UCL	480.2

Suggested UCL to Use

95% Student's-t UCL	272.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Appendix 14

ProUCL calculations to derive sediment EPCs for benthic invertebrates and for use in wildlife food chain modeling

Sediment data for Pro UCL

Sample Location		Arsenic		Beryllium		Cadmium		Copper		Lead		Manganese		Mercury		Selenium		Silver		Zinc		Cr		Ni		
Animas River above mainstem cement creek																										
A60		24.4	1	2.01	0	14.7	1	286	1	2100	1	12600	1			0.502	0	4.05	1	3180	1	4.97	1	8.95	1	May-12
A61		44.0	1.0	2.53	1	11.3	1	466	1	2120	1	11000	1			0.505	0	7.34	1	2840	1	5.69	1	16.5	1	Oct-12
A64		44.2	1	2.77	1	11.9	1	336	1	1770	1	9670	1			0.905	1	7.14	1	3470	1	4.86	1	7.58	1	May-13
A65		30.3	1	2.02	0	10.3	1	328	1	1840	1	12900	1			0.504	0	5.53	1	2590	1	4.71	1	7.19	1	
A66		26.9	1	1.99	0	8.44	1	257	1	1750	1	7830	1			0.497	0	5.06	1	1950	1	4.42	1	7.2	1	
A68		26.3	1	2.01	0	13.7	1	352	1	2180	1	10300	1			0.501	0	9.22	1	2830	1	4.76	1	6.68	1	
A68		25.9	1	2.01	0	13.4	1	374	1	1890	1	12200	1	0.081	D	1.29	1	7.09	1	3030	1	5.68	1	5.92	1	
A68		89.5	1	6.77	1	24.2	1	745	1	3030	1	22300	1	0.19	D	2.86	1	13.3	1	11500	1	5.21	1	8.76	1	
A60		16.4	1	2.01	0	5.84	1	166	1	554	1	3400	1	0.033	D	1.0	0	3.48	1	1530	1	6.35	1	9.62	1	Apr-14
A61		19.8	1	2.99	1	9.02	1	638	1	891	1	6400	1	0.091	D	1.1	1	4.28	1	2530	1	5.28	1	8.56	1	
A64		18.8	1	2.02	0	6.25	1	199	1	1050	1	4920	1	0.053	D	1.01	0	3.59	1	1950	1	5.15	1	7.44	1	
A65		21.8	1	2.16	1	10.2	1	331	1	900	1	10300	1	0.073	D	1.01	0	3.87	1	2890	1	5.49	1	9.9	1	
A66		18.3	1	2.24	1	18.3	1	378	1	1230	1	20500	1	0.06	D	1.0	0	4.13	1	4380	1	4.07	1	10.1	1	
A68		19.1	1	2.82	1	15.7	1	390	1	1080	1	19700	1	0.056	D	0.998	0	4.35	1	4890	1	4.21	1	10.3	1	
A60		20.4	1	2.03	0	9.55	1	262	1	1610	1	7460	1	0.07	D	1.02	0	5.96	1	2130	1	3.88	1	6.26	1	Sep-14
A61		20.5	1	2.1	1	4.95	1	286	1	1400	1	8210	1	0.05	D	0.995	0	5.23	1	2330	1	3.55	1	6.52	1	
A64		21.3	1	3.0	1	7.93	1	264	1	1120	1	6850	1	0.13	D	1.01	0	4.88	1	2730	1	3.55	1	6.84	1	
A65		19.4	1	1.99	0	6.82	1	271	1	1220	1	8180	1	0.03	D	0.997	0	3.61	1	1700	1	3.76	1	6.49	1	
A66		23.7	1	2.03	0	9.17	1	243	1	1190	1	8190	1	0.05	D	1.01	0	4.81	1	2500	1	3.7	1	7.11	1	
A68		17.5	1	1.97	0	10.8	1	216	1	1240	1	9430	1	0.02	JD	0.985	0	2.9	1	2480	1	3.73	1	6.56	1	
	count	20		20		20		20		20		20		14		20		20		20						
	Max	89.5	1	6.77	1	24.2	1	745	1	3030	1	22300	1	0.19	0	2.86	1	13.3	1	11500						
	Min	16.4	1	1.97	0	4.95	1	166	1	554	1	3400	1	0.02	0	0.497	0	2.9	1	1530						

		aluminum		arsenic		beryllium		cadmium		copper		lead		manganese		nickel		selenium		silver		Zinc		Hg		Cr	
Animas River downstream of mainstem Mineral Creek																											
A72	May-12	12200	1	40.6	1	1.97	0	2.8	1	152	1	581	1	2710	1	6.38	1	2.03	1	1.99	1	748	1	0.072	1	6.1	1
A72	Oct-12	21500	1	36.3	1	2	0	1.81	1	179	1	542	1	1470	1	4.79	1	1.83	1	2.76	1	646	1	0.06	1	4.05	1
A72	May-13	11800	1	26.1	1	1.97	0	1.15	1	77.8	1	299	1	1210	1	4.88	1	1.04	1	1.3	1	386	1			6.41	1
A72	Apr-14	18900	1	37	1	2.0	0	1.7	1	145	1	470	1	1710	1	4.33	1	1.05	1	1.68	1	616	1	0.039	1	3.45	1
A72	Sep-14	9960	1	26.8	1	2.03	0	3.03	1	133	1	499	1	3400	1	5.33	1	1.02	0	1.83	1	858	1	0.05	1	3.01	1
A73	Oct-12	11800	1	25.5	1	1.97	0	3.64	1	223	1	729	1	4140	1	6.84	1	1.43	1	2.32	1	1000	1	0.05	1	4.02	1
A73	May-13	9220	1	31.9	1	2.02	0	4.1	1	176	1	591	1	3320	1	6.07	1	0.717	1	2.78	1	998	1	0.036	1	5.6	1
A73	Apr-14	40700	1	33.8	1	4.2	1	5.6	1	284	1	297	1	7120	1	7.19	1	1.0	0	1.35	1	1450	1			2.83	1
A73	Sep-14	6770	1	20.5	1	2.04	0	2.7	1	113		435	1	2780	1	5.5	1	1.02	0	1.24	1	749	1	0.02	1	3.5	1
A73B	Oct-12	31900	1	39.4	1	3.24	1	4.24	1	292	1	468	1	2610	1	12.1	1	2.89	1	3.09	1	1720	1	0.09	1	5.02	1
A73B	May-13	10600	1	30.4	1	2	0	3.56	1	140	1	593	1	4340	1	9.78	1	0.5	0	1.65	1	964	1			4.72	1
A73B	Sep-14	6620	1	19.9	1	2.03	0	2.72	1	98.8	1	540	1	2480	1	8.16	1	1.01	0	1.25	1	659	1	0.04	1	3.68	1
A75B	Oct-12	48600	1	37.2	1	5.98	1	10.5	1	413	1	435	1	3820	1	16.5	1	3.26	1	2.18	1	5320	1	0.07	1	5.16	1
A75B	May-13	7220	1	13.3	1	1.99	0	2.65	1	82.7	1	354	1	2340	1	5.93	1	0.588	1	1.51	1	672	1			5.45	1
A75B	Sep-14	6640	1	9.22	1	1.99	0	1.99	1	67	1	98	1	2070	1	6.71	1	0.994	0	0.512	1	578	1	0.01	0	5.01	1
A75D	Oct-12	15600	1	13.2	1	1.97	0	4.87	1	152	1	231	1	3010	1	9.09	1	1.4	1	0.724	1	1930	1	0.04	1	3.73	1
A75D	May-13	8550	1	18.2	1	1.99	0	3.88	1	108	1	367	1	3730	1	7.27	1	0.498	0	1.37	1	1030	1	0.038	1	4.99	1
A75D	Apr-14	29900	1	28.5	1	3.66	1	6.75	1	223	1	261	1	6900	1	13.1	1	1.06	1	1.27	1	2910	1			4.39	1
A75D	Sep-14	7660	1	17.5	1	2.03	0	3.73	1	103	1	339	1	3750	1	8.2	1	1.02	0	0.948	1	1080	1	0.02	0	3.72	1
Bakers Bridge	Oct-12	37400	1	29.7	1	4.85	1	18.6	1	357	1	378	1	10500	1	31.6	1	3.1	1	1.71	1	8670	1	0.06	1	5.21	1
Bakers Bridge	May-13	7360	1	15.9	1	1.98	0	2.46	1	116	1	328	1	2130	1	7.36	1	0.496	0	1.08	1	2080	1			7.38	1
Bakers Bridge	Apr-14	27300	1	25.9	1	3.51	1	14.6	1	199	1	248	1	13100	1	22	1	1.16	1	1.33	1	6030	1	0.043	1	4.28	1
Bakers Bridge	Sep-14	8040	1	16.2	1	1.99	0	4.63	1	92	1	244	1	3970	1	12.1	1	0.997	0	1.02	1	1700	1	0.02	1	4.74	1

shaded = ND

ProUCL calculations for As in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 10:36
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	16.4	Mean	27.43
Maximum	89.5	Median	21.55
SD	16.51	Std. Error of Mean	3.692
Coefficient of Variation	0.602	Skewness	3.144

Normal GOF Test

Shapiro Wilk Test Statistic	0.593	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.313	Lilliefors GOF Test
5% Lilliefors Critical Value	0.198	Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level		

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	33.81	95% Adjusted-CLT UCL (Chen-1995)	36.27
		95% Modified-t UCL (Johnson-1978)	34.24

Gamma GOF Test

A-D Test Statistic	1.88	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.259	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.194	Data Not Gamma Distributed at 5% Significance Level
Data Not Gamma Distributed at 5% Significance Level		

Gamma Statistics

k hat (MLE)	5.168	k star (bias corrected MLE)	4.426
Theta hat (MLE)	5.307	Theta star (bias corrected MLE)	6.197
nu hat (MLE)	206.7	nu star (bias corrected)	177
MLE Mean (bias corrected)	27.43	MLE Sd (bias corrected)	13.04
		Approximate Chi Square Value (0.05)	147.3
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	145.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	32.97	95% Adjusted Gamma UCL (use when n<50)	33.46

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.79	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.905	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.221	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.198	Data Not Lognormal at 5% Significance Level
Data Not Lognormal at 5% Significance Level		

Lognormal Statistics

Minimum of Logged Data	2.797	Mean of logged Data	3.212
Maximum of Logged Data	4.494	SD of logged Data	0.405

Assuming Lognormal Distribution

95% H-UCL	32.25	90% Chebyshev (MVUE) UCL	34.29
95% Chebyshev (MVUE) UCL	37.68	97.5% Chebyshev (MVUE) UCL	42.38
99% Chebyshev (MVUE) UCL	51.6		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	33.5	95% Jackknife UCL	33.81
95% Standard Bootstrap UCL	33.45	95% Bootstrap-t UCL	42.98
95% Hall's Bootstrap UCL	53.96	95% Percentile Bootstrap UCL	33.73
95% BCA Bootstrap UCL	37.12		
90% Chebyshev(Mean, Sd) UCL	38.5	95% Chebyshev(Mean, Sd) UCL	43.52
97.5% Chebyshev(Mean, Sd) UCL	50.48	99% Chebyshev(Mean, Sd) UCL	64.16

Suggested UCL to Use

95% Student's-t UCL	33.81	or 95% Modified-t UCL	34.24

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Be in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 10:42
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operation	2000

General Statistics

Total Number of Observations	20	Number of Distinct Observations	14
Number of Detects	9	Number of Non-Detects	11
Number of Distinct Detects	9	Number of Distinct Non-Detects	5
Minimum Detect	2.1	Minimum Non-Detect	1.97
Maximum Detect	6.77	Maximum Non-Detect	2.03
Variance Detects	2.075	Percent Non-Detects	55%
Mean Detects	3.042	SD Detects	1.44
Median Detects	2.77	CV Detects	0.473
Skewness Detects	2.668	Kurtosis Detects	7.565
Mean of Logged Detects	1.045	SD of Logged Detects	0.353

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.616	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.401	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.295	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	2.453	Standard Error of Mean	0.25
SD	1.056	95% KM (BCA) UCL	2.95
95% KM (t) UCL	2.885	95% KM (Percentile Bootstrap) UCL	2.9
95% KM (z) UCL	2.864	95% KM Bootstrap t UCL	3.482
90% KM Chebyshev UCL	3.204	95% KM Chebyshev UCL	3.544
97.5% KM Chebyshev UCL	4.016	99% KM Chebyshev UCL	4.944

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.129	Anderson-Darling GOF Test	
5% A-D Critical Value	0.722	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.356	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.28	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.606	k star (bias corrected MLE)	5.145
Theta hat (MLE)	0.4	Theta star (bias corrected MLE)	0.591
nu hat (MLE)	136.9	nu star (bias corrected)	92.61
MLE Mean (bias corrected)	3.042	MLE Sd (bias corrected)	1.341

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	5.398	nu hat (KM)	215.9
Approximate Chi Square Value (215.90, α)	182.9	Adjusted Chi Square Value (215.90, β)	180.5
95% Gamma Approximate KM-UCL (use when n>=50	2.895	95% Gamma Adjusted KM-UCL (use when n<50)	2.934

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.492
Maximum	6.77	Median	0.625
SD	1.727	CV	1.158
k hat (MLE)	0.43	k star (bias corrected MLE)	0.399
Theta hat (MLE)	3.466	Theta star (bias corrected MLE)	3.738
nu hat (MLE)	17.22	nu star (bias corrected)	15.97
MLE Mean (bias corrected)	1.492	MLE Sd (bias corrected)	2.361
		Adjusted Level of Significance (β)	0.038
Approximate Chi Square Value (15.97, α)	7.939	Adjusted Chi Square Value (15.97, β)	7.493
95% Gamma Approximate UCL (use when n>=50)	3.001	95% Gamma Adjusted UCL (use when n<50)	3.179

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.748	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.329	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.295	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.979	Mean in Log Scale	0.515
SD in Original Scale	1.37	SD in Log Scale	0.566
95% t UCL (assumes normality of ROS data)	2.508	95% Percentile Bootstrap UCL	2.502
95% BCA Bootstrap UCL	2.657	95% Bootstrap t UCL	2.861
95% H-UCL (Log ROS)	2.575		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.921	Mean in Log Scale	0.473
SD in Original Scale	1.398	SD in Log Scale	0.579
95% t UCL (Assumes normality)	2.462	95% H-Stat UCL	2.507

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	2.885	95% KM (% Bootstrap) UCL	2.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Cd in sediment of the Animas River above mainstem Cement Creek

User Selected Options		
Date/Time of Computation		2/18/2015 10:50
From File	WorkSheet.xls	
Full Precision	OFF	
Confidence Coefficient	95%	
Number of Bootstrap Operations	2000	

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	4.95	Mean	11.12
Maximum	24.2	Median	10.25
SD	4.627	Std. Error of Mean	1.035
Coefficient of Variation	0.416	Skewness	1.254

Normal GOF Test

Shapiro Wilk Test Statistic	0.917	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.135	Lilliefors GOF Test
5% Lilliefors Critical Value	0.198	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	12.91	95% Adjusted-CLT UCL (Chen-1995)	13.14
		95% Modified-t UCL (Johnson-1978)	12.96

Gamma GOF Test

A-D Test Statistic	0.156	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0828	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.194	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.801	k star (bias corrected MLE)	5.814
Theta hat (MLE)	1.635	Theta star (bias corrected MLE)	1.913
nu hat (MLE)	272.1	nu star (bias corrected)	232.6
MLE Mean (bias corrected)	11.12	MLE Sd (bias corrected)	4.613
		Approximate Chi Square Value (0.05)	198.3
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	195.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	13.05	95% Adjusted Gamma UCL (use when n<50)	13.21

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.992	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.067	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.599	Mean of logged Data	2.334
Maximum of Logged Data	3.186	SD of logged Data	0.395

Assuming Lognormal Distribution

95% H-UCL	13.28	90% Chebyshev (MVUE) UCL	14.12
95% Chebyshev (MVUE) UCL	15.49	97.5% Chebyshev (MVUE) UCL	17.39
99% Chebyshev (MVUE) UCL	21.11		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	12.83	95% Jackknife UCL	12.91
95% Standard Bootstrap UCL	12.84	95% Bootstrap-t UCL	13.35
95% Hall's Bootstrap UCL	13.78	95% Percentile Bootstrap UCL	12.89
95% BCA Bootstrap UCL	13.13		
90% Chebyshev(Mean, Sd) UCL	14.23	95% Chebyshev(Mean, Sd) UCL	15.63
97.5% Chebyshev(Mean, Sd) UCL	17.58	99% Chebyshev(Mean, Sd) UCL	21.42

Suggested UCL to Use

95% Student's-t UCL	12.91

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River above mainstem Cement Creek

User Selected Options		
Date/Time of Computation		2/18/2015 10:56
From File	WorkSheet.xls	
Full Precision	OFF	
Confidence Coefficient	95%	
Number of Bootstrap Operations	2000	

Cu

General Statistics

Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	166	Mean	339.4
Maximum	745	Median	307
SD	141.1	Std. Error of Mean	31.56
Coefficient of Variation	0.416	Skewness	1.722

Normal GOF Test			
Shapiro Wilk Test Statistic	0.832	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.21	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	394	95% Adjusted-CLT UCL (Chen-1995)	404.3
		95% Modified-t UCL (Johnson-1978)	396

Gamma GOF Test			
A-D Test Statistic	0.578	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.154	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.194	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics			
k hat (MLE)	7.596	k star (bias corrected MLE)	6.49
Theta hat (MLE)	44.68	Theta star (bias corrected MLE)	52.3
nu hat (MLE)	303.8	nu star (bias corrected)	259.6
MLE Mean (bias corrected)	339.4	MLE Sd (bias corrected)	133.2
		Approximate Chi Square Value (0.05)	223.3
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	220.6

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50)	394.6	95% Adjusted Gamma UCL (use when n<50)	399.3

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.956	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.135	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics			
Minimum of Logged Data	5.112	Mean of logged Data	5.76
Maximum of Logged Data	6.613	SD of logged Data	0.363

Assuming Lognormal Distribution			
95% H-UCL	396.9	90% Chebyshev (MVUE) UCL	421.5
95% Chebyshev (MVUE) UCL	459.5	97.5% Chebyshev (MVUE) UCL	512.2
99% Chebyshev (MVUE) UCL	615.7		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	391.3	95% Jackknife UCL	394
95% Standard Bootstrap UCL	389.5	95% Bootstrap-t UCL	422
95% Hall's Bootstrap UCL	516.4	95% Percentile Bootstrap UCL	392.5
95% BCA Bootstrap UCL	398.8		
90% Chebyshev(Mean, Sd) UCL	434.1	95% Chebyshev(Mean, Sd) UCL	477
97.5% Chebyshev(Mean, Sd) UCL	536.5	99% Chebyshev(Mean, Sd) UCL	653.4

Suggested UCL to Use

95% Adjusted Gamma UCL	399.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cr in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/23/2015 8:37
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	3.55	Mean	4.651
Maximum	6.35	Median	4.735
SD	0.827	Std. Error of Mean	0.185
Coefficient of Variation	0.178	Skewness	0.261

Normal GOF Test

Shapiro Wilk Test Statistic	0.945	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.124	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4.971	95% Adjusted-CLT UCL (Chen-1995)	4.967
		95% Modified-t UCL (Johnson-1978)	4.973

Gamma GOF Test

A-D Test Statistic	0.422	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.131	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.193	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	33.44	k star (bias corrected MLE)	28.45
Theta hat (MLE)	0.139	Theta star (bias corrected MLE)	0.163
nu hat (MLE)	1337	nu star (bias corrected)	1138
MLE Mean (bias corrected)	4.651	MLE Sd (bias corrected)	0.872
		Approximate Chi Square Value (0.05)	1061
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	1055

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4.99	95% Adjusted Gamma UCL (use when n<50)	5.018

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.943	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.125	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.267	Mean of logged Data	1.522
Maximum of Logged Data	1.848	SD of logged Data	0.178

Assuming Lognormal Distribution

95% H-UCL	5.004	90% Chebyshev (MVUE) UCL	5.209
95% Chebyshev (MVUE) UCL	5.462	97.5% Chebyshev (MVUE) UCL	5.813
99% Chebyshev (MVUE) UCL	6.503		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.955	95% Jackknife UCL	4.971
95% Standard Bootstrap UCL	4.944	95% Bootstrap-t UCL	4.983
95% Hall's Bootstrap UCL	4.967	95% Percentile Bootstrap UCL	4.941
95% BCA Bootstrap UCL	4.984		
90% Chebyshev(Mean, Sd) UCL	5.206	95% Chebyshev(Mean, Sd) UCL	5.457
97.5% Chebyshev(Mean, Sd) UCL	5.806	99% Chebyshev(Mean, Sd) UCL	6.491

Suggested UCL to Use

95% Student's-t UCL	4.971

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hg in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:01
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	14	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	0.02	Mean	0.0705
Maximum	0.19	Median	0.058
SD	0.0442	Std. Error of Mean	0.0118
Coefficient of Variation	0.627	Skewness	1.715

Normal GOF Test

Shapiro Wilk Test Statistic	0.844	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.192	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.237	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.0914	95% Adjusted-CLT UCL (Chen-1995)	0.0957
		95% Modified-t UCL (Johnson-1978)	0.0923

Gamma GOF Test

A-D Test Statistic	0.292	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.129	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.23	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.322	k star (bias corrected MLE)	2.657
Theta hat (MLE)	0.0212	Theta star (bias corrected MLE)	0.0265
nu hat (MLE)	93	nu star (bias corrected)	74.41
MLE Mean (bias corrected)	0.0705	MLE Sd (bias corrected)	0.0432
		Approximate Chi Square Value (0.05)	55.54
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	53.38

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0944	95% Adjusted Gamma UCL (use when n<50)	0.0983

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.16	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.237	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.912	Mean of logged Data	-2.81
Maximum of Logged Data	-1.661	SD of logged Data	0.581

Assuming Lognormal Distribution

95% H-UCL	0.101	90% Chebyshev (MVUE) UCL	0.104
95% Chebyshev (MVUE) UCL	0.12	97.5% Chebyshev (MVUE) UCL	0.141
99% Chebyshev (MVUE) UCL	0.183		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0899	95% Jackknife UCL	0.0914
95% Standard Bootstrap UCL	0.0891	95% Bootstrap-t UCL	0.106
95% Hall's Bootstrap UCL	0.204	95% Percentile Bootstrap UCL	0.0911
95% BCA Bootstrap UCL	0.0951		
90% Chebyshev(Mean, Sd) UCL	0.106	95% Chebyshev(Mean, Sd) UCL	0.122
97.5% Chebyshev(Mean, Sd) UCL	0.144	99% Chebyshev(Mean, Sd) UCL	0.188

Suggested UCL to Use

95% Student's-t UCL	0.0914

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Pb in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 10:57
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	554	Mean	1508
Maximum	3030	Median	1320
SD	582	Std. Error of Mean	130.1
Coefficient of Variation	0.386	Skewness	0.809

Normal GOF Test

Shapiro Wilk Test Statistic	0.944	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.178	Lilliefors GOF Test
5% Lilliefors Critical Value	0.198	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1733	95% Adjusted-CLT UCL (Chen-1995)	1747
		95% Modified-t UCL (Johnson-1978)	1737

Gamma GOF Test

A-D Test Statistic	0.281	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.149	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.194	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.178	k star (bias corrected MLE)	6.134
Theta hat (MLE)	210.1	Theta star (bias corrected MLE)	245.9
nu hat (MLE)	287.1	nu star (bias corrected)	245.4
MLE Mean (bias corrected)	1508	MLE Sd (bias corrected)	609
		Approximate Chi Square Value (0.05)	210.1
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	207.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1761	95% Adjusted Gamma UCL (use when n<50)	1783

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.973	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.124	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.317	Mean of logged Data	7.247
Maximum of Logged Data	8.016	SD of logged Data	0.394

Assuming Lognormal Distribution

95% H-UCL	1807	90% Chebyshev (MVUE) UCL	1921
95% Chebyshev (MVUE) UCL	2106	97.5% Chebyshev (MVUE) UCL	2364
99% Chebyshev (MVUE) UCL	2869		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1722	95% Jackknife UCL	1733
95% Standard Bootstrap UCL	1718	95% Bootstrap-t UCL	1766
95% Hall's Bootstrap UCL	1765	95% Percentile Bootstrap UCL	1711
95% BCA Bootstrap UCL	1744		
90% Chebyshev(Mean, Sd) UCL	1899	95% Chebyshev(Mean, Sd) UCL	2076
97.5% Chebyshev(Mean, Sd) UCL	2321	99% Chebyshev(Mean, Sd) UCL	2803

Suggested UCL to Use

95% Student's-t UCL	1733

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Mn in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:00
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	3400	Mean	10617
Maximum	22300	Median	9550
SD	5041	Std. Error of Mean	1127
Coefficient of Variation	0.475	Skewness	1.162

Normal GOF Test

Shapiro Wilk Test Statistic	0.879	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.175	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	12566	95% Adjusted-CLT UCL (Chen-1995)	12784
		95% Modified-t UCL (Johnson-1978)	12615

Gamma GOF Test

A-D Test Statistic	0.449	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.124	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.194	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.159	k star (bias corrected MLE)	4.418
Theta hat (MLE)	2058	Theta star (bias corrected MLE)	2403
nu hat (MLE)	206.3	nu star (bias corrected)	176.7
MLE Mean (bias corrected)	10617	MLE Sd (bias corrected)	5051
		Approximate Chi Square Value (0.05)	147
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	144.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	12766	95% Adjusted Gamma UCL (use when n<50)	12954

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.965	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.111	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.132	Mean of logged Data	9.17
Maximum of Logged Data	10.01	SD of logged Data	0.461

Assuming Lognormal Distribution

95% H-UCL	13172	90% Chebyshev (MVUE) UCL	14006
95% Chebyshev (MVUE) UCL	15540	97.5% Chebyshev (MVUE) UCL	17668
99% Chebyshev (MVUE) UCL	21850		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	12471	95% Jackknife UCL	12566
95% Standard Bootstrap UCL	12438	95% Bootstrap-t UCL	13047
95% Hall's Bootstrap UCL	12981	95% Percentile Bootstrap UCL	12460
95% BCA Bootstrap UCL	12792		
90% Chebyshev(Mean, Sd) UCL	13999	95% Chebyshev(Mean, Sd) UCL	15530
97.5% Chebyshev(Mean, Sd) UCL	17657	99% Chebyshev(Mean, Sd) UCL	21833

Suggested UCL to Use

95% Student's-t UCL	12566

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/23/2015 8:37
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	5.92	Mean	8.224
Maximum	16.5	Median	7.32
SD	2.39	Std. Error of Mean	0.534
Coefficient of Variation	0.291	Skewness	2.335

Normal GOF Test			
Shapiro Wilk Test Statistic	0.758	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.206	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	9.148	95% Adjusted-CLT UCL (Chen-1995)	9.401
		95% Modified-t UCL (Johnson-1978)	9.195

Gamma GOF Test			
A-D Test Statistic	0.919	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.741	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.195	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.194	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	16.13	k star (bias corrected MLE)	13.74
Theta hat (MLE)	0.51	Theta star (bias corrected MLE)	0.599
nu hat (MLE)	645	nu star (bias corrected)	549.6
MLE Mean (bias corrected)	8.224	MLE Sd (bias corrected)	2.219
		Approximate Chi Square Value (0.05)	496.2
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	492.2
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	9.109	95% Adjusted Gamma UCL (use when n<50)	9.183

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.872	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.182	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.778	Mean of logged Data	2.076
Maximum of Logged Data	2.803	SD of logged Data	0.243

Assuming Lognormal Distribution			
95% H-UCL	9.084	90% Chebyshev (MVUE) UCL	9.547
95% Chebyshev (MVUE) UCL	10.16	97.5% Chebyshev (MVUE) UCL	11.01
99% Chebyshev (MVUE) UCL	12.67		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	9.103	95% Jackknife UCL	9.148
95% Standard Bootstrap UCL	9.073	95% Bootstrap-t UCL	9.687
95% Hall's Bootstrap UCL	12.83	95% Percentile Bootstrap UCL	9.099
95% BCA Bootstrap UCL	9.488		
90% Chebyshev(Mean, Sd) UCL	9.827	95% Chebyshev(Mean, Sd) UCL	10.55
97.5% Chebyshev(Mean, Sd) UCL	11.56	99% Chebyshev(Mean, Sd) UCL	13.54

Suggested UCL to Use

95% Student's-t UCL	9.148	or 95% Modified-t UCL	9.195

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Se in sediment of the Animas River above mainstem Cement Creek

User Selected Options
Date/Time of Computation 2/18/2015 11:02
From File WorkSheet.xls
Full Precision OFF
Confidence Coefficient 95%
Number of Bootstrap Operations 2000

General Statistics

Total Number of Observations	20	Number of Distinct Observations	16
Number of Detects	4	Number of Non-Detects	16
Number of Distinct Detects	4	Number of Distinct Non-Detects	12
Minimum Detect	0.905	Minimum Non-Detect	0.497
Maximum Detect	2.86	Maximum Non-Detect	1.02
Variance Detects	0.801	Percent Non-Detects	80%
Mean Detects	1.539	SD Detects	0.895
Median Detects	1.195	CV Detects	0.581
Skewness Detects	1.817	Kurtosis Detects	3.401
Mean of Logged Detects	0.325	SD of Logged Detects	0.505

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.788	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.359	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.743	Standard Error of Mean	0.148
SD	0.54	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.998	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.986	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.186	95% KM Chebyshev UCL	1.387
97.5% KM Chebyshev UCL	1.666	99% KM Chebyshev UCL	2.214

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.486	Anderson-Darling GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.339	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.889	k star (bias corrected MLE)	1.389
Theta hat (MLE)	0.315	Theta star (bias corrected MLE)	1.108
nu hat (MLE)	39.12	nu star (bias corrected)	11.11
MLE Mean (bias corrected)	1.539	MLE Sd (bias corrected)	1.306

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.889	nu hat (KM)	75.57
Approximate Chi Square Value (75.57, α)	56.55	Adjusted Chi Square Value (75.57, β)	55.25
95% Gamma Approximate KM-UCL (use when n>=50)	0.993	95% Gamma Adjusted KM-UCL (use when n<50)	1.016

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.321
Maximum	2.86	Median	0.01
SD	0.719	CV	2.241
k hat (MLE)	0.293	k star (bias corrected MLE)	0.283
Theta hat (MLE)	1.095	Theta star (bias corrected MLE)	1.136
nu hat (MLE)	11.73	nu star (bias corrected)	11.3
MLE Mean (bias corrected)	0.321	MLE Sd (bias corrected)	0.604
		Adjusted Level of Significance (β)	0.038
Approximate Chi Square Value (11.30, α)	4.77	Adjusted Chi Square Value (11.30, β)	4.438
95% Gamma Approximate UCL (use when n>=50)	0.76	95% Gamma Adjusted UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.873	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.306	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.525	Mean in Log Scale	-1.024
SD in Original Scale	0.636	SD in Log Scale	0.782
95% t UCL (assumes normality of ROS data)	0.771	95% Percentile Bootstrap UCL	0.78
95% BCA Bootstrap UCL	0.859	95% Bootstrap t UCL	1.086
95% H-UCL (Log ROS)	0.741		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-0.439	95% H-UCL (KM -Log)	0.885
KM SD (logged)	0.462	95% Critical H Value (KM-Log)	1.983
KM Standard Error of Mean (logged)	0.139		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.646	Mean in Log Scale	-0.66
SD in Original Scale	0.589	SD in Log Scale	0.619
95% t UCL (Assumes normality)	0.874	95% H-Stat UCL	0.848

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.998	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:03
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	2.9	Mean	5.491
Maximum	13.3	Median	4.845
SD	2.429	Std. Error of Mean	0.543
Coefficient of Variation	0.442	Skewness	2

Normal GOF Test

Shapiro Wilk Test Statistic	0.805	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.194	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6.43	95% Adjusted-CLT UCL (Chen-1995)	6.644
		95% Modified-t UCL (Johnson-1978)	6.471

Gamma GOF Test

A-D Test Statistic	0.642	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.151	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.194	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.105	k star (bias corrected MLE)	6.072
Theta hat (MLE)	0.773	Theta star (bias corrected MLE)	0.904
nu hat (MLE)	284.2	nu star (bias corrected)	242.9
MLE Mean (bias corrected)	5.491	MLE Sd (bias corrected)	2.228
		Approximate Chi Square Value (0.05)	207.8
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	205.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	6.418	95% Adjusted Gamma UCL (use when n<50)	6.498

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.941	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.125	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.065	Mean of logged Data	1.631
Maximum of Logged Data	2.588	SD of logged Data	0.37

Assuming Lognormal Distribution

95% H-UCL	6.43	90% Chebyshev (MVUE) UCL	6.831
95% Chebyshev (MVUE) UCL	7.457	97.5% Chebyshev (MVUE) UCL	8.324
99% Chebyshev (MVUE) UCL	10.03		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	6.384	95% Jackknife UCL	6.43
95% Standard Bootstrap UCL	6.373	95% Bootstrap-t UCL	6.957
95% Hall's Bootstrap UCL	9.672	95% Percentile Bootstrap UCL	6.436
95% BCA Bootstrap UCL	6.694		
90% Chebyshev(Mean, Sd) UCL	7.121	95% Chebyshev(Mean, Sd) UCL	7.859
97.5% Chebyshev(Mean, Sd) UCL	8.883	99% Chebyshev(Mean, Sd) UCL	10.9

Suggested UCL to Use

95% Student's-t UCL	6.43

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Zn in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	1530	Mean	3172
Maximum	11500	Median	2660
SD	2124	Std. Error of Mean	474.9
Coefficient of Variation	0.67	Skewness	3.481

Normal GOF Test

Shapiro Wilk Test Statistic	0.577	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.298	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3993	95% Adjusted-CLT UCL (Chen-1995)	4348
		95% Modified-t UCL (Johnson-1978)	4054

Gamma GOF Test

A-D Test Statistic	1.438	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.235	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.195	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	4.47	k star (bias corrected MLE)	3.833
Theta hat (MLE)	709.6	Theta star (bias corrected MLE)	827.5
nu hat (MLE)	178.8	nu star (bias corrected)	153.3
MLE Mean (bias corrected)	3172	MLE Sd (bias corrected)	1620
		Approximate Chi Square Value (0.05)	125.7
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	123.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3868	95% Adjusted Gamma UCL (use when n<50)	3930

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.854	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.193	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	7.333	Mean of logged Data	7.946
Maximum of Logged Data	9.35	SD of logged Data	0.436

Assuming Lognormal Distribution

95% H-UCL	3777	90% Chebyshev (MVUE) UCL	4017
95% Chebyshev (MVUE) UCL	4438	97.5% Chebyshev (MVUE) UCL	5021
99% Chebyshev (MVUE) UCL	6168		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3953	95% Jackknife UCL	3993
95% Standard Bootstrap UCL	3935	95% Bootstrap-t UCL	5347
95% Hall's Bootstrap UCL	7080	95% Percentile Bootstrap UCL	4031
95% BCA Bootstrap UCL	4441		
90% Chebyshev(Mean, Sd) UCL	4596	95% Chebyshev(Mean, Sd) UCL	5242
97.5% Chebyshev(Mean, Sd) UCL	6137	99% Chebyshev(Mean, Sd) UCL	7897

Suggested UCL to Use

95% Student's-t UCL	3993	or 95% Modified-t UCL	4054

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Al in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:37
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	9960	Mean	14872
Maximum	21500	Median	12200
SD	5021	Std. Error of Mean	2246
Coefficient of Variation	0.338	Skewness	0.625

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.873	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.303	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	19659	95% Adjusted-CLT UCL (Chen-1995)	19237
		95% Modified-t UCL (Johnson-1978)	19764

Gamma GOF Test

A-D Test Statistic	0.437	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.308	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.42	k star (bias corrected MLE)	4.702
Theta hat (MLE)	1302	Theta star (bias corrected MLE)	3163
nu hat (MLE)	114.2	nu star (bias corrected)	47.02
MLE Mean (bias corrected)	14872	MLE Sd (bias corrected)	6858
		Approximate Chi Square Value (0.05)	32.28
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	27.06

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	21660	95% Adjusted Gamma UCL (use when n<50)	25846

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.894	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.279	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.206	Mean of logged Data	9.563
Maximum of Logged Data	9.976	SD of logged Data	0.33

Assuming Lognormal Distribution

95% H-UCL	22609	90% Chebyshev (MVUE) UCL	21419
95% Chebyshev (MVUE) UCL	24392	97.5% Chebyshev (MVUE) UCL	28518
99% Chebyshev (MVUE) UCL	36622		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	18566	95% Jackknife UCL	19659
95% Standard Bootstrap UCL	18189	95% Bootstrap-t UCL	31997
95% Hall's Bootstrap UCL	72144	95% Percentile Bootstrap UCL	18520
95% BCA Bootstrap UCL	18520		
90% Chebyshev(Mean, Sd) UCL	21609	95% Chebyshev(Mean, Sd) UCL	24661
97.5% Chebyshev(Mean, Sd) UCL	28896	99% Chebyshev(Mean, Sd) UCL	37216

Suggested UCL to Use

95% Student's-t UCL	19659

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:39
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	26.1	Mean	33.36
Maximum	40.6	Median	36.3
SD	6.52	Std. Error of Mean	2.916
Coefficient of Variation	0.195	Skewness	-0.318

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test		
Shapiro Wilk Test Statistic	0.861	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.274	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level
Data appear Normal at 5% Significance Level		

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	39.58	95% Adjusted-CLT UCL (Chen-1995)	37.71
		95% Modified-t UCL (Johnson-1978)	39.51

Gamma GOF Test		
A-D Test Statistic	0.522	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.305	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics			
k hat (MLE)	31.44	k star (bias corrected MLE)	12.71
Theta hat (MLE)	1.061	Theta star (bias corrected MLE)	2.625
nu hat (MLE)	314.4	nu star (bias corrected)	127.1
MLE Mean (bias corrected)	33.36	MLE Sd (bias corrected)	9.358
		Approximate Chi Square Value (0.05)	102
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	92.23

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	41.55	95% Adjusted Gamma UCL (use when n<50)	45.96

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.845	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.29	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics			
Minimum of Logged Data	3.262	Mean of logged Data	3.491
Maximum of Logged Data	3.704	SD of logged Data	0.202

Assuming Lognormal Distribution			
95% H-UCL	41.86	90% Chebyshev (MVUE) UCL	42.4
95% Chebyshev (MVUE) UCL	46.5	97.5% Chebyshev (MVUE) UCL	52.18
99% Chebyshev (MVUE) UCL	63.33		

Nonparametric Distribution Free UCL Statistics	
Data appear to follow a Discernible Distribution at 5% Significance Level	

Nonparametric Distribution Free UCLs			
95% CLT UCL	38.16	95% Jackknife UCL	39.58
95% Standard Bootstrap UCL	37.76	95% Bootstrap-t UCL	39.89
95% Hall's Bootstrap UCL	36.05	95% Percentile Bootstrap UCL	37.58
95% BCA Bootstrap UCL	37.12		
90% Chebyshev(Mean, Sd) UCL	42.11	95% Chebyshev(Mean, Sd) UCL	46.07
97.5% Chebyshev(Mean, Sd) UCL	51.57	99% Chebyshev(Mean, Sd) UCL	62.37

Suggested UCL to Use

95% Student's-t UCL	39.58

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cd in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	2/18/2015 11:46
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	1.15	Mean	2.098
Maximum	3.03	Median	1.81
SD	0.791	Std. Error of Mean	0.354
Coefficient of Variation	0.377	Skewness	0.182

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.917	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.242	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.852	95% Adjusted-CLT UCL (Chen-1995)	2.711
		95% Modified-t UCL (Johnson-1978)	2.857
Gamma GOF Test			
A-D Test Statistic	0.321	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.239	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	8.413	k star (bias corrected MLE)	3.499
Theta hat (MLE)	0.249	Theta star (bias corrected MLE)	0.6
nu hat (MLE)	84.13	nu star (bias corrected)	34.99
MLE Mean (bias corrected)	2.098	MLE Sd (bias corrected)	1.122
		Approximate Chi Square Value (0.05)	22.45
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	18.2
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	3.269	95% Adjusted Gamma UCL (use when n<50)	4.034
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.931	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.211	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.14	Mean of logged Data	0.68
Maximum of Logged Data	1.109	SD of logged Data	0.396
Assuming Lognormal Distribution			
95% H-UCL	3.603	90% Chebyshev (MVUE) UCL	3.212
95% Chebyshev (MVUE) UCL	3.715	97.5% Chebyshev (MVUE) UCL	4.413
99% Chebyshev (MVUE) UCL	5.784		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	2.68	95% Jackknife UCL	2.852
95% Standard Bootstrap UCL	2.626	95% Bootstrap-t UCL	3.551
95% Hall's Bootstrap UCL	4.181	95% Percentile Bootstrap UCL	2.626
95% BCA Bootstrap UCL	2.602		
90% Chebyshev(Mean, Sd) UCL	3.159	95% Chebyshev(Mean, Sd) UCL	3.64
97.5% Chebyshev(Mean, Sd) UCL	4.307	99% Chebyshev(Mean, Sd) UCL	5.617

Suggested UCL to Use

95% Student's-t UCL	2.852

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:47
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	77.8	Mean	137.4
Maximum	179	Median	145
SD	37.33	Std. Error of Mean	16.69
Coefficient of Variation	0.272	Skewness	-1.086

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.926	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.254	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	172.9	95% Adjusted-CLT UCL (Chen-1995)	156.2
		95% Modified-t UCL (Johnson-1978)	171.6
Gamma GOF Test			
A-D Test Statistic	0.437	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.288	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	14.01	k star (bias corrected MLE)	5.738
Theta hat (MLE)	9.803	Theta star (bias corrected MLE)	23.94
nu hat (MLE)	140.1	nu star (bias corrected)	57.38
MLE Mean (bias corrected)	137.4	MLE Sd (bias corrected)	57.34
		Approximate Chi Square Value (0.05)	40.97
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	35
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	192.4	95% Adjusted Gamma UCL (use when n<50)	225.2
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.856	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.305	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.354	Mean of logged Data	4.886
Maximum of Logged Data	5.187	SD of logged Data	0.317
Assuming Lognormal Distribution			
95% H-UCL	205	90% Chebyshev (MVUE) UCL	196.2
95% Chebyshev (MVUE) UCL	222.7	97.5% Chebyshev (MVUE) UCL	259.4
99% Chebyshev (MVUE) UCL	331.4		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	164.8	95% Jackknife UCL	172.9
95% Standard Bootstrap UCL	162	95% Bootstrap-t UCL	160.5
95% Hall's Bootstrap UCL	156.7	95% Percentile Bootstrap UCL	160
95% BCA Bootstrap UCL	153.8		
90% Chebyshev(Mean, Sd) UCL	187.4	95% Chebyshev(Mean, Sd) UCL	210.1
97.5% Chebyshev(Mean, Sd) UCL	241.6	99% Chebyshev(Mean, Sd) UCL	303.5

Suggested UCL to Use

95% Student's-t UCL	172.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cr in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/2/2015 12:44
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	3.01	Mean	4.604
Maximum	6.41	Median	4.05
SD	1.556	Std. Error of Mean	0.696
Coefficient of Variation	0.338	Skewness	0.385

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.868	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.239	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6.087	95% Adjusted-CLT UCL (Chen-1995)	5.876
		95% Modified-t UCL (Johnson-1978)	6.107
Gamma GOF Test			
A-D Test Statistic	0.411	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.26	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	11.06	k star (bias corrected MLE)	4.557
Theta hat (MLE)	0.416	Theta star (bias corrected MLE)	1.01
nu hat (MLE)	110.6	nu star (bias corrected)	45.57
MLE Mean (bias corrected)	4.604	MLE Sd (bias corrected)	2.157
		Approximate Chi Square Value (0.05)	31.09
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	25.97
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	6.75	95% Adjusted Gamma UCL (use when n<50)	8.08
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.233	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.102	Mean of logged Data	1.481
Maximum of Logged Data	1.858	SD of logged Data	0.339
Assuming Lognormal Distribution			
95% H-UCL	7.101	90% Chebyshev (MVUE) UCL	6.684
95% Chebyshev (MVUE) UCL	7.627	97.5% Chebyshev (MVUE) UCL	8.936
99% Chebyshev (MVUE) UCL	11.51		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	5.748	95% Jackknife UCL	6.087
95% Standard Bootstrap UCL	5.617	95% Bootstrap-t UCL	8.093
95% Hall's Bootstrap UCL	7.589	95% Percentile Bootstrap UCL	5.73
95% BCA Bootstrap UCL	5.694		
90% Chebyshev(Mean, Sd) UCL	6.691	95% Chebyshev(Mean, Sd) UCL	7.636
97.5% Chebyshev(Mean, Sd) UCL	8.948	99% Chebyshev(Mean, Sd) UCL	11.53

Suggested UCL to Use

95% Student's-t UCL	6.087

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hg in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 9:09
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	0.039	Mean	0.0553
Maximum	0.072	Median	0.055
SD	0.0141	Std. Error of Mean	0.00704
Coefficient of Variation	0.255	Skewness	0.0886

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.997	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.145	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.0718	95% Adjusted-CLT UCL (Chen-1995)	0.0672
		95% Modified-t UCL (Johnson-1978)	0.0719

Gamma GOF Test

A-D Test Statistic	0.197	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.173	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	19.99	k star (bias corrected MLE)	5.164
Theta hat (MLE)	0.00276	Theta star (bias corrected MLE)	0.0107
nu hat (MLE)	159.9	nu star (bias corrected)	41.32
MLE Mean (bias corrected)	0.0553	MLE Sd (bias corrected)	0.0243
		Approximate Chi Square Value (0.05)	27.58
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0828	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.993	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.16	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.244	Mean of logged Data	-2.921
Maximum of Logged Data	-2.631	SD of logged Data	0.262

Assuming Lognormal Distribution

95% H-UCL	0.0832	90% Chebyshev (MVUE) UCL	0.0769
95% Chebyshev (MVUE) UCL	0.0866	97.5% Chebyshev (MVUE) UCL	0.1
99% Chebyshev (MVUE) UCL	0.127		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0668	95% Jackknife UCL	0.0718
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0.0764	95% Chebyshev(Mean, Sd) UCL	0.0859
97.5% Chebyshev(Mean, Sd) UCL	0.0992	99% Chebyshev(Mean, Sd) UCL	0.125

Suggested UCL to Use

95% Student's-t UCL	0.0718

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Pb in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:49
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	299	Mean	478.2
Maximum	581	Median	499
SD	108.7	Std. Error of Mean	48.61
Coefficient of Variation	0.227	Skewness	-1.428

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.888	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.27	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	581.8	95% Adjusted-CLT UCL (Chen-1995)	525
		95% Modified-t UCL (Johnson-1978)	576.6

Gamma GOF Test			
A-D Test Statistic	0.487	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.299	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics			
k hat (MLE)	20.27	k star (bias corrected MLE)	8.242
Theta hat (MLE)	23.59	Theta star (bias corrected MLE)	58.02
nu hat (MLE)	202.7	nu star (bias corrected)	82.42
MLE Mean (bias corrected)	478.2	MLE Sd (bias corrected)	166.6
		Approximate Chi Square Value (0.05)	62.49
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	54.97

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	630.6	95% Adjusted Gamma UCL (use when n<50)	717

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.829	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.312	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics			
Minimum of Logged Data	5.7	Mean of logged Data	6.145
Maximum of Logged Data	6.365	SD of logged Data	0.261

Assuming Lognormal Distribution			
95% H-UCL	653.4	90% Chebyshev (MVUE) UCL	647
95% Chebyshev (MVUE) UCL	722.9	97.5% Chebyshev (MVUE) UCL	828.3
99% Chebyshev (MVUE) UCL	1035		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	558.1	95% Jackknife UCL	581.8
95% Standard Bootstrap UCL	548.5	95% Bootstrap-t UCL	555.4
95% Hall's Bootstrap UCL	529.1	95% Percentile Bootstrap UCL	541.2
95% BCA Bootstrap UCL	531.8		
90% Chebyshev(Mean, Sd) UCL	624	95% Chebyshev(Mean, Sd) UCL	690.1
97.5% Chebyshev(Mean, Sd) UCL	781.7	99% Chebyshev(Mean, Sd) UCL	961.8

Suggested UCL to Use

95% Student's-t UCL	581.8

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Mn in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:50
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	1210	Mean	2100
Maximum	3400	Median	1710
SD	922.4	Std. Error of Mean	412.5
Coefficient of Variation	0.439	Skewness	0.748

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.905	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.264	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2979	95% Adjusted-CLT UCL (Chen-1995)	2926
		95% Modified-t UCL (Johnson-1978)	3002
Gamma GOF Test			
A-D Test Statistic	0.32	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.251	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	6.801	k star (bias corrected MLE)	2.854
Theta hat (MLE)	308.8	Theta star (bias corrected MLE)	735.9
nu hat (MLE)	68.01	nu star (bias corrected)	28.54
MLE Mean (bias corrected)	2100	MLE Sd (bias corrected)	1243
		Approximate Chi Square Value (0.05)	17.35
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	13.68
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	3455	95% Adjusted Gamma UCL (use when n<50)	4381
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.938	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.219	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	7.098	Mean of logged Data	7.574
Maximum of Logged Data	8.132	SD of logged Data	0.431
Assuming Lognormal Distribution			
95% H-UCL	3853	90% Chebyshev (MVUE) UCL	3299
95% Chebyshev (MVUE) UCL	3844	97.5% Chebyshev (MVUE) UCL	4601
99% Chebyshev (MVUE) UCL	6087		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	2779	95% Jackknife UCL	2979
95% Standard Bootstrap UCL	2696	95% Bootstrap-t UCL	4698
95% Hall's Bootstrap UCL	9488	95% Percentile Bootstrap UCL	2724
95% BCA Bootstrap UCL	2738		
90% Chebyshev(Mean, Sd) UCL	3338	95% Chebyshev(Mean, Sd) UCL	3898
97.5% Chebyshev(Mean, Sd) UCL	4676	99% Chebyshev(Mean, Sd) UCL	6204

Suggested UCL to Use

95% Student's-t UCL	2979

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:52
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	4.33	Mean	5.142
Maximum	6.38	Median	4.88
SD	0.778	Std. Error of Mean	0.348
Coefficient of Variation	0.151	Skewness	1.157

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.921	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.232	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.884	95% Adjusted-CLT UCL (Chen-1995)	5.907
		95% Modified-t UCL (Johnson-1978)	5.914
Gamma GOF Test			
A-D Test Statistic	0.3	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.678	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.237	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	57.71	k star (bias corrected MLE)	23.22
Theta hat (MLE)	0.0891	Theta star (bias corrected MLE)	0.221
nu hat (MLE)	577.1	nu star (bias corrected)	232.2
MLE Mean (bias corrected)	5.142	MLE Sd (bias corrected)	1.067
		Approximate Chi Square Value (0.05)	197.9
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	184
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	6.032	95% Adjusted Gamma UCL (use when n<50)	6.489
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.947	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.218	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.466	Mean of logged Data	1.629
Maximum of Logged Data	1.853	SD of logged Data	0.146
Assuming Lognormal Distribution			
95% H-UCL	6.004	90% Chebyshev (MVUE) UCL	6.144
95% Chebyshev (MVUE) UCL	6.599	97.5% Chebyshev (MVUE) UCL	7.229
99% Chebyshev (MVUE) UCL	8.468		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	5.714	95% Jackknife UCL	5.884
95% Standard Bootstrap UCL	5.643	95% Bootstrap-t UCL	6.52
95% Hall's Bootstrap UCL	9.599	95% Percentile Bootstrap UCL	5.67
95% BCA Bootstrap UCL	5.78		
90% Chebyshev(Mean, Sd) UCL	6.186	95% Chebyshev(Mean, Sd) UCL	6.658
97.5% Chebyshev(Mean, Sd) UCL	7.314	99% Chebyshev(Mean, Sd) UCL	8.603

Suggested UCL to Use

95% Student's-t UCL	5.884

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Se in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:53
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operation	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	1
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	1.04	Minimum Non-Detect	1.02
Maximum Detect	2.03	Maximum Non-Detect	1.02
Variance Detects	0.268	Percent Non-Detects	20%
Mean Detects	1.488	SD Detects	0.517
Median Detects	1.44	CV Detects	0.348
Skewness Detects	0.127	Kurtosis Detects	-5.265
Mean of Logged Detects	0.35	SD of Logged Detects	0.356

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.819	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.301	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.394	Standard Error of Mean	0.228
SD	0.442	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.881	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.77	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	2.079	95% KM Chebyshev UCL	2.39
97.5% KM Chebyshev UCL	2.82	99% KM Chebyshev UCL	3.667

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.56	Anderson-Darling GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.336	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	10.8	k star (bias corrected MLE)	2.867
Theta hat (MLE)	0.138	Theta star (bias corrected MLE)	0.519
nu hat (MLE)	86.41	nu star (bias corrected)	22.94
MLE Mean (bias corrected)	1.488	MLE Sd (bias corrected)	0.879

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	9.934	nu hat (KM)	99.34
Approximate Chi Square Value (99.34, α)	77.34	Adjusted Chi Square Value (99.34, β)	68.89
95% Gamma Approximate KM-UCL (use when n>=50	1.79	95% Gamma Adjusted KM-UCL (use when n<50)	2.01

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.364	Mean	1.263
Maximum	2.03	Median	1.05
SD	0.673	CV	0.533
k hat (MLE)	3.378	k star (bias corrected MLE)	1.485
Theta hat (MLE)	0.374	Theta star (bias corrected MLE)	0.851
nu hat (MLE)	33.78	nu star (bias corrected)	14.85
MLE Mean (bias corrected)	1.263	MLE Sd (bias corrected)	1.036
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (14.85, α)	7.154	Adjusted Chi Square Value (14.85, β)	4.997
95% Gamma Approximate UCL (use when n>=50)	2.621	95% Gamma Adjusted UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.804	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.301	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.306	Mean in Log Scale	0.172
SD in Original Scale	0.604	SD in Log Scale	0.504
95% t UCL (assumes normality of ROS data)	1.882	95% Percentile Bootstrap UCL	1.714
95% BCA Bootstrap UCL	1.66	95% Bootstrap t UCL	2.339
95% H-UCL (Log ROS)	2.842		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	0.284	95% H-UCL (KM -Log)	2.014
KM SD (logged)	0.306	95% Critical H Value (KM-Log)	2.415
KM Standard Error of Mean (logged)	0.158		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.292	Mean in Log Scale	0.145
SD in Original Scale	0.626	SD in Log Scale	0.552
95% t UCL (Assumes normality)	1.889	95% H-Stat UCL	3.183

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.881	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:55
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	1.3	Mean	1.912
Maximum	2.76	Median	1.83
SD	0.539	Std. Error of Mean	0.241
Coefficient of Variation	0.282	Skewness	0.982

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.941	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.242	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.425	95% Adjusted-CLT UCL (Chen-1995)	2.421
		95% Modified-t UCL (Johnson-1978)	2.443
Gamma GOF Test			
A-D Test Statistic	0.238	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.203	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	16.62	k star (bias corrected MLE)	6.782
Theta hat (MLE)	0.115	Theta star (bias corrected MLE)	0.282
nu hat (MLE)	166.2	nu star (bias corrected)	67.82
MLE Mean (bias corrected)	1.912	MLE Sd (bias corrected)	0.734
		Approximate Chi Square Value (0.05)	49.87
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	43.21
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	2.6	95% Adjusted Gamma UCL (use when n<50)	3.001
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.979	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.198	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.262	Mean of logged Data	0.618
Maximum of Logged Data	1.015	SD of logged Data	0.274
Assuming Lognormal Distribution			
95% H-UCL	2.653	90% Chebyshev (MVUE) UCL	2.61
95% Chebyshev (MVUE) UCL	2.927	97.5% Chebyshev (MVUE) UCL	3.367
99% Chebyshev (MVUE) UCL	4.23		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	2.308	95% Jackknife UCL	2.425
95% Standard Bootstrap UCL	2.267	95% Bootstrap-t UCL	2.572
95% Hall's Bootstrap UCL	4.682	95% Percentile Bootstrap UCL	2.298
95% BCA Bootstrap UCL	2.39		
90% Chebyshev(Mean, Sd) UCL	2.635	95% Chebyshev(Mean, Sd) UCL	2.962
97.5% Chebyshev(Mean, Sd) UCL	3.416	99% Chebyshev(Mean, Sd) UCL	4.309

Suggested UCL to Use

95% Student's-t UCL	2.425

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Zn in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:56
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	386	Mean	650.8
Maximum	858	Median	646
SD	175.9	Std. Error of Mean	78.66
Coefficient of Variation	0.27	Skewness	-0.674

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.965	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.222	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	818.5	95% Adjusted-CLT UCL (Chen-1995)	754.9
		95% Modified-t UCL (Johnson-1978)	814.5
Gamma GOF Test			
A-D Test Statistic	0.309	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.251	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	14.95	k star (bias corrected MLE)	6.112
Theta hat (MLE)	43.54	Theta star (bias corrected MLE)	106.5
nu hat (MLE)	149.5	nu star (bias corrected)	61.12
MLE Mean (bias corrected)	650.8	MLE Sd (bias corrected)	263.2
		Approximate Chi Square Value (0.05)	44.14
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	37.92
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	901.1	95% Adjusted Gamma UCL (use when n<50)	1049
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.912	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.272	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.956	Mean of logged Data	6.444
Maximum of Logged Data	6.755	SD of logged Data	0.302
Assuming Lognormal Distribution			
95% H-UCL	947.9	90% Chebyshev (MVUE) UCL	916.4
95% Chebyshev (MVUE) UCL	1036	97.5% Chebyshev (MVUE) UCL	1202
99% Chebyshev (MVUE) UCL	1528		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	780.2	95% Jackknife UCL	818.5
95% Standard Bootstrap UCL	763.8	95% Bootstrap-t UCL	797.7
95% Hall's Bootstrap UCL	794	95% Percentile Bootstrap UCL	765.6
95% BCA Bootstrap UCL	745.2		
90% Chebyshev(Mean, Sd) UCL	886.8	95% Chebyshev(Mean, Sd) UCL	993.7
97.5% Chebyshev(Mean, Sd) UCL	1142	99% Chebyshev(Mean, Sd) UCL	1433

Suggested UCL to Use

95% Student's-t UCL	818.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Al in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:25
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	6770	Mean	17123
Maximum	40700	Median	10510
SD	15852	Std. Error of Mean	7926
Coefficient of Variation	0.926	Skewness	1.9

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.748	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.381	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	35775	95% Adjusted-CLT UCL (Chen-1995)	38205
		95% Modified-t UCL (Johnson-1978)	37030
Gamma GOF Test			
A-D Test Statistic	0.515	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.353	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.05	k star (bias corrected MLE)	0.679
Theta hat (MLE)	8354	Theta star (bias corrected MLE)	25214
nu hat (MLE)	16.4	nu star (bias corrected)	5.433
MLE Mean (bias corrected)	17123	MLE Sd (bias corrected)	20778
		Approximate Chi Square Value (0.05)	1.357
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	68540	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.875	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.305	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	8.82	Mean of logged Data	9.485
Maximum of Logged Data	10.61	SD of logged Data	0.786
Assuming Lognormal Distribution			
95% H-UCL	201468	90% Chebyshev (MVUE) UCL	34933
95% Chebyshev (MVUE) UCL	43315	97.5% Chebyshev (MVUE) UCL	54949
99% Chebyshev (MVUE) UCL	77801		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	30160	95% Jackknife UCL	35775
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	40900	95% Chebyshev(Mean, Sd) UCL	51671
97.5% Chebyshev(Mean, Sd) UCL	66620	99% Chebyshev(Mean, Sd) UCL	95985

Suggested UCL to Use

95% Student's-t UCL	35775

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:26
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	20.5	Mean	27.93
Maximum	33.8	Median	28.7
SD	6.092	Std. Error of Mean	3.046
Coefficient of Variation	0.218	Skewness	-0.466

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.937	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.243	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	35.09	95% Adjusted-CLT UCL (Chen-1995)	32.18
		95% Modified-t UCL (Johnson-1978)	34.97

Gamma GOF Test			
A-D Test Statistic	0.31	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.278	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics			
k hat (MLE)	26.51	k star (bias corrected MLE)	6.794
Theta hat (MLE)	1.053	Theta star (bias corrected MLE)	4.11
nu hat (MLE)	212.1	nu star (bias corrected)	54.35
MLE Mean (bias corrected)	27.93	MLE Sd (bias corrected)	10.71
		Approximate Chi Square Value (0.05)	38.41
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	39.51	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.247	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics			
Minimum of Logged Data	3.02	Mean of logged Data	3.311
Maximum of Logged Data	3.52	SD of logged Data	0.228

Assuming Lognormal Distribution			
95% H-UCL	39.34	90% Chebyshev (MVUE) UCL	37.47
95% Chebyshev (MVUE) UCL	41.79	97.5% Chebyshev (MVUE) UCL	47.79
99% Chebyshev (MVUE) UCL	59.56		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	32.94	95% Jackknife UCL	35.09
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	37.06	95% Chebyshev(Mean, Sd) UCL	41.2
97.5% Chebyshev(Mean, Sd) UCL	46.95	99% Chebyshev(Mean, Sd) UCL	58.23

Suggested UCL to Use

95% Student's-t UCL	35.09

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cd in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:30
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2.7	Mean	4.01
Maximum	5.6	Median	3.87
SD	1.21	Std. Error of Mean	0.605
Coefficient of Variation	0.302	Skewness	0.649

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.976	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.22	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.433	95% Adjusted-CLT UCL (Chen-1995)	5.214
		95% Modified-t UCL (Johnson-1978)	5.466
Gamma GOF Test			
A-D Test Statistic	0.213	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.182	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	14.85	k star (bias corrected MLE)	3.88
Theta hat (MLE)	0.27	Theta star (bias corrected MLE)	1.034
nu hat (MLE)	118.8	nu star (bias corrected)	31.04
MLE Mean (bias corrected)	4.01	MLE Sd (bias corrected)	2.036
		Approximate Chi Square Value (0.05)	19.31
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	6.445	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.995	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.176	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.993	Mean of logged Data	1.355
Maximum of Logged Data	1.723	SD of logged Data	0.302
Assuming Lognormal Distribution			
95% H-UCL	6.588	90% Chebyshev (MVUE) UCL	5.812
95% Chebyshev (MVUE) UCL	6.629	97.5% Chebyshev (MVUE) UCL	7.762
99% Chebyshev (MVUE) UCL	9.988		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	5.005	95% Jackknife UCL	5.433
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.824	95% Chebyshev(Mean, Sd) UCL	6.646
97.5% Chebyshev(Mean, Sd) UCL	7.787	99% Chebyshev(Mean, Sd) UCL	10.03

Suggested UCL to Use

95% Student's-t UCL	5.433

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:36
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	113	Mean	199
Maximum	284	Median	199.5
SD	72.4	Std. Error of Mean	36.2
Coefficient of Variation	0.364	Skewness	-0.0356

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	1	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.133	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	284.2	95% Adjusted-CLT UCL (Chen-1995)	257.9
		95% Modified-t UCL (Johnson-1978)	284.1

Gamma GOF Test

A-D Test Statistic	0.208	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.178	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.288	k star (bias corrected MLE)	2.489
Theta hat (MLE)	21.43	Theta star (bias corrected MLE)	79.97
nu hat (MLE)	74.3	nu star (bias corrected)	19.91
MLE Mean (bias corrected)	199	MLE Sd (bias corrected)	126.1
		Approximate Chi Square Value (0.05)	10.78
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	367.4	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.979	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.181	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.727	Mean of logged Data	5.239
Maximum of Logged Data	5.649	SD of logged Data	0.393

Assuming Lognormal Distribution

95% H-UCL	415.1	90% Chebyshev (MVUE) UCL	315.6
95% Chebyshev (MVUE) UCL	368.3	97.5% Chebyshev (MVUE) UCL	441.3
99% Chebyshev (MVUE) UCL	584.8		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	258.5	95% Jackknife UCL	284.2
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	307.6	95% Chebyshev(Mean, Sd) UCL	356.8
97.5% Chebyshev(Mean, Sd) UCL	425.1	99% Chebyshev(Mean, Sd) UCL	559.2

Suggested UCL to Use

95% Student's-t UCL	284.2

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cr in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/2/2015 12:44
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2.83	Mean	3.988
Maximum	5.6	Median	3.76
SD	1.18	Std. Error of Mean	0.59
Coefficient of Variation	0.296	Skewness	1.024

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.948	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.239	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.376	95% Adjusted-CLT UCL (Chen-1995)	5.281
		95% Modified-t UCL (Johnson-1978)	5.427
Gamma GOF Test			
A-D Test Statistic	0.238	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.204	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	16.09	k star (bias corrected MLE)	4.19
Theta hat (MLE)	0.248	Theta star (bias corrected MLE)	0.952
nu hat (MLE)	128.7	nu star (bias corrected)	33.52
MLE Mean (bias corrected)	3.988	MLE Sd (bias corrected)	1.948
		Approximate Chi Square Value (0.05)	21.28
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	6.281	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.985	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.195	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.04	Mean of logged Data	1.352
Maximum of Logged Data	1.723	SD of logged Data	0.286
Assuming Lognormal Distribution			
95% H-UCL	6.323	90% Chebyshev (MVUE) UCL	5.685
95% Chebyshev (MVUE) UCL	6.456	97.5% Chebyshev (MVUE) UCL	7.525
99% Chebyshev (MVUE) UCL	9.626		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	4.958	95% Jackknife UCL	5.376
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.758	95% Chebyshev(Mean, Sd) UCL	6.56
97.5% Chebyshev(Mean, Sd) UCL	7.673	99% Chebyshev(Mean, Sd) UCL	9.859

Suggested UCL to Use

95% Student's-t UCL	5.376

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hg in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 9:15
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	0.02	Mean	0.0353
Maximum	0.05	Median	0.036
SD	0.015	Std. Error of Mean	0.00867
Coefficient of Variation	0.425	Skewness	-0.199

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.999	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.184	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.0606	95% Adjusted-CLT UCL (Chen-1995)	0.0485
		95% Modified-t UCL (Johnson-1978)	0.0605

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	7.544	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00468	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	45.27	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.974	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.241	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.912	Mean of logged Data	-3.411
Maximum of Logged Data	-2.996	SD of logged Data	0.464

Assuming Lognormal Distribution

95% H-UCL	0.265	90% Chebyshev (MVUE) UCL	0.0632
95% Chebyshev (MVUE) UCL	0.0758	97.5% Chebyshev (MVUE) UCL	0.0932
99% Chebyshev (MVUE) UCL	0.127		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0496	95% Jackknife UCL	0.0606
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0.0613	95% Chebyshev(Mean, Sd) UCL	0.0731
97.5% Chebyshev(Mean, Sd) UCL	0.0895	99% Chebyshev(Mean, Sd) UCL	0.122

Suggested UCL to Use

95% Student's-t UCL	0.0606

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Pb in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:39
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	297	Mean	513
Maximum	729	Median	513
SD	187.5	Std. Error of Mean	93.75
Coefficient of Variation	0.366	Skewness	0

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.989	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.161	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	733.6	95% Adjusted-CLT UCL (Chen-1995)	667.2
		95% Modified-t UCL (Johnson-1978)	733.6

Gamma GOF Test

A-D Test Statistic	0.217	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.209	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.315	k star (bias corrected MLE)	2.496
Theta hat (MLE)	55.07	Theta star (bias corrected MLE)	205.6
nu hat (MLE)	74.52	nu star (bias corrected)	19.96
MLE Mean (bias corrected)	513	MLE Sd (bias corrected)	324.7
		Approximate Chi Square Value (0.05)	10.82
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	946.1	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.977	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.192	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.694	Mean of logged Data	6.186
Maximum of Logged Data	6.592	SD of logged Data	0.391

Assuming Lognormal Distribution

95% H-UCL	1063	90% Chebyshev (MVUE) UCL	811.6
95% Chebyshev (MVUE) UCL	946.5	97.5% Chebyshev (MVUE) UCL	1134
99% Chebyshev (MVUE) UCL	1501		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	667.2	95% Jackknife UCL	733.6
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	794.3	95% Chebyshev(Mean, Sd) UCL	921.7
97.5% Chebyshev(Mean, Sd) UCL	1098	99% Chebyshev(Mean, Sd) UCL	1446

Suggested UCL to Use

95% Student's-t UCL	733.6

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Mn in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:40
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2780	Mean	4340
Maximum	7120	Median	3730
SD	1936	Std. Error of Mean	967.9
Coefficient of Variation	0.446	Skewness	1.527

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.866	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.291	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6618	95% Adjusted-CLT UCL (Chen-1995)	6722
		95% Modified-t UCL (Johnson-1978)	6741
Gamma GOF Test			
A-D Test Statistic	0.345	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.658	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.254	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	7.696	k star (bias corrected MLE)	2.091
Theta hat (MLE)	563.9	Theta star (bias corrected MLE)	2076
nu hat (MLE)	61.57	nu star (bias corrected)	16.73
MLE Mean (bias corrected)	4340	MLE Sd (bias corrected)	3001
		Approximate Chi Square Value (0.05)	8.477
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	8563	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.231	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	7.93	Mean of logged Data	8.309
Maximum of Logged Data	8.871	SD of logged Data	0.408
Assuming Lognormal Distribution			
95% H-UCL	9408	90% Chebyshev (MVUE) UCL	6932
95% Chebyshev (MVUE) UCL	8115	97.5% Chebyshev (MVUE) UCL	9757
99% Chebyshev (MVUE) UCL	12983		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	5932	95% Jackknife UCL	6618
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	7244	95% Chebyshev(Mean, Sd) UCL	8559
97.5% Chebyshev(Mean, Sd) UCL	10385	99% Chebyshev(Mean, Sd) UCL	13971

Suggested UCL to Use

95% Student's-t UCL	6618

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:42
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	5.5	Mean	6.4
Maximum	7.19	Median	6.455
SD	0.761	Std. Error of Mean	0.38
Coefficient of Variation	0.119	Skewness	-0.283

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.959	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.218	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	7.295	95% Adjusted-CLT UCL (Chen-1995)	6.968
		95% Modified-t UCL (Johnson-1978)	7.286

Gamma GOF Test			
A-D Test Statistic	0.268	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.656	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.252	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics			
k hat (MLE)	92.73	k star (bias corrected MLE)	23.35
Theta hat (MLE)	0.069	Theta star (bias corrected MLE)	0.274
nu hat (MLE)	741.9	nu star (bias corrected)	186.8
MLE Mean (bias corrected)	6.4	MLE Sd (bias corrected)	1.324
		Approximate Chi Square Value (0.05)	156.2
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	7.655	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.956	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.224	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics			
Minimum of Logged Data	1.705	Mean of logged Data	1.851
Maximum of Logged Data	1.973	SD of logged Data	0.121

Assuming Lognormal Distribution			
95% H-UCL	7.507	90% Chebyshev (MVUE) UCL	7.557
95% Chebyshev (MVUE) UCL	8.08	97.5% Chebyshev (MVUE) UCL	8.808
99% Chebyshev (MVUE) UCL	10.24		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	7.026	95% Jackknife UCL	7.295
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	7.541	95% Chebyshev(Mean, Sd) UCL	8.058
97.5% Chebyshev(Mean, Sd) UCL	8.776	99% Chebyshev(Mean, Sd) UCL	10.19

Suggested UCL to Use

95% Student's-t UCL	7.295

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Se in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:43
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	2
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	0.717	Minimum Non-Detect	1
Maximum Detect	1.43	Maximum Non-Detect	1.02
Variance Detects	0.254	Percent Non-Detects	50%
Mean Detects	1.074	SD Detects	0.504
Median Detects	1.074	CV Detects	0.47
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	0.0125	SD of Logged Detects	0.488

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.895	Standard Error of Mean	0.218
SD	0.309	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.409	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.254	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.55	95% KM Chebyshev UCL	1.847
97.5% KM Chebyshev UCL	2.259	99% KM Chebyshev UCL	3.067

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	8.721	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.123	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	34.88	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	8.408	nu hat (KM)	67.27
		Adjusted Level of Significance (β)	0.00498
Approximate Chi Square Value (67.27, α)	49.39	Adjusted Chi Square Value (67.27, β)	41.13
95% Gamma Approximate KM-UCL (use when n>=50	1.219	95% Gamma Adjusted KM-UCL (use when n<50)	1.464

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.895	Mean in Log Scale	-0.16
SD in Original Scale	0.357	SD in Log Scale	0.345
95% t UCL (assumes normality of ROS data)	1.315	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	1.627		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.789	Mean in Log Scale	-0.335
SD in Original Scale	0.439	SD in Log Scale	0.491
95% t UCL (Assumes normality)	1.305	95% H-Stat UCL	2.243

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.409	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:45
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1.24	Mean	1.923
Maximum	2.78	Median	1.835
SD	0.75	Std. Error of Mean	0.375
Coefficient of Variation	0.39	Skewness	0.297

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.884	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.277	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.805	95% Adjusted-CLT UCL (Chen-1995)	2.599
		95% Modified-t UCL (Johnson-1978)	2.814

Gamma GOF Test

A-D Test Statistic	0.418	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.658	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.307	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.664	k star (bias corrected MLE)	2.333
Theta hat (MLE)	0.222	Theta star (bias corrected MLE)	0.824
nu hat (MLE)	69.31	nu star (bias corrected)	18.66
MLE Mean (bias corrected)	1.923	MLE Sd (bias corrected)	1.259
		Approximate Chi Square Value (0.05)	9.871
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.635	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.878	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.271	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.215	Mean of logged Data	0.595
Maximum of Logged Data	1.022	SD of logged Data	0.398

Assuming Lognormal Distribution

95% H-UCL	4.059	90% Chebyshev (MVUE) UCL	3.056
95% Chebyshev (MVUE) UCL	3.569	97.5% Chebyshev (MVUE) UCL	4.282
99% Chebyshev (MVUE) UCL	5.682		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.539	95% Jackknife UCL	2.805
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	3.047	95% Chebyshev(Mean, Sd) UCL	3.557
97.5% Chebyshev(Mean, Sd) UCL	4.264	99% Chebyshev(Mean, Sd) UCL	5.653

Suggested UCL to Use

95% Student's-t UCL	2.805

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Zn in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:46
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	749	Mean	1049
Maximum	1450	Median	999
SD	292	Std. Error of Mean	146
Coefficient of Variation	0.278	Skewness	0.992

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.908	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.317	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1393	95% Adjusted-CLT UCL (Chen-1995)	1367
		95% Modified-t UCL (Johnson-1978)	1405
Gamma GOF Test			
A-D Test Statistic	0.354	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.299	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	18.06	k star (bias corrected MLE)	4.682
Theta hat (MLE)	58.09	Theta star (bias corrected MLE)	224.1
nu hat (MLE)	144.5	nu star (bias corrected)	37.46
MLE Mean (bias corrected)	1049	MLE Sd (bias corrected)	484.9
		Approximate Chi Square Value (0.05)	24.44
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1608	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.938	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.28	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.619	Mean of logged Data	6.928
Maximum of Logged Data	7.279	SD of logged Data	0.271
Assuming Lognormal Distribution			
95% H-UCL	1609	90% Chebyshev (MVUE) UCL	1472
95% Chebyshev (MVUE) UCL	1664	97.5% Chebyshev (MVUE) UCL	1930
99% Chebyshev (MVUE) UCL	2454		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1289	95% Jackknife UCL	1393
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1487	95% Chebyshev(Mean, Sd) UCL	1686
97.5% Chebyshev(Mean, Sd) UCL	1961	99% Chebyshev(Mean, Sd) UCL	2502

Suggested UCL to Use

95% Student's-t UCL	1393

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Al in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:09
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	6620	Mean	16373
Maximum	31900	Median	10600
SD	13593	Std. Error of Mean	7848
Coefficient of Variation	0.83	Skewness	1.566

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.865	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.331	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	39289	95% Adjusted-CLT UCL (Chen-1995)	36866
		95% Modified-t UCL (Johnson-1978)	40472

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	2.381	k star (bias corrected MLE)	N/A
Theta hat (MLE)	6877	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	14.29	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.949	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.269	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.798	Mean of logged Data	9.479
Maximum of Logged Data	10.37	SD of logged Data	0.807

Assuming Lognormal Distribution

95% H-UCL	7347437	90% Chebyshev (MVUE) UCL	36910
95% Chebyshev (MVUE) UCL	46345	97.5% Chebyshev (MVUE) UCL	59441
99% Chebyshev (MVUE) UCL	85165		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	29282	95% Jackknife UCL	39289
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	39917	95% Chebyshev(Mean, Sd) UCL	50581
97.5% Chebyshev(Mean, Sd) UCL	65383	99% Chebyshev(Mean, Sd) UCL	94459

Suggested UCL to Use

95% Student's-t UCL	39289

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:10
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	19.9	Mean	29.9
Maximum	39.4	Median	30.4
SD	9.76	Std. Error of Mean	5.635
Coefficient of Variation	0.326	Skewness	-0.23

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.998	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.187	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	46.35	95% Adjusted-CLT UCL (Chen-1995)	38.37
		95% Modified-t UCL (Johnson-1978)	46.23
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	13.25	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.257	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	79.49	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.23	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.991	Mean of logged Data	3.36
Maximum of Logged Data	3.674	SD of logged Data	0.345
Assuming Lognormal Distribution			
95% H-UCL	93.07	90% Chebyshev (MVUE) UCL	47.55
95% Chebyshev (MVUE) UCL	55.52	97.5% Chebyshev (MVUE) UCL	66.6
99% Chebyshev (MVUE) UCL	88.35		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	39.17	95% Jackknife UCL	46.35
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	46.8	95% Chebyshev(Mean, Sd) UCL	54.46
97.5% Chebyshev(Mean, Sd) UCL	65.09	99% Chebyshev(Mean, Sd) UCL	85.96

Suggested UCL to Use

95% Student's-t UCL	46.35

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cd in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:10
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	2.72	Mean	3.507
Maximum	4.24	Median	3.56
SD	0.761	Std. Error of Mean	0.44
Coefficient of Variation	0.217	Skewness	-0.314

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.996	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.195	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4.79	95% Adjusted-CLT UCL (Chen-1995)	4.145
		95% Modified-t UCL (Johnson-1978)	4.777

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics			
k hat (MLE)	30.75	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.114	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	184.5	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.985	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.223	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.001	Mean of logged Data	1.238
Maximum of Logged Data	1.445	SD of logged Data	0.224
Assuming Lognormal Distribution			
95% H-UCL	6.116	90% Chebyshev (MVUE) UCL	4.858
95% Chebyshev (MVUE) UCL	5.469	97.5% Chebyshev (MVUE) UCL	6.318
99% Chebyshev (MVUE) UCL	7.986		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	4.23	95% Jackknife UCL	4.79
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	4.825	95% Chebyshev(Mean, Sd) UCL	5.423
97.5% Chebyshev(Mean, Sd) UCL	6.252	99% Chebyshev(Mean, Sd) UCL	7.881

Suggested UCL to Use

95% Student's-t UCL	4.79

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cr in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/2/2015 12:44
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	3.68	Mean	4.473
Maximum	5.02	Median	4.72
SD	0.703	Std. Error of Mean	0.406
Coefficient of Variation	0.157	Skewness	-1.384

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.908	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.304	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.659	95% Adjusted-CLT UCL (Chen-1995)	4.794
		95% Modified-t UCL (Johnson-1978)	5.605

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	57.31	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.0781	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	343.9	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.892	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.315	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.303	Mean of logged Data	1.489
Maximum of Logged Data	1.613	SD of logged Data	0.164

Assuming Lognormal Distribution

95% H-UCL	6.422	90% Chebyshev (MVUE) UCL	5.744
95% Chebyshev (MVUE) UCL	6.319	97.5% Chebyshev (MVUE) UCL	7.118
99% Chebyshev (MVUE) UCL	8.686		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5.141	95% Jackknife UCL	5.659
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.691	95% Chebyshev(Mean, Sd) UCL	6.243
97.5% Chebyshev(Mean, Sd) UCL	7.009	99% Chebyshev(Mean, Sd) UCL	8.513

Suggested UCL to Use

95% Student's-t UCL	5.659

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cu in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:10
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	98.8	Mean	176.9
Maximum	292	Median	140
SD	101.8	Std. Error of Mean	58.75
Coefficient of Variation	0.575	Skewness	1.418

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.901	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.308	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	348.5	95% Adjusted-CLT UCL (Chen-1995)	325
		95% Modified-t UCL (Johnson-1978)	356.5
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	4.91	k star (bias corrected MLE)	N/A
Theta hat (MLE)	36.04	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	29.46	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.959	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.259	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.593	Mean of logged Data	5.07
Maximum of Logged Data	5.677	SD of logged Data	0.553
Assuming Lognormal Distribution			
95% H-UCL	3088	90% Chebyshev (MVUE) UCL	338.4
95% Chebyshev (MVUE) UCL	411.9	97.5% Chebyshev (MVUE) UCL	514
99% Chebyshev (MVUE) UCL	714.6		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	273.6	95% Jackknife UCL	348.5
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	353.2	95% Chebyshev(Mean, Sd) UCL	433
97.5% Chebyshev(Mean, Sd) UCL	543.8	99% Chebyshev(Mean, Sd) UCL	761.5

Suggested UCL to Use

95% Student's-t UCL	348.5

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Pb in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:11
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	468	Mean	533.7
Maximum	593	Median	540
SD	62.74	Std. Error of Mean	36.22
Coefficient of Variation	0.118	Skewness	-0.45

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.992	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.207	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	639.4	95% Adjusted-CLT UCL (Chen-1995)	583.2
		95% Modified-t UCL (Johnson-1978)	637.9

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	106.7	k star (bias corrected MLE)	N/A
Theta hat (MLE)	5.002	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	640.1	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.986	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.222	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.148	Mean of logged Data	6.275
Maximum of Logged Data	6.385	SD of logged Data	0.119

Assuming Lognormal Distribution

95% H-UCL	679.3	90% Chebyshev (MVUE) UCL	643.7
95% Chebyshev (MVUE) UCL	693.5	97.5% Chebyshev (MVUE) UCL	762.7
99% Chebyshev (MVUE) UCL	898.5		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	593.2	95% Jackknife UCL	639.4
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	642.3	95% Chebyshev(Mean, Sd) UCL	691.6
97.5% Chebyshev(Mean, Sd) UCL	759.9	99% Chebyshev(Mean, Sd) UCL	894.1

Suggested UCL to Use

95% Student's-t UCL	639.4

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Mn in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:11
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	2480	Mean	3143
Maximum	4340	Median	2610
SD	1038	Std. Error of Mean	599.5
Coefficient of Variation	0.33	Skewness	1.702

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.802	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.363	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4894	95% Adjusted-CLT UCL (Chen-1995)	4759
		95% Modified-t UCL (Johnson-1978)	4992

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	15.11	k star (bias corrected MLE)	N/A
Theta hat (MLE)	208	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	90.66	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.818	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.356	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.816	Mean of logged Data	8.02
Maximum of Logged Data	8.376	SD of logged Data	0.309

Assuming Lognormal Distribution

95% H-UCL	7994	90% Chebyshev (MVUE) UCL	4799
95% Chebyshev (MVUE) UCL	5552	97.5% Chebyshev (MVUE) UCL	6597
99% Chebyshev (MVUE) UCL	8649		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4129	95% Jackknife UCL	4894
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	4942	95% Chebyshev(Mean, Sd) UCL	5757
97.5% Chebyshev(Mean, Sd) UCL	6887	99% Chebyshev(Mean, Sd) UCL	9108

Suggested UCL to Use

95% Student's-t UCL	4894

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:11
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	8.16	Mean	10.01
Maximum	12.1	Median	9.78
SD	1.98	Std. Error of Mean	1.143
Coefficient of Variation	0.198	Skewness	0.523

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.99	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.214	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	13.35	95% Adjusted-CLT UCL (Chen-1995)	12.26
		95% Modified-t UCL (Johnson-1978)	13.41
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	38.66	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.259	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	232	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.998	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.188	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.099	Mean of logged Data	2.291
Maximum of Logged Data	2.493	SD of logged Data	0.197
Assuming Lognormal Distribution			
95% H-UCL	15.91	90% Chebyshev (MVUE) UCL	13.42
95% Chebyshev (MVUE) UCL	14.96	97.5% Chebyshev (MVUE) UCL	17.1
99% Chebyshev (MVUE) UCL	21.3		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	11.89	95% Jackknife UCL	13.35
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	13.44	95% Chebyshev(Mean, Sd) UCL	15
97.5% Chebyshev(Mean, Sd) UCL	17.15	99% Chebyshev(Mean, Sd) UCL	21.39

Suggested UCL to Use

95% Student's-t UCL	13.35

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:12
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	1.25	Mean	1.997
Maximum	3.09	Median	1.65
SD	0.968	Std. Error of Mean	0.559
Coefficient of Variation	0.485	Skewness	1.405

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.904	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.307	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.628	95% Adjusted-CLT UCL (Chen-1995)	3.4
		95% Modified-t UCL (Johnson-1978)	3.704
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	6.909	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.289	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	41.45	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.953	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.266	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.223	Mean of logged Data	0.617
Maximum of Logged Data	1.128	SD of logged Data	0.464
Assuming Lognormal Distribution			
95% H-UCL	14.82	90% Chebyshev (MVUE) UCL	3.545
95% Chebyshev (MVUE) UCL	4.25	97.5% Chebyshev (MVUE) UCL	5.229
99% Chebyshev (MVUE) UCL	7.15		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	2.916	95% Jackknife UCL	3.628
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	3.673	95% Chebyshev(Mean, Sd) UCL	4.432
97.5% Chebyshev(Mean, Sd) UCL	5.486	99% Chebyshev(Mean, Sd) UCL	7.556

Suggested UCL to Use

95% Student's-t UCL	3.628

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Zn in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:12
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	659	Mean	1114
Maximum	1720	Median	964
SD	546.2	Std. Error of Mean	315.4
Coefficient of Variation	0.49	Skewness	1.145

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.943	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.275	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2035	95% Adjusted-CLT UCL (Chen-1995)	1856
		95% Modified-t UCL (Johnson-1978)	2070

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	6.514	k star (bias corrected MLE)	N/A
Theta hat (MLE)	171.1	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	39.09	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.986	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.221	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.491	Mean of logged Data	6.937
Maximum of Logged Data	7.45	SD of logged Data	0.483

Assuming Lognormal Distribution

95% H-UCL	9849	90% Chebyshev (MVUE) UCL	2016
95% Chebyshev (MVUE) UCL	2425	97.5% Chebyshev (MVUE) UCL	2994
99% Chebyshev (MVUE) UCL	4110		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1633	95% Jackknife UCL	2035
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	2060	95% Chebyshev(Mean, Sd) UCL	2489
97.5% Chebyshev(Mean, Sd) UCL	3084	99% Chebyshev(Mean, Sd) UCL	4252

Suggested UCL to Use

95% Student's-t UCL	2035

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Al in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:57
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	6640	Mean	20820
Maximum	48600	Median	7220
SD	24060	Std. Error of Mean	13891
Coefficient of Variation	1.156	Skewness	1.731

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.76	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.381	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	61382	95% Adjusted-CLT UCL (Chen-1995)	58502
		95% Modified-t UCL (Johnson-1978)	63695

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	1.248	k star (bias corrected MLE)	N/A
Theta hat (MLE)	16682	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	7.488	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.781	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.372	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.801	Mean of logged Data	9.492
Maximum of Logged Data	10.79	SD of logged Data	1.126

Assuming Lognormal Distribution

95% H-UCL	3.02E+09	90% Chebyshev (MVUE) UCL	52502
95% Chebyshev (MVUE) UCL	67461	97.5% Chebyshev (MVUE) UCL	88224
99% Chebyshev (MVUE) UCL	129007		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	43669	95% Jackknife UCL	61382
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	62493	95% Chebyshev(Mean, Sd) UCL	81370
97.5% Chebyshev(Mean, Sd) UCL	107569	99% Chebyshev(Mean, Sd) UCL	159034

Suggested UCL to Use

95% Student's-t UCL	61382

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:57
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	9.22	Mean	19.91
Maximum	37.2	Median	13.3
SD	15.11	Std. Error of Mean	8.727
Coefficient of Variation	0.759	Skewness	1.591

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.857	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.336	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	45.39	95% Adjusted-CLT UCL (Chen-1995)	42.83
		95% Modified-t UCL (Johnson-1978)	46.72

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	2.895	k star (bias corrected MLE)	N/A
Theta hat (MLE)	6.877	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	17.37	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.93	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.287	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.221	Mean of logged Data	2.808
Maximum of Logged Data	3.616	SD of logged Data	0.723

Assuming Lognormal Distribution

95% H-UCL	2668	90% Chebyshev (MVUE) UCL	42.69
95% Chebyshev (MVUE) UCL	53.14	97.5% Chebyshev (MVUE) UCL	67.65
99% Chebyshev (MVUE) UCL	96.16		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	34.26	95% Jackknife UCL	45.39
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	46.09	95% Chebyshev(Mean, Sd) UCL	57.94
97.5% Chebyshev(Mean, Sd) UCL	74.4	99% Chebyshev(Mean, Sd) UCL	106.7

Suggested UCL to Use

95% Student's-t UCL	45.39

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cd in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:57
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	1.99	Mean	5.047
Maximum	10.5	Median	2.65
SD	4.734	Std. Error of Mean	2.733
Coefficient of Variation	0.938	Skewness	1.694

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.808	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.36	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	13.03	95% Adjusted-CLT UCL (Chen-1995)	12.4
		95% Modified-t UCL (Johnson-1978)	13.47

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	1.931	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.613	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	11.59	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.875	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.325	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.688	Mean of logged Data	1.338
Maximum of Logged Data	2.351	SD of logged Data	0.889

Assuming Lognormal Distribution

95% H-UCL	8316	90% Chebyshev (MVUE) UCL	11.75
95% Chebyshev (MVUE) UCL	14.86	97.5% Chebyshev (MVUE) UCL	19.18
99% Chebyshev (MVUE) UCL	27.66		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	9.543	95% Jackknife UCL	13.03
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	13.25	95% Chebyshev(Mean, Sd) UCL	16.96
97.5% Chebyshev(Mean, Sd) UCL	22.12	99% Chebyshev(Mean, Sd) UCL	32.24

Suggested UCL to Use

95% Student's-t UCL	13.03

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:57
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	67	Mean	187.6
Maximum	413	Median	82.7
SD	195.4	Std. Error of Mean	112.8
Coefficient of Variation	1.042	Skewness	1.719

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.784	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.371	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	517	95% Adjusted-CLT UCL (Chen-1995)	492.8
		95% Modified-t UCL (Johnson-1978)	535.6

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	1.562	k star (bias corrected MLE)	N/A
Theta hat (MLE)	120.1	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	9.373	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.836	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.347	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.205	Mean of logged Data	4.881
Maximum of Logged Data	6.023	SD of logged Data	0.995

Assuming Lognormal Distribution

95% H-UCL	2000919	90% Chebyshev (MVUE) UCL	454.7
95% Chebyshev (MVUE) UCL	579.6	97.5% Chebyshev (MVUE) UCL	752.9
99% Chebyshev (MVUE) UCL	1093		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	373.1	95% Jackknife UCL	517
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	526	95% Chebyshev(Mean, Sd) UCL	679.3
97.5% Chebyshev(Mean, Sd) UCL	892.1	99% Chebyshev(Mean, Sd) UCL	1310

Suggested UCL to Use

95% Student's-t UCL	517

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cr in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/2/2015 12:44
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	5.01	Mean	5.207
Maximum	5.45	Median	5.16
SD	0.224	Std. Error of Mean	0.129
Coefficient of Variation	0.043	Skewness	0.898

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.967	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.249	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.584	95% Adjusted-CLT UCL (Chen-1995)	5.491
		95% Modified-t UCL (Johnson-1978)	5.595

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	819.2	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00636	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	4915	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.971	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.245	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.611	Mean of logged Data	1.649
Maximum of Logged Data	1.696	SD of logged Data	0.0427

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	5.592
95% Chebyshev (MVUE) UCL	5.766	97.5% Chebyshev (MVUE) UCL	6.008
99% Chebyshev (MVUE) UCL	6.484		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5.419	95% Jackknife UCL	5.584
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.594	95% Chebyshev(Mean, Sd) UCL	5.77
97.5% Chebyshev(Mean, Sd) UCL	6.013	99% Chebyshev(Mean, Sd) UCL	6.492

Suggested UCL to Use

95% Student's-t UCL	5.584

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Pb in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	98	Mean	295.7
Maximum	435	Median	354
SD	175.9	Std. Error of Mean	101.6
Coefficient of Variation	0.595	Skewness	-1.328

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.918	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.297	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	592.2	95% Adjusted-CLT UCL (Chen-1995)	379.5
		95% Modified-t UCL (Johnson-1978)	579.2

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	2.944	k star (bias corrected MLE)	N/A
Theta hat (MLE)	100.4	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	17.66	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.851	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.339	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.585	Mean of logged Data	5.51
Maximum of Logged Data	6.075	SD of logged Data	0.808

Assuming Lognormal Distribution

95% H-UCL	139915	90% Chebyshev (MVUE) UCL	697.6
95% Chebyshev (MVUE) UCL	876	97.5% Chebyshev (MVUE) UCL	1124
99% Chebyshev (MVUE) UCL	1610		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	462.7	95% Jackknife UCL	592.2
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	600.4	95% Chebyshev(Mean, Sd) UCL	738.4
97.5% Chebyshev(Mean, Sd) UCL	929.9	99% Chebyshev(Mean, Sd) UCL	1306

Suggested UCL to Use

95% Student's-t UCL	592.2

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Mn in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	2070	Mean	2743
Maximum	3820	Median	2340
SD	942.1	Std. Error of Mean	543.9
Coefficient of Variation	0.343	Skewness	1.573

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.863	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.332	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4332	95% Adjusted-CLT UCL (Chen-1995)	4166
		95% Modified-t UCL (Johnson-1978)	4414

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	13.85	k star (bias corrected MLE)	N/A
Theta hat (MLE)	198	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	83.13	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.314	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.635	Mean of logged Data	7.88
Maximum of Logged Data	8.248	SD of logged Data	0.324

Assuming Lognormal Distribution

95% H-UCL	7558	90% Chebyshev (MVUE) UCL	4256
95% Chebyshev (MVUE) UCL	4944	97.5% Chebyshev (MVUE) UCL	5898
99% Chebyshev (MVUE) UCL	7773		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3638	95% Jackknife UCL	4332
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	4375	95% Chebyshev(Mean, Sd) UCL	5114
97.5% Chebyshev(Mean, Sd) UCL	6140	99% Chebyshev(Mean, Sd) UCL	8156

Suggested UCL to Use

95% Student's-t UCL	4332

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	5.93	Mean	9.713
Maximum	16.5	Median	6.71
SD	5.89	Std. Error of Mean	3.401
Coefficient of Variation	0.606	Skewness	1.698

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.805	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.362	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	19.64	95% Adjusted-CLT UCL (Chen-1995)	18.87
		95% Modified-t UCL (Johnson-1978)	20.2

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	4.658	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.085	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	27.95	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.839	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.345	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.78	Mean of logged Data	2.162
Maximum of Logged Data	2.803	SD of logged Data	0.559

Assuming Lognormal Distribution

95% H-UCL	178.7	90% Chebyshev (MVUE) UCL	18.58
95% Chebyshev (MVUE) UCL	22.64	97.5% Chebyshev (MVUE) UCL	28.27
99% Chebyshev (MVUE) UCL	39.34		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	15.31	95% Jackknife UCL	19.64
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	19.92	95% Chebyshev(Mean, Sd) UCL	24.54
97.5% Chebyshev(Mean, Sd) UCL	30.95	99% Chebyshev(Mean, Sd) UCL	43.55

Suggested UCL to Use

95% Student's-t UCL	19.64

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Se in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	1
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	0.588	Minimum Non-Detect	0.994
Maximum Detect	3.26	Maximum Non-Detect	0.994
Variance Detects	3.57	Percent Non-Detects	33.33%
Mean Detects	1.924	SD Detects	1.889
Median Detects	1.924	CV Detects	0.982
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	0.325	SD of Logged Detects	1.211

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.479	Standard Error of Mean	1.028
SD	1.26	95% KM (BCA) UCL	N/A
95% KM (t) UCL	4.482	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	3.17	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	4.564	95% KM Chebyshev UCL	5.962
97.5% KM Chebyshev UCL	7.901	99% KM Chebyshev UCL	11.71

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	1.667	k star (bias corrected MLE)	N/A
Theta hat (MLE)	1.154	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	6.667	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.378	nu hat (KM)	8.269
		Adjusted Level of Significance (β)	0.00136
Approximate Chi Square Value (8.27, α)	2.892	Adjusted Chi Square Value (8.27, β)	1.019
95% Gamma Approximate KM-UCL (use when n>=50	4.228	95% Gamma Adjusted KM-UCL (use when n<50)	11.99

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.479	Mean in Log Scale	0.0399
SD in Original Scale	1.543	SD in Log Scale	0.989
95% t UCL (assumes normality of ROS data)	4.079	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	14069		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.448	Mean in Log Scale	-0.0162
SD in Original Scale	1.57	SD in Log Scale	1.041
95% t UCL (Assumes normality)	4.094	95% H-Stat UCL	37170

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	7.901

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	0.512	Mean	1.401
Maximum	2.18	Median	1.51
SD	0.839	Std. Error of Mean	0.485
Coefficient of Variation	0.599	Skewness	-0.576

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.987	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.218	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.816	95% Adjusted-CLT UCL (Chen-1995)	2.026
		95% Modified-t UCL (Johnson-1978)	2.789
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	3.226	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.434	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	19.35	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.925	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.291	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.669	Mean of logged Data	0.174
Maximum of Logged Data	0.779	SD of logged Data	0.753
Assuming Lognormal Distribution			
95% H-UCL	294.6	90% Chebyshev (MVUE) UCL	3.166
95% Chebyshev (MVUE) UCL	3.954	97.5% Chebyshev (MVUE) UCL	5.048
99% Chebyshev (MVUE) UCL	7.196		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	2.198	95% Jackknife UCL	2.816
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	2.854	95% Chebyshev(Mean, Sd) UCL	3.513
97.5% Chebyshev(Mean, Sd) UCL	4.427	99% Chebyshev(Mean, Sd) UCL	6.222

Suggested UCL to Use

95% Student's-t UCL	2.816

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Zn in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	578	Mean	2190
Maximum	5320	Median	672
SD	2711	Std. Error of Mean	1565
Coefficient of Variation	1.238	Skewness	1.73

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.765	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.379	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6760	95% Adjusted-CLT UCL (Chen-1995)	6435
		95% Modified-t UCL (Johnson-1978)	7021

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	1.058	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2070	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	6.349	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.801	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.364	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.36	Mean of logged Data	7.15
Maximum of Logged Data	8.579	SD of logged Data	1.24

Assuming Lognormal Distribution

95% H-UCL	4.08E+09	90% Chebyshev (MVUE) UCL	5684
95% Chebyshev (MVUE) UCL	7345	97.5% Chebyshev (MVUE) UCL	9652
99% Chebyshev (MVUE) UCL	14182		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4765	95% Jackknife UCL	6760
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	6886	95% Chebyshev(Mean, Sd) UCL	9013
97.5% Chebyshev(Mean, Sd) UCL	11965	99% Chebyshev(Mean, Sd) UCL	17764

Suggested UCL to Use

95% Student's-t UCL	6760

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Al in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:19
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	7660	Mean	15428
Maximum	29900	Median	12075
SD	10281	Std. Error of Mean	5141
Coefficient of Variation	0.666	Skewness	1.372

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.855	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.248	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	27525	95% Adjusted-CLT UCL (Chen-1995)	27653
		95% Modified-t UCL (Johnson-1978)	28113

Gamma GOF Test

A-D Test Statistic	0.369	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.288	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.396	k star (bias corrected MLE)	1.016
Theta hat (MLE)	4542	Theta star (bias corrected MLE)	15188
nu hat (MLE)	27.17	nu star (bias corrected)	8.126
MLE Mean (bias corrected)	15428	MLE Sd (bias corrected)	15307
		Approximate Chi Square Value (0.05)	2.808
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	44642	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.91	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.256	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.944	Mean of logged Data	9.49
Maximum of Logged Data	10.31	SD of logged Data	0.627

Assuming Lognormal Distribution

95% H-UCL	78329	90% Chebyshev (MVUE) UCL	29207
95% Chebyshev (MVUE) UCL	35525	97.5% Chebyshev (MVUE) UCL	44293
99% Chebyshev (MVUE) UCL	61516		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	23883	95% Jackknife UCL	27525
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	30849	95% Chebyshev(Mean, Sd) UCL	37835
97.5% Chebyshev(Mean, Sd) UCL	47531	99% Chebyshev(Mean, Sd) UCL	66576

Suggested UCL to Use

95% Student's-t UCL	27525

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:19
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	13.2	Mean	19.35
Maximum	28.5	Median	17.85
SD	6.488	Std. Error of Mean	3.244
Coefficient of Variation	0.335	Skewness	1.283

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.895	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.32	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	26.98	95% Adjusted-CLT UCL (Chen-1995)	26.91
		95% Modified-t UCL (Johnson-1978)	27.33
Gamma GOF Test			
A-D Test Statistic	0.343	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.3	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	12.9	k star (bias corrected MLE)	3.392
Theta hat (MLE)	1.5	Theta star (bias corrected MLE)	5.705
nu hat (MLE)	103.2	nu star (bias corrected)	27.14
MLE Mean (bias corrected)	19.35	MLE Sd (bias corrected)	10.51
		Approximate Chi Square Value (0.05)	16.26
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	32.3	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.944	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.278	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.58	Mean of logged Data	2.923
Maximum of Logged Data	3.35	SD of logged Data	0.318
Assuming Lognormal Distribution			
95% H-UCL	33	90% Chebyshev (MVUE) UCL	28.47
95% Chebyshev (MVUE) UCL	32.62	97.5% Chebyshev (MVUE) UCL	38.38
99% Chebyshev (MVUE) UCL	49.68		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	24.69	95% Jackknife UCL	26.98
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	29.08	95% Chebyshev(Mean, Sd) UCL	33.49
97.5% Chebyshev(Mean, Sd) UCL	39.61	99% Chebyshev(Mean, Sd) UCL	51.63

Suggested UCL to Use

95% Student's-t UCL	26.98

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cd in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:19
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	3.73	Mean	4.808
Maximum	6.75	Median	4.375
SD	1.39	Std. Error of Mean	0.695
Coefficient of Variation	0.289	Skewness	1.31

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.866	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.248	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6.443	95% Adjusted-CLT UCL (Chen-1995)	6.437
		95% Modified-t UCL (Johnson-1978)	6.519

Gamma GOF Test

A-D Test Statistic	0.387	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.283	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	17.43	k star (bias corrected MLE)	4.525
Theta hat (MLE)	0.276	Theta star (bias corrected MLE)	1.063
nu hat (MLE)	139.5	nu star (bias corrected)	36.2
MLE Mean (bias corrected)	4.808	MLE Sd (bias corrected)	2.26
		Approximate Chi Square Value (0.05)	23.43
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.428	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.894	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.252	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.316	Mean of logged Data	1.541
Maximum of Logged Data	1.91	SD of logged Data	0.272

Assuming Lognormal Distribution

95% H-UCL	7.388	90% Chebyshev (MVUE) UCL	6.751
95% Chebyshev (MVUE) UCL	7.634	97.5% Chebyshev (MVUE) UCL	8.86
99% Chebyshev (MVUE) UCL	11.27		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5.951	95% Jackknife UCL	6.443
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	6.893	95% Chebyshev(Mean, Sd) UCL	7.838
97.5% Chebyshev(Mean, Sd) UCL	9.149	99% Chebyshev(Mean, Sd) UCL	11.72

Suggested UCL to Use

95% Student's-t UCL	6.443

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cr in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/2/2015 12:45
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	3.72	Mean	4.208
Maximum	4.99	Median	4.06
SD	0.609	Std. Error of Mean	0.304
Coefficient of Variation	0.145	Skewness	0.77

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.87	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.284	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4.924	95% Adjusted-CLT UCL (Chen-1995)	4.833
		95% Modified-t UCL (Johnson-1978)	4.943
Gamma GOF Test			
A-D Test Statistic	0.421	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.656	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.32	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	65.57	k star (bias corrected MLE)	16.56
Theta hat (MLE)	0.0642	Theta star (bias corrected MLE)	0.254
nu hat (MLE)	524.6	nu star (bias corrected)	132.5
MLE Mean (bias corrected)	4.208	MLE Sd (bias corrected)	1.034
		Approximate Chi Square Value (0.05)	106.9
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	5.215	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.87	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.287	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.314	Mean of logged Data	1.429
Maximum of Logged Data	1.607	SD of logged Data	0.142
Assuming Lognormal Distribution			
95% H-UCL	5.097	90% Chebyshev (MVUE) UCL	5.101
95% Chebyshev (MVUE) UCL	5.505	97.5% Chebyshev (MVUE) UCL	6.067
99% Chebyshev (MVUE) UCL	7.171		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	4.708	95% Jackknife UCL	4.924
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.12	95% Chebyshev(Mean, Sd) UCL	5.534
97.5% Chebyshev(Mean, Sd) UCL	6.108	99% Chebyshev(Mean, Sd) UCL	7.235

Suggested UCL to Use

95% Student's-t UCL	4.924

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:19
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	103	Mean	146.5
Maximum	223	Median	130
SD	55.55	Std. Error of Mean	27.77
Coefficient of Variation	0.379	Skewness	1.2

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.872	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.256	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	211.9	95% Adjusted-CLT UCL (Chen-1995)	210
		95% Modified-t UCL (Johnson-1978)	214.6
Gamma GOF Test			
A-D Test Statistic	0.377	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.293	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	10.15	k star (bias corrected MLE)	2.705
Theta hat (MLE)	14.43	Theta star (bias corrected MLE)	54.15
nu hat (MLE)	81.23	nu star (bias corrected)	21.64
MLE Mean (bias corrected)	146.5	MLE Sd (bias corrected)	89.07
		Approximate Chi Square Value (0.05)	12.07
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	262.7	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.899	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.262	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.635	Mean of logged Data	4.937
Maximum of Logged Data	5.407	SD of logged Data	0.358
Assuming Lognormal Distribution			
95% H-UCL	276.2	90% Chebyshev (MVUE) UCL	223.9
95% Chebyshev (MVUE) UCL	259.2	97.5% Chebyshev (MVUE) UCL	308.1
99% Chebyshev (MVUE) UCL	404.1		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	192.2	95% Jackknife UCL	211.9
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	229.8	95% Chebyshev(Mean, Sd) UCL	267.6
97.5% Chebyshev(Mean, Sd) UCL	320	99% Chebyshev(Mean, Sd) UCL	422.9

Suggested UCL to Use

95% Student's-t UCL	211.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hg in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 9:17
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	1
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	0.038	Minimum Non-Detect	0.02
Maximum Detect	0.04	Maximum Non-Detect	0.02
Variance Detects	2.00E-06	Percent Non-Detects	33.33%
Mean Detects	0.039	SD Detects	0.00141
Median Detects	0.039	CV Detects	0.0363
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-3.245	SD of Logged Detects	0.0363

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0327	Standard Error of Mean	0.00734
SD	0.00899	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0541	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0447	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0547	95% KM Chebyshev UCL	0.0647
97.5% KM Chebyshev UCL	0.0785	99% KM Chebyshev UCL	0.106

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	1521	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.56E-05	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	6083	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	13.19	nu hat (KM)	79.15
		Adjusted Level of Significance (β)	0.00136
Approximate Chi Square Value (79.15, α)	59.66	Adjusted Chi Square Value (79.15, β)	46.69
95% Gamma Approximate KM-UCL (use when n>=50)	0.0433	95% Gamma Adjusted KM-UCL (use when n<50)	0.0554

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0376	Mean in Log Scale	-3.283
SD in Original Scale	0.00268	SD in Log Scale	0.072
95% t UCL (assumes normality of ROS data)	0.0421	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	N/A		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0293	Mean in Log Scale	-3.698
SD in Original Scale	0.0168	SD in Log Scale	0.786
95% t UCL (Assumes normality)	0.0576	95% H-Stat UCL	10.03

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Pb in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:19
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	231	Mean	299.5
Maximum	367	Median	300
SD	64.01	Std. Error of Mean	32
Coefficient of Variation	0.214	Skewness	-0.0237

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test		
Shapiro Wilk Test Statistic	0.923	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.231	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level
Data appear Normal at 5% Significance Level		

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	374.8	95% Adjusted-CLT UCL (Chen-1995)	351.7
		95% Modified-t UCL (Johnson-1978)	374.8

Gamma GOF Test		
A-D Test Statistic	0.334	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.27	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics			
k hat (MLE)	28.67	k star (bias corrected MLE)	7.335
Theta hat (MLE)	10.45	Theta star (bias corrected MLE)	40.83
nu hat (MLE)	229.4	nu star (bias corrected)	58.68
MLE Mean (bias corrected)	299.5	MLE Sd (bias corrected)	110.6
		Approximate Chi Square Value (0.05)	42.07
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	417.8	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.924	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.242	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics			
Minimum of Logged Data	5.442	Mean of logged Data	5.685
Maximum of Logged Data	5.905	SD of logged Data	0.217

Assuming Lognormal Distribution			
95% H-UCL	413.1	90% Chebyshev (MVUE) UCL	396.9
95% Chebyshev (MVUE) UCL	441	97.5% Chebyshev (MVUE) UCL	502.2
99% Chebyshev (MVUE) UCL	622.4		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	352.1	95% Jackknife UCL	374.8
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	395.5	95% Chebyshev(Mean, Sd) UCL	439
97.5% Chebyshev(Mean, Sd) UCL	499.4	99% Chebyshev(Mean, Sd) UCL	617.9

Suggested UCL to Use

95% Student's-t UCL	374.8

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Mn in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:20
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	3010	Mean	4348
Maximum	6900	Median	3740
SD	1736	Std. Error of Mean	868.1
Coefficient of Variation	0.399	Skewness	1.757

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.792	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.385	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6390	95% Adjusted-CLT UCL (Chen-1995)	6590
		95% Modified-t UCL (Johnson-1978)	6517

Gamma GOF Test

A-D Test Statistic	0.537	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.385	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.836	k star (bias corrected MLE)	2.626
Theta hat (MLE)	442	Theta star (bias corrected MLE)	1656
nu hat (MLE)	78.69	nu star (bias corrected)	21.01
MLE Mean (bias corrected)	4348	MLE Sd (bias corrected)	2683
		Approximate Chi Square Value (0.05)	11.6
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7876	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.851	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.356	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.01	Mean of logged Data	8.326
Maximum of Logged Data	8.839	SD of logged Data	0.357

Assuming Lognormal Distribution

95% H-UCL	8164	90% Chebyshev (MVUE) UCL	6628
95% Chebyshev (MVUE) UCL	7669	97.5% Chebyshev (MVUE) UCL	9114
99% Chebyshev (MVUE) UCL	11953		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5775	95% Jackknife UCL	6390
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	6952	95% Chebyshev(Mean, Sd) UCL	8131
97.5% Chebyshev(Mean, Sd) UCL	9769	99% Chebyshev(Mean, Sd) UCL	12985

Suggested UCL to Use

95% Student's-t UCL	6390

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:20
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	7.27	Mean	9.415
Maximum	13.1	Median	8.645
SD	2.567	Std. Error of Mean	1.283
Coefficient of Variation	0.273	Skewness	1.512

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.874	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.3	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	12.44	95% Adjusted-CLT UCL (Chen-1995)	12.56
		95% Modified-t UCL (Johnson-1978)	12.6

Gamma GOF Test

A-D Test Statistic	0.365	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.282	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	19.86	k star (bias corrected MLE)	5.132
Theta hat (MLE)	0.474	Theta star (bias corrected MLE)	1.834
nu hat (MLE)	158.9	nu star (bias corrected)	41.06
MLE Mean (bias corrected)	9.415	MLE Sd (bias corrected)	4.156
		Approximate Chi Square Value (0.05)	27.37
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	14.12	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.919	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.265	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.984	Mean of logged Data	2.217
Maximum of Logged Data	2.573	SD of logged Data	0.254

Assuming Lognormal Distribution

95% H-UCL	13.93	90% Chebyshev (MVUE) UCL	12.97
95% Chebyshev (MVUE) UCL	14.58	97.5% Chebyshev (MVUE) UCL	16.83
99% Chebyshev (MVUE) UCL	21.23		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	11.53	95% Jackknife UCL	12.44
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	13.26	95% Chebyshev(Mean, Sd) UCL	15.01
97.5% Chebyshev(Mean, Sd) UCL	17.43	99% Chebyshev(Mean, Sd) UCL	22.18

Suggested UCL to Use

95% Student's-t UCL	12.44

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Se in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:20
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	2
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	1.06	Minimum Non-Detect	0.498
Maximum Detect	1.4	Maximum Non-Detect	1.02
Variance Detects	0.0578	Percent Non-Detects	50%
Mean Detects	1.23	SD Detects	0.24
Median Detects	1.23	CV Detects	0.195
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	0.197	SD of Logged Detects	0.197

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.864	Standard Error of Mean	0.272
SD	0.385	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.505	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.312	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.681	95% KM Chebyshev UCL	2.051
97.5% KM Chebyshev UCL	2.565	99% KM Chebyshev UCL	3.574

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	52.01	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.0236	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	208.1	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	5.03	nu hat (KM)	40.24
		Adjusted Level of Significance (β)	0.00498
Approximate Chi Square Value (40.24, α)	26.71	Adjusted Chi Square Value (40.24, β)	20.87
95% Gamma Approximate KM-UCL (use when n>=50)	1.302	95% Gamma Adjusted KM-UCL (use when n<50)	1.666

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.914	Mean in Log Scale	-0.159
SD in Original Scale	0.391	SD in Log Scale	0.426
95% t UCL (assumes normality of ROS data)	1.373	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	2.103		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.805	Mean in Log Scale	-0.417
SD in Original Scale	0.521	SD in Log Scale	0.776
95% t UCL (Assumes normality)	1.418	95% H-Stat UCL	9.42

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.505	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!
Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:20
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	0.724	Mean	1.078
Maximum	1.37	Median	1.109
SD	0.297	Std. Error of Mean	0.148
Coefficient of Variation	0.275	Skewness	-0.372

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.938	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.241	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.427	95% Adjusted-CLT UCL (Chen-1995)	1.293
		95% Modified-t UCL (Johnson-1978)	1.423
Gamma GOF Test			
A-D Test Statistic	0.309	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.278	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	16.43	k star (bias corrected MLE)	4.274
Theta hat (MLE)	0.0656	Theta star (bias corrected MLE)	0.252
nu hat (MLE)	131.4	nu star (bias corrected)	34.19
MLE Mean (bias corrected)	1.078	MLE Sd (bias corrected)	0.521
		Approximate Chi Square Value (0.05)	21.82
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.689	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.929	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.248	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.323	Mean of logged Data	0.0444
Maximum of Logged Data	0.315	SD of logged Data	0.292
Assuming Lognormal Distribution			
95% H-UCL	1.733	90% Chebyshev (MVUE) UCL	1.548
95% Chebyshev (MVUE) UCL	1.761	97.5% Chebyshev (MVUE) UCL	2.056
99% Chebyshev (MVUE) UCL	2.636		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1.322	95% Jackknife UCL	1.427
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1.523	95% Chebyshev(Mean, Sd) UCL	1.725
97.5% Chebyshev(Mean, Sd) UCL	2.005	99% Chebyshev(Mean, Sd) UCL	2.555

Suggested UCL to Use

95% Student's-t UCL	1.427

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Zn in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:20
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1030	Mean	1738
Maximum	2910	Median	1505
SD	884.1	Std. Error of Mean	442
Coefficient of Variation	0.509	Skewness	0.946

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.878	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.271	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2778	95% Adjusted-CLT UCL (Chen-1995)	2688
		95% Modified-t UCL (Johnson-1978)	2813
Gamma GOF Test			
A-D Test Statistic	0.39	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.311	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	5.458	k star (bias corrected MLE)	1.531
Theta hat (MLE)	318.3	Theta star (bias corrected MLE)	1135
nu hat (MLE)	43.66	nu star (bias corrected)	12.25
MLE Mean (bias corrected)	1738	MLE Sd (bias corrected)	1404
		Approximate Chi Square Value (0.05)	5.392
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	3947	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.888	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.278	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.937	Mean of logged Data	7.366
Maximum of Logged Data	7.976	SD of logged Data	0.497
Assuming Lognormal Distribution			
95% H-UCL	5086	90% Chebyshev (MVUE) UCL	2999
95% Chebyshev (MVUE) UCL	3572	97.5% Chebyshev (MVUE) UCL	4369
99% Chebyshev (MVUE) UCL	5934		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	2465	95% Jackknife UCL	2778
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	3064	95% Chebyshev(Mean, Sd) UCL	3664
97.5% Chebyshev(Mean, Sd) UCL	4498	99% Chebyshev(Mean, Sd) UCL	6136

Suggested UCL to Use

95% Student's-t UCL	2778

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Al in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:37
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	7360	Mean	20025
Maximum	37400	Median	17670
SD	14820	Std. Error of Mean	7410
Coefficient of Variation	0.74	Skewness	0.385

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.865	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.291	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	37463	95% Adjusted-CLT UCL (Chen-1995)	33735
		95% Modified-t UCL (Johnson-1978)	37700

Gamma GOF Test

A-D Test Statistic	0.477	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.325	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.195	k star (bias corrected MLE)	0.715
Theta hat (MLE)	9122	Theta star (bias corrected MLE)	27988
nu hat (MLE)	17.56	nu star (bias corrected)	5.724
MLE Mean (bias corrected)	20025	MLE Sd (bias corrected)	23674
		Approximate Chi Square Value (0.05)	1.5
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	76391	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.84	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.289	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.904	Mean of logged Data	9.66
Maximum of Logged Data	10.53	SD of logged Data	0.833

Assuming Lognormal Distribution

95% H-UCL	330609	90% Chebyshev (MVUE) UCL	43920
95% Chebyshev (MVUE) UCL	54715	97.5% Chebyshev (MVUE) UCL	69699
99% Chebyshev (MVUE) UCL	99131		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	32213	95% Jackknife UCL	37463
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	42254	95% Chebyshev(Mean, Sd) UCL	52323
97.5% Chebyshev(Mean, Sd) UCL	66299	99% Chebyshev(Mean, Sd) UCL	93751

Suggested UCL to Use

95% Student's-t UCL	37463

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:37
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	15.9	Mean	21.93
Maximum	29.7	Median	21.05
SD	6.96	Std. Error of Mean	3.48
Coefficient of Variation	0.317	Skewness	0.25

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.849	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.295	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	30.11	95% Adjusted-CLT UCL (Chen-1995)	28.11
		95% Modified-t UCL (Johnson-1978)	30.19
Gamma GOF Test			
A-D Test Statistic	0.494	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.329	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	13.17	k star (bias corrected MLE)	3.459
Theta hat (MLE)	1.665	Theta star (bias corrected MLE)	6.339
nu hat (MLE)	105.4	nu star (bias corrected)	27.67
MLE Mean (bias corrected)	21.93	MLE Sd (bias corrected)	11.79
		Approximate Chi Square Value (0.05)	16.67
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	36.39	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.836	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.295	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.766	Mean of logged Data	3.049
Maximum of Logged Data	3.391	SD of logged Data	0.321
Assuming Lognormal Distribution			
95% H-UCL	37.68	90% Chebyshev (MVUE) UCL	32.39
95% Chebyshev (MVUE) UCL	37.13	97.5% Chebyshev (MVUE) UCL	43.71
99% Chebyshev (MVUE) UCL	56.64		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	27.65	95% Jackknife UCL	30.11
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	32.37	95% Chebyshev(Mean, Sd) UCL	37.09
97.5% Chebyshev(Mean, Sd) UCL	43.66	99% Chebyshev(Mean, Sd) UCL	56.55

Suggested UCL to Use

95% Student's-t UCL	30.11

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Be in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:37
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	2
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	3.51	Minimum Non-Detect	1.98
Maximum Detect	4.85	Maximum Non-Detect	1.99
Variance Detects	0.898	Percent Non-Detects	50%
Mean Detects	4.18	SD Detects	0.948
Median Detects	4.18	CV Detects	0.227
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	1.417	SD of Logged Detects	0.229

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	3.08	Standard Error of Mean	0.847
SD	1.198	95% KM (BCA) UCL	N/A
95% KM (t) UCL	5.073	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	4.473	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	5.621	95% KM Chebyshev UCL	6.772
97.5% KM Chebyshev UCL	8.369	99% KM Chebyshev UCL	11.51

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	38.59	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.108	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	154.3	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	6.613	nu hat (KM)	52.91
		Adjusted Level of Significance (β)	0.00498
Approximate Chi Square Value (52.91, α)	37.2	Adjusted Chi Square Value (52.91, β)	30.15
95% Gamma Approximate KM-UCL (use when n>=50)	4.381	95% Gamma Adjusted KM-UCL (use when n<50)	5.405

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.992	Mean in Log Scale	1.004
SD in Original Scale	1.477	SD in Log Scale	0.496
95% t UCL (assumes normality of ROS data)	4.73	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	8.731		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.586	Mean in Log Scale	0.705
SD in Original Scale	1.92	SD in Log Scale	0.833
95% t UCL (Assumes normality)	4.845	95% H-Stat UCL	42.74

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	5.073	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!
Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Cd in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2.46	Mean	10.07
Maximum	18.6	Median	9.615
SD	7.763	Std. Error of Mean	3.881
Coefficient of Variation	0.771	Skewness	0.158

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.901	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.258	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	19.21	95% Adjusted-CLT UCL (Chen-1995)	16.78
		95% Modified-t UCL (Johnson-1978)	19.26

Gamma GOF Test

A-D Test Statistic	0.355	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.661	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.281	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.812	k star (bias corrected MLE)	0.62
Theta hat (MLE)	5.558	Theta star (bias corrected MLE)	16.25
nu hat (MLE)	14.5	nu star (bias corrected)	4.958
MLE Mean (bias corrected)	10.07	MLE Sd (bias corrected)	12.79
		Approximate Chi Square Value (0.05)	1.133
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	44.08	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.913	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.259	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.9	Mean of logged Data	2.009
Maximum of Logged Data	2.923	SD of logged Data	0.956

Assuming Lognormal Distribution

95% H-UCL	401.9	90% Chebyshev (MVUE) UCL	24.09
95% Chebyshev (MVUE) UCL	30.34	97.5% Chebyshev (MVUE) UCL	39.01
99% Chebyshev (MVUE) UCL	56.05		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	16.46	95% Jackknife UCL	19.21
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	21.72	95% Chebyshev(Mean, Sd) UCL	26.99
97.5% Chebyshev(Mean, Sd) UCL	34.31	99% Chebyshev(Mean, Sd) UCL	48.69

Suggested UCL to Use

95% Student's-t UCL	19.21

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	92	Mean	191
Maximum	357	Median	157.5
SD	119.8	Std. Error of Mean	59.89
Coefficient of Variation	0.627	Skewness	1.234

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.893	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.234	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	331.9	95% Adjusted-CLT UCL (Chen-1995)	329
		95% Modified-t UCL (Johnson-1978)	338.1
Gamma GOF Test			
A-D Test Statistic	0.295	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.26	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	3.713	k star (bias corrected MLE)	1.095
Theta hat (MLE)	51.44	Theta star (bias corrected MLE)	174.4
nu hat (MLE)	29.7	nu star (bias corrected)	8.759
MLE Mean (bias corrected)	191	MLE Sd (bias corrected)	182.5
		Approximate Chi Square Value (0.05)	3.182
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	525.7	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.954	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.223	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.522	Mean of logged Data	5.112
Maximum of Logged Data	5.878	SD of logged Data	0.604
Assuming Lognormal Distribution			
95% H-UCL	873	90% Chebyshev (MVUE) UCL	356.9
95% Chebyshev (MVUE) UCL	432.7	97.5% Chebyshev (MVUE) UCL	537.8
99% Chebyshev (MVUE) UCL	744.4		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	289.5	95% Jackknife UCL	331.9
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	370.7	95% Chebyshev(Mean, Sd) UCL	452.1
97.5% Chebyshev(Mean, Sd) UCL	565	99% Chebyshev(Mean, Sd) UCL	786.9

Suggested UCL to Use

95% Student's-t UCL	331.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cr in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/2/2015 12:45
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	4.28	Mean	5.403
Maximum	7.38	Median	4.975
SD	1.372	Std. Error of Mean	0.686
Coefficient of Variation	0.254	Skewness	1.554

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.864	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.306	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	7.017	95% Adjusted-CLT UCL (Chen-1995)	7.1
		95% Modified-t UCL (Johnson-1978)	7.106

Gamma GOF Test			
A-D Test Statistic	0.387	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.291	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics			
k hat (MLE)	22.87	k star (bias corrected MLE)	5.883
Theta hat (MLE)	0.236	Theta star (bias corrected MLE)	0.918
nu hat (MLE)	182.9	nu star (bias corrected)	47.07
MLE Mean (bias corrected)	5.403	MLE Sd (bias corrected)	2.227
		Approximate Chi Square Value (0.05)	32.32
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	7.867	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.906	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.274	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics			
Minimum of Logged Data	1.454	Mean of logged Data	1.665
Maximum of Logged Data	1.999	SD of logged Data	0.237

Assuming Lognormal Distribution			
95% H-UCL	7.721	90% Chebyshev (MVUE) UCL	7.304
95% Chebyshev (MVUE) UCL	8.168	97.5% Chebyshev (MVUE) UCL	9.368
99% Chebyshev (MVUE) UCL	11.72		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	6.531	95% Jackknife UCL	7.017
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	7.46	95% Chebyshev(Mean, Sd) UCL	8.393
97.5% Chebyshev(Mean, Sd) UCL	9.686	99% Chebyshev(Mean, Sd) UCL	12.23

Suggested UCL to Use

95% Student's-t UCL	7.017

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hg in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 9:20
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	0.02	Mean	0.041
Maximum	0.06	Median	0.043
SD	0.0201	Std. Error of Mean	0.0116
Coefficient of Variation	0.49	Skewness	-0.444

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.993	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.206	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.0748	95% Adjusted-CLT UCL (Chen-1995)	0.0569
		95% Modified-t UCL (Johnson-1978)	0.0743

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	5.344	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00767	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	32.06	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.951	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.268	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.912	Mean of logged Data	-3.291
Maximum of Logged Data	-2.813	SD of logged Data	0.563

Assuming Lognormal Distribution

95% H-UCL	0.806	90% Chebyshev (MVUE) UCL	0.08
95% Chebyshev (MVUE) UCL	0.0976	97.5% Chebyshev (MVUE) UCL	0.122
99% Chebyshev (MVUE) UCL	0.17		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0601	95% Jackknife UCL	0.0748
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0.0758	95% Chebyshev(Mean, Sd) UCL	0.0915
97.5% Chebyshev(Mean, Sd) UCL	0.113	99% Chebyshev(Mean, Sd) UCL	0.156

Suggested UCL to Use

95% Student's-t UCL	0.0748

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Pb in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	244	Mean	299.5
Maximum	378	Median	288
SD	65.08	Std. Error of Mean	32.54
Coefficient of Variation	0.217	Skewness	0.482

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.876	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.286	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	376.1	95% Adjusted-CLT UCL (Chen-1995)	361.4
		95% Modified-t UCL (Johnson-1978)	377.4

Gamma GOF Test

A-D Test Statistic	0.426	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.321	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	28.76	k star (bias corrected MLE)	7.356
Theta hat (MLE)	10.42	Theta star (bias corrected MLE)	40.72
nu hat (MLE)	230.1	nu star (bias corrected)	58.85
MLE Mean (bias corrected)	299.5	MLE Sd (bias corrected)	110.4
		Approximate Chi Square Value (0.05)	42.21
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	417.6	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.871	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.287	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.497	Mean of logged Data	5.685
Maximum of Logged Data	5.935	SD of logged Data	0.215

Assuming Lognormal Distribution

95% H-UCL	411.2	90% Chebyshev (MVUE) UCL	395.7
95% Chebyshev (MVUE) UCL	439.3	97.5% Chebyshev (MVUE) UCL	499.9
99% Chebyshev (MVUE) UCL	618.8		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	353	95% Jackknife UCL	376.1
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	397.1	95% Chebyshev(Mean, Sd) UCL	441.3
97.5% Chebyshev(Mean, Sd) UCL	502.7	99% Chebyshev(Mean, Sd) UCL	623.3

Suggested UCL to Use

95% Student's-t UCL	376.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Mn in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2130	Mean	7425
Maximum	13100	Median	7235
SD	5216	Std. Error of Mean	2608
Coefficient of Variation	0.703	Skewness	0.104

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.913	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.246	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	13563	95% Adjusted-CLT UCL (Chen-1995)	11860
		95% Modified-t UCL (Johnson-1978)	13586

Gamma GOF Test

A-D Test Statistic	0.336	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.279	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.235	k star (bias corrected MLE)	0.725
Theta hat (MLE)	3323	Theta star (bias corrected MLE)	10237
nu hat (MLE)	17.88	nu star (bias corrected)	5.803
MLE Mean (bias corrected)	7425	MLE Sd (bias corrected)	8718
		Approximate Chi Square Value (0.05)	1.54
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	27980	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.921	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.255	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.664	Mean of logged Data	8.672
Maximum of Logged Data	9.48	SD of logged Data	0.849

Assuming Lognormal Distribution

95% H-UCL	138250	90% Chebyshev (MVUE) UCL	16668
95% Chebyshev (MVUE) UCL	20798	97.5% Chebyshev (MVUE) UCL	26529
99% Chebyshev (MVUE) UCL	37787		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	11715	95% Jackknife UCL	13563
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	15250	95% Chebyshev(Mean, Sd) UCL	18794
97.5% Chebyshev(Mean, Sd) UCL	23713	99% Chebyshev(Mean, Sd) UCL	33377

Suggested UCL to Use

95% Student's-t UCL	13563

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	7.36	Mean	18.27
Maximum	31.6	Median	17.05
SD	10.78	Std. Error of Mean	5.391
Coefficient of Variation	0.59	Skewness	0.475

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.962	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.216	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	30.95	95% Adjusted-CLT UCL (Chen-1995)	28.5
		95% Modified-t UCL (Johnson-1978)	31.16

Gamma GOF Test

A-D Test Statistic	0.232	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.207	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.568	k star (bias corrected MLE)	1.059
Theta hat (MLE)	5.119	Theta star (bias corrected MLE)	17.25
nu hat (MLE)	28.55	nu star (bias corrected)	8.47
MLE Mean (bias corrected)	18.27	MLE Sd (bias corrected)	17.75
		Approximate Chi Square Value (0.05)	3.01
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	51.4	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.975	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.197	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.996	Mean of logged Data	2.758
Maximum of Logged Data	3.453	SD of logged Data	0.644

Assuming Lognormal Distribution

95% H-UCL	102.2	90% Chebyshev (MVUE) UCL	35.53
95% Chebyshev (MVUE) UCL	43.31	97.5% Chebyshev (MVUE) UCL	54.12
99% Chebyshev (MVUE) UCL	75.34		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	27.13	95% Jackknife UCL	30.95
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	34.44	95% Chebyshev(Mean, Sd) UCL	41.76
97.5% Chebyshev(Mean, Sd) UCL	51.93	99% Chebyshev(Mean, Sd) UCL	71.9

Suggested UCL to Use

95% Student's-t UCL	30.95

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1.02	Mean	1.285
Maximum	1.71	Median	1.205
SD	0.314	Std. Error of Mean	0.157
Coefficient of Variation	0.244	Skewness	1.074

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.903	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.243	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.654	95% Adjusted-CLT UCL (Chen-1995)	1.633
		95% Modified-t UCL (Johnson-1978)	1.668

Gamma GOF Test

A-D Test Statistic	0.33	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.275	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	23.81	k star (bias corrected MLE)	6.118
Theta hat (MLE)	0.054	Theta star (bias corrected MLE)	0.21
nu hat (MLE)	190.5	nu star (bias corrected)	48.95
MLE Mean (bias corrected)	1.285	MLE Sd (bias corrected)	0.52
		Approximate Chi Square Value (0.05)	33.89
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.856	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.924	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.243	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0198	Mean of logged Data	0.23
Maximum of Logged Data	0.536	SD of logged Data	0.234

Assuming Lognormal Distribution

95% H-UCL	1.829	90% Chebyshev (MVUE) UCL	1.733
95% Chebyshev (MVUE) UCL	1.937	97.5% Chebyshev (MVUE) UCL	2.219
99% Chebyshev (MVUE) UCL	2.774		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.543	95% Jackknife UCL	1.654
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1.755	95% Chebyshev(Mean, Sd) UCL	1.968
97.5% Chebyshev(Mean, Sd) UCL	2.264	99% Chebyshev(Mean, Sd) UCL	2.845

Suggested UCL to Use

95% Student's-t UCL	1.654

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Se in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	2
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	1.16	Minimum Non-Detect	0.496
Maximum Detect	3.1	Maximum Non-Detect	0.997
Variance Detects	1.882	Percent Non-Detects	50%
Mean Detects	2.13	SD Detects	1.372
Median Detects	2.13	CV Detects	0.644
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	0.64	SD of Logged Detects	0.695

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.313	Standard Error of Mean	0.754
SD	1.067	95% KM (BCA) UCL	N/A
95% KM (t) UCL	3.088	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	2.554	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	3.576	95% KM Chebyshev UCL	4.601
97.5% KM Chebyshev UCL	6.024	99% KM Chebyshev UCL	8.818

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	4.462	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.477	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	17.85	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.515	nu hat (KM)	12.12
		Adjusted Level of Significance (β)	0.00498
Approximate Chi Square Value (12.12, α)	5.306	Adjusted Chi Square Value (12.12, β)	3.132
95% Gamma Approximate KM-UCL (use when n>=50)	2.999	95% Gamma Adjusted KM-UCL (use when n<50)	5.08

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.142	Mean in Log Scale	-0.618
SD in Original Scale	1.389	SD in Log Scale	1.507
95% t UCL (assumes normality of ROS data)	2.776	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	9381		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.252	Mean in Log Scale	-0.203
SD in Original Scale	1.291	SD in Log Scale	1.09
95% t UCL (Assumes normality)	2.771	95% H-Stat UCL	141.3

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.088	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 11:31
From File	WorkSheet_e.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1700	Mean	4620
Maximum	8670	Median	4055
SD	3335	Std. Error of Mean	1668
Coefficient of Variation	0.722	Skewness	0.502

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.891	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.277	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	8544	95% Adjusted-CLT UCL (Chen-1995)	7810
		95% Modified-t UCL (Johnson-1978)	8614
Gamma GOF Test			
A-D Test Statistic	0.397	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.304	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.371	k star (bias corrected MLE)	0.759
Theta hat (MLE)	1949	Theta star (bias corrected MLE)	6084
nu hat (MLE)	18.97	nu star (bias corrected)	6.075
MLE Mean (bias corrected)	4620	MLE Sd (bias corrected)	5302
		Approximate Chi Square Value (0.05)	1.678
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	16724	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.887	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.264	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	7.438	Mean of logged Data	8.213
Maximum of Logged Data	9.068	SD of logged Data	0.796
Assuming Lognormal Distribution			
95% H-UCL	60185	90% Chebyshev (MVUE) UCL	9897
95% Chebyshev (MVUE) UCL	12284	97.5% Chebyshev (MVUE) UCL	15597
99% Chebyshev (MVUE) UCL	22105		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	7363	95% Jackknife UCL	8544
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	9623	95% Chebyshev(Mean, Sd) UCL	11889
97.5% Chebyshev(Mean, Sd) UCL	15034	99% Chebyshev(Mean, Sd) UCL	21212

Suggested UCL to Use

95% Student's-t UCL	8544

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Appendix 15

ProUCL calculations to derive EPCs for dissolved metals in field-collected pore water for benthic invertebrates

ProUCL calculations for dissolved Al in pore water from the Animas River above the confluence with mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/5/2015 14:28
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	9
Number of Detects	8	Number of Non-Detects	3
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	20.9	Minimum Non-Detect	20
Maximum Detect	6170	Maximum Non-Detect	20
Variance Detects	4686062	Percent Non-Detects	27.27%
Mean Detects	1259	SD Detects	2165
Median Detects	260	CV Detects	1.72
Skewness Detects	2.123	Kurtosis Detects	4.375
Mean of Logged Detects	5.552	SD of Logged Detects	2.069

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.661	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.357	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.313	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	921	Standard Error of Mean	584.3
SD	1813	95% KM (BCA) UCL	2035
95% KM (t) UCL	1980	95% KM (Percentile Bootstrap) UCL	1989
95% KM (z) UCL	1882	95% KM Bootstrap t UCL	7837
90% KM Chebyshev UCL	2674	95% KM Chebyshev UCL	3468
97.5% KM Chebyshev UCL	4570	99% KM Chebyshev UCL	6735

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.458	Anderson-Darling GOF Test	
5% A-D Critical Value	0.778	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.208	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.413	k star (bias corrected MLE)	0.341
Theta hat (MLE)	3050	Theta star (bias corrected MLE)	3689
nu hat (MLE)	6.604	nu star (bias corrected)	5.461
MLE Mean (bias corrected)	1259	MLE Sd (bias corrected)	2155

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.258	nu hat (KM)	5.679
Approximate Chi Square Value (5.68, α)	1.478	Adjusted Chi Square Value (5.68, β)	1.159
95% Gamma Approximate KM-UCL (use when n>=50)	3539	95% Gamma Adjusted KM-UCL (use when n<50)	4514

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	915.6
Maximum	6170	Median	42.8
SD	1904	CV	2.08
k hat (MLE)	0.185	k star (bias corrected MLE)	0.195
Theta hat (MLE)	4962	Theta star (bias corrected MLE)	4700
nu hat (MLE)	4.06	nu star (bias corrected)	4.286
MLE Mean (bias corrected)	915.6	MLE Sd (bias corrected)	2074
		Adjusted Level of Significance (β)	0.0278
Approximate Chi Square Value (4.29, α)	0.838	Adjusted Chi Square Value (4.29, β)	0.623
95% Gamma Approximate UCL (use when n>=50)	4684	95% Gamma Adjusted UCL (use when n<50)	6297

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.936	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.182	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.313	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	916.1	Mean in Log Scale	4.109
SD in Original Scale	1904	SD in Log Scale	3.059
95% t UCL (assumes normality of ROS data)	1957	95% Percentile Bootstrap UCL	1966
95% BCA Bootstrap UCL	2394	95% Bootstrap t UCL	7860
95% H-UCL (Log ROS)	10504481		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	4.855	95% H-UCL (KM -Log)	25280
KM SD (logged)	2.005	95% Critical H Value (KM-Log)	5.165
KM Standard Error of Mean (logged)	0.646		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	918.3	Mean in Log Scale	4.666
SD in Original Scale	1903	SD in Log Scale	2.302
95% t UCL (Assumes normality)	1958	95% H-Stat UCL	106111

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	3468	95% GROS Adjusted Gamma UCL	6297
95% Adjusted Gamma KM-UCL	4514		

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd in pore water from the Animas River above the confluence with mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/5/2015 14:28
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	0.279	Mean	23.58
Maximum	106.5	Median	1.67
SD	40.29	Std. Error of Mean	12.15
Coefficient of Variation	1.708	Skewness	1.752

Normal GOF Test

Shapiro Wilk Test Statistic	0.625	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.33	Lilliefors GOF Test
5% Lilliefors Critical Value	0.267	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	45.6	95% Adjusted-CLT UCL (Chen-1995)	50.42
		95% Modified-t UCL (Johnson-1978)	46.67

Gamma GOF Test

A-D Test Statistic	0.806	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.809	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.245	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.274	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.357	k star (bias corrected MLE)	0.32
Theta hat (MLE)	66.14	Theta star (bias corrected MLE)	73.72
nu hat (MLE)	7.844	nu star (bias corrected)	7.038
MLE Mean (bias corrected)	23.58	MLE Sd (bias corrected)	41.7
		Approximate Chi Square Value (0.05)	2.192
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	1.778

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	75.74	95% Adjusted Gamma UCL (use when n<50)	93.35

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.891	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.18	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.267	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.277	Mean of logged Data	1.28
Maximum of Logged Data	4.668	SD of logged Data	2.232

Assuming Lognormal Distribution

95% H-UCL	2400	90% Chebyshev (MVUE) UCL	78.75
95% Chebyshev (MVUE) UCL	102.9	97.5% Chebyshev (MVUE) UCL	136.4
99% Chebyshev (MVUE) UCL	202.2		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	43.56	95% Jackknife UCL	45.6
95% Standard Bootstrap UCL	42.7	95% Bootstrap-t UCL	110.9
95% Hall's Bootstrap UCL	147.4	95% Percentile Bootstrap UCL	42.46
95% BCA Bootstrap UCL	50.92		
90% Chebyshev(Mean, Sd) UCL	60.02	95% Chebyshev(Mean, Sd) UCL	76.53
97.5% Chebyshev(Mean, Sd) UCL	99.44	99% Chebyshev(Mean, Sd) UCL	144.4

Suggested UCL to Use

95% Adjusted Gamma UCL	93.35

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cu in pore water from the Animas River above the confluence with mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/5/2015 14:28
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	1.27	Mean	223.9
Maximum	2250	Median	3.46
SD	672.7	Std. Error of Mean	202.8
Coefficient of Variation	3.004	Skewness	3.304

Normal GOF Test

Shapiro Wilk Test Statistic	0.379	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.485	Lilliefors GOF Test
5% Lilliefors Critical Value	0.267	Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level		

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	591.5	95% Adjusted-CLT UCL (Chen-1995)	773.4
		95% Modified-t UCL (Johnson-1978)	625.2

Gamma GOF Test

A-D Test Statistic	1.64	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.848	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.325	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.28	Data Not Gamma Distributed at 5% Significance Level
Data Not Gamma Distributed at 5% Significance Level		

Gamma Statistics

k hat (MLE)	0.231	k star (bias corrected MLE)	0.229
Theta hat (MLE)	968.9	Theta star (bias corrected MLE)	979.2
nu hat (MLE)	5.084	nu star (bias corrected)	5.031
MLE Mean (bias corrected)	223.9	MLE Sd (bias corrected)	468.2
		Approximate Chi Square Value (0.05)	1.167
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	0.895

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	965.7	95% Adjusted Gamma UCL (use when n<50)	1259

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.82	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.85	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.279	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.267	Data Not Lognormal at 5% Significance Level
Data Not Lognormal at 5% Significance Level		

Lognormal Statistics

Minimum of Logged Data	0.239	Mean of logged Data	2.299
Maximum of Logged Data	7.719	SD of logged Data	2.412

Assuming Lognormal Distribution

95% H-UCL	19254	90% Chebyshev (MVUE) UCL	302.3
95% Chebyshev (MVUE) UCL	396.6	97.5% Chebyshev (MVUE) UCL	527.6
99% Chebyshev (MVUE) UCL	784.8		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	557.5	95% Jackknife UCL	591.5
95% Standard Bootstrap UCL	551.4	95% Bootstrap-t UCL	7505
95% Hall's Bootstrap UCL	5240	95% Percentile Bootstrap UCL	628.4
95% BCA Bootstrap UCL	833.1		
90% Chebyshev(Mean, Sd) UCL	832.4	95% Chebyshev(Mean, Sd) UCL	1108
97.5% Chebyshev(Mean, Sd) UCL	1491	99% Chebyshev(Mean, Sd) UCL	2242

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL	2242

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Pb in pore water from the Animas River above the confluence with mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/5/2015 14:29
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	8
Number of Detects	6	Number of Non-Detects	5
Number of Distinct Detects	6	Number of Distinct Non-Detects	2
Minimum Detect	0.123	Minimum Non-Detect	0.1
Maximum Detect	65.6	Maximum Non-Detect	0.5
Variance Detects	673.6	Percent Non-Detects	45.45%
Mean Detects	13.66	SD Detects	25.95
Median Detects	1.29	CV Detects	1.9
Skewness Detects	2.255	Kurtosis Detects	5.155
Mean of Logged Detects	0.579	SD of Logged Detects	2.418

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.626	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.34	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.362	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	7.499	Standard Error of Mean	6.194
SD	18.75	95% KM (BCA) UCL	18.37
95% KM (t) UCL	18.73	95% KM (Percentile Bootstrap) UCL	19.22
95% KM (z) UCL	17.69	95% KM Bootstrap t UCL	194.9
90% KM Chebyshev UCL	26.08	95% KM Chebyshev UCL	34.5
97.5% KM Chebyshev UCL	46.18	99% KM Chebyshev UCL	69.13

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.446	Anderson-Darling GOF Test	
5% A-D Critical Value	0.762	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.262	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.355	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.333	k star (bias corrected MLE)	0.278
Theta hat (MLE)	41.01	Theta star (bias corrected MLE)	49.2
nu hat (MLE)	3.997	nu star (bias corrected)	3.332
MLE Mean (bias corrected)	13.66	MLE Sd (bias corrected)	25.92

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.16	nu hat (KM)	3.518
Approximate Chi Square Value (3.52, α)	0.541	Adjusted Chi Square Value (3.52, β)	0.388
95% Gamma Approximate KM-UCL (use when n>=50)	48.76	95% Gamma Adjusted KM-UCL (use when n<50)	68.03

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	7.455
Maximum	65.6	Median	0.123
SD	19.69	CV	2.641
k hat (MLE)	0.195	k star (bias corrected MLE)	0.203
Theta hat (MLE)	38.21	Theta star (bias corrected MLE)	36.82
nu hat (MLE)	4.293	nu star (bias corrected)	4.455
MLE Mean (bias corrected)	7.455	MLE Sd (bias corrected)	16.57
		Adjusted Level of Significance (β)	0.0278
Approximate Chi Square Value (4.46, α)	0.909	Adjusted Chi Square Value (4.46, β)	0.682
95% Gamma Approximate UCL (use when n>=50)	36.53	95% Gamma Adjusted UCL (use when n<50)	48.74

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.945	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.179	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.362	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.454	Mean in Log Scale	-2.26
SD in Original Scale	19.69	SD in Log Scale	3.839
95% t UCL (assumes normality of ROS data)	18.21	95% Percentile Bootstrap UCL	18.36
95% BCA Bootstrap UCL	25.51	95% Bootstrap t UCL	247
95% H-UCL (Log ROS)	16469143		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-0.713	95% H-UCL (KM -Log)	222.1
KM SD (logged)	2.162	95% Critical H Value (KM-Log)	5.526
KM Standard Error of Mean (logged)	0.715		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	7.492	Mean in Log Scale	-0.899
SD in Original Scale	19.67	SD in Log Scale	2.453
95% t UCL (Assumes normality)	18.24	95% H-Stat UCL	1011

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	18.73	95% KM (Percentile Bootstrap) UCL	19.22

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Mn in pore water from the Animas River above the confluence mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/5/2015 14:29
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
Number of Detects	10	Number of Non-Detects	1
Number of Distinct Detects	10	Number of Distinct Non-Detects	1
Minimum Detect	2.57	Minimum Non-Detect	2
Maximum Detect	78300	Maximum Non-Detect	2
Variance Detects	8.44E+08	Percent Non-Detects	9.09%
Mean Detects	17912	SD Detects	29057
Median Detects	1065	CV Detects	1.622
Skewness Detects	1.611	Kurtosis Detects	1.264
Mean of Logged Detects	6.525	SD of Logged Detects	4.007

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.68	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.313	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.28	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	16284	Standard Error of Mean	8512
SD	26782	95% KM (BCA) UCL	30726
95% KM (t) UCL	31711	95% KM (Percentile Bootstrap) UCL	30586
95% KM (z) UCL	30285	95% KM Bootstrap t UCL	68468
90% KM Chebyshev UCL	41820	95% KM Chebyshev UCL	53387
97.5% KM Chebyshev UCL	69441	99% KM Chebyshev UCL	100977

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.393	Anderson-Darling GOF Test	
5% A-D Critical Value	0.846	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.165	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.293	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.222	k star (bias corrected MLE)	0.222
Theta hat (MLE)	80843	Theta star (bias corrected MLE)	80771
nu hat (MLE)	4.431	nu star (bias corrected)	4.435
MLE Mean (bias corrected)	17912	MLE Sd (bias corrected)	38036

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.37	nu hat (KM)	8.133
Approximate Chi Square Value (8.13, α)	2.812	Adjusted Chi Square Value (8.13, β)	2.328
95% Gamma Approximate KM-UCL (use when n>=50)	47093	95% Gamma Adjusted KM-UCL (use when n<50)	56893

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	16284
Maximum	78300	Median	590
SD	28090	CV	1.725
k hat (MLE)	0.179	k star (bias corrected MLE)	0.191
Theta hat (MLE)	91020	Theta star (bias corrected MLE)	85381
nu hat (MLE)	3.936	nu star (bias corrected)	4.196
MLE Mean (bias corrected)	16284	MLE Sd (bias corrected)	37287
		Adjusted Level of Significance (β)	0.0278
Approximate Chi Square Value (4.20, α)	0.801	Adjusted Chi Square Value (4.20, β)	0.593
95% Gamma Approximate UCL (use when n>=50)	85346	95% Gamma Adjusted UCL (use when n<50)	115211

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.892	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.185	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.28	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	16284	Mean in Log Scale	5.649
SD in Original Scale	28090	SD in Log Scale	4.785
95% t UCL (assumes normality of ROS data)	31634	95% Percentile Bootstrap UCL	30309
95% BCA Bootstrap UCL	35146	95% Bootstrap t UCL	68483
95% H-UCL (Log ROS)	1.41E+15		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	5.995	95% H-UCL (KM -Log)	2.97E+11
KM SD (logged)	3.993	95% Critical H Value (KM-Log)	9.856
KM Standard Error of Mean (logged)	1.269		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	16284	Mean in Log Scale	5.932
SD in Original Scale	28090	SD in Log Scale	4.28
95% t UCL (Assumes normality)	31634	95% H-Stat UCL	5.66E+12

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	53387	95% GROS Adjusted Gamma UCL	115211
95% Adjusted Gamma KM-UCL	56893		

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn in pore water from the Animas River above the confluence with mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/5/2015 14:29
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	179	Mean	5735
Maximum	29900	Median	675
SD	9691	Std. Error of Mean	2922
Coefficient of Variation	1.69	Skewness	2.038

Normal GOF Test		
Shapiro Wilk Test Statistic	0.653	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.3	Lilliefors GOF Test
5% Lilliefors Critical Value	0.267	Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level		

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	11031	95% Adjusted-CLT UCL (Chen-1995)	12459
		95% Modified-t UCL (Johnson-1978)	11330

Gamma GOF Test		
A-D Test Statistic	0.829	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.791	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.248	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.271	Detected data appear Gamma Distributed at 5% Significance Level
Detected data follow Appr. Gamma Distribution at 5% Significance Level		

Gamma Statistics			
k hat (MLE)	0.447	k star (bias corrected MLE)	0.386
Theta hat (MLE)	12831	Theta star (bias corrected MLE)	14870
nu hat (MLE)	9.833	nu star (bias corrected)	8.485
MLE Mean (bias corrected)	5735	MLE Sd (bias corrected)	9234
		Approximate Chi Square Value (0.05)	3.019
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	2.512

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50)	16118	95% Adjusted Gamma UCL (use when n<50)	19367

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.879	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.221	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.267	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics			
Minimum of Logged Data	5.187	Mean of logged Data	7.208
Maximum of Logged Data	10.31	SD of logged Data	1.843

Assuming Lognormal Distribution			
95% H-UCL	120509	90% Chebyshev (MVUE) UCL	15021
95% Chebyshev (MVUE) UCL	19376	97.5% Chebyshev (MVUE) UCL	25421
99% Chebyshev (MVUE) UCL	37294		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	10541	95% Jackknife UCL	11031
95% Standard Bootstrap UCL	10420	95% Bootstrap-t UCL	23243
95% Hall's Bootstrap UCL	33946	95% Percentile Bootstrap UCL	10845
95% BCA Bootstrap UCL	12604		
90% Chebyshev(Mean, Sd) UCL	14500	95% Chebyshev(Mean, Sd) UCL	18471
97.5% Chebyshev(Mean, Sd) UCL	23982	99% Chebyshev(Mean, Sd) UCL	34807

Suggested UCL to Use

95% Adjusted Gamma UCL	19367

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hardness in pore water from the Animas River above the confluence with mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/9/2015 10:14
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	118	Mean	296
Maximum	853	Median	158
SD	226.9	Std. Error of Mean	68.42
Coefficient of Variation	0.767	Skewness	1.649

Normal GOF Test

Shapiro Wilk Test Statistic	0.784	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.274	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.267	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	420	95% Adjusted-CLT UCL (Chen-1995)	444.9
		95% Modified-t UCL (Johnson-1978)	425.7

Gamma GOF Test

A-D Test Statistic	0.755	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.737	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.288	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.258	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.391	k star (bias corrected MLE)	1.8
Theta hat (MLE)	123.8	Theta star (bias corrected MLE)	164.5
nu hat (MLE)	52.6	nu star (bias corrected)	39.59
MLE Mean (bias corrected)	296	MLE Sd (bias corrected)	220.7
		Approximate Chi Square Value (0.05)	26.17
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	24.41

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	447.7	95% Adjusted Gamma UCL (use when n<50)	480.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.868	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.271	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.267	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.771	Mean of logged Data	5.467
Maximum of Logged Data	6.749	SD of logged Data	0.676

Assuming Lognormal Distribution

95% H-UCL	500	90% Chebyshev (MVUE) UCL	474.2
95% Chebyshev (MVUE) UCL	557.4	97.5% Chebyshev (MVUE) UCL	673
99% Chebyshev (MVUE) UCL	899.9		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	408.5	95% Jackknife UCL	420
95% Standard Bootstrap UCL	403.1	95% Bootstrap-t UCL	505.1
95% Hall's Bootstrap UCL	557.7	95% Percentile Bootstrap UCL	410.2
95% BCA Bootstrap UCL	439.5		
90% Chebyshev(Mean, Sd) UCL	501.3	95% Chebyshev(Mean, Sd) UCL	594.2
97.5% Chebyshev(Mean, Sd) UCL	723.3	99% Chebyshev(Mean, Sd) UCL	976.7

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	594.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Appendix 16

Fall 2010 benthic macroinvertebrate data analysis for the Animas River stakeholder's group

2010 Benthic Macroinvertebrate Data Analysis, for the Animas River Stakeholders's Group, 12/7/10

Chester Anderson, B.U.G.S. Consulting

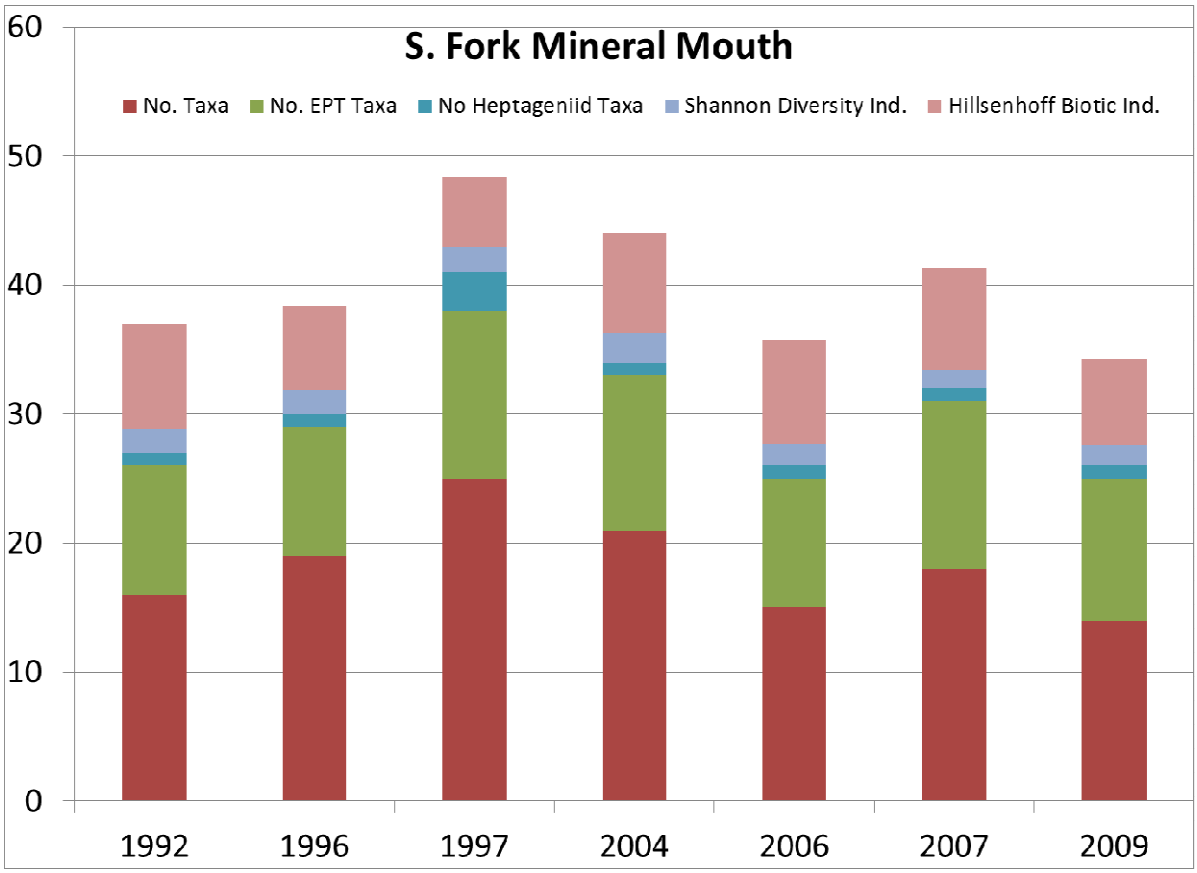
Methods:

I looked at several indices that are relatively independent of each other:

1. Total number of taxa along with the Shannon-Wiener diversity index. The Shannon Wiener index incorporates the relative number of each taxa (evenness) along with the total number of taxa into 1 metric. Typically the value of the Shannon-Wiener diversity index ranges from 1.5 (low species richness and evenness) to 3.5 (high species evenness and richness).
2. Total number of EPT (Ephemerotpera (mayflies) Plectoptera (stoneflies) and Trichoptera (caddisflies)) taxa along with the proportion of EPT taxa to the total number of taxa. These taxa tend to be more sensitive to pollution than other taxa.
3. Total number of Heptaganiid (flat-headed mayflies) taxa along with the proportion of Heptaganiid taxa to the total number of taxa. Heptaganiid are known to be very sensitive to metal pollution.
4. Hilsenhoff biotic index. The HBI ranges from 0 to 10, higher values indicating taxa with greater tolerances to pollution and thus poorer conditions in the river. The HBI formula takes accounts for the relative number of each taxa with particular tolerance values into the final metric. For graphical consistency with the other metrics, I subtracted the HBI from 10. Therefore, with my modified HBI, an increasing value indicates improving conditions on the graphs shown below. Although originally created for sensitivity to organic pollution, tolerance values work okay as indications of overall sensitivity to pollution.

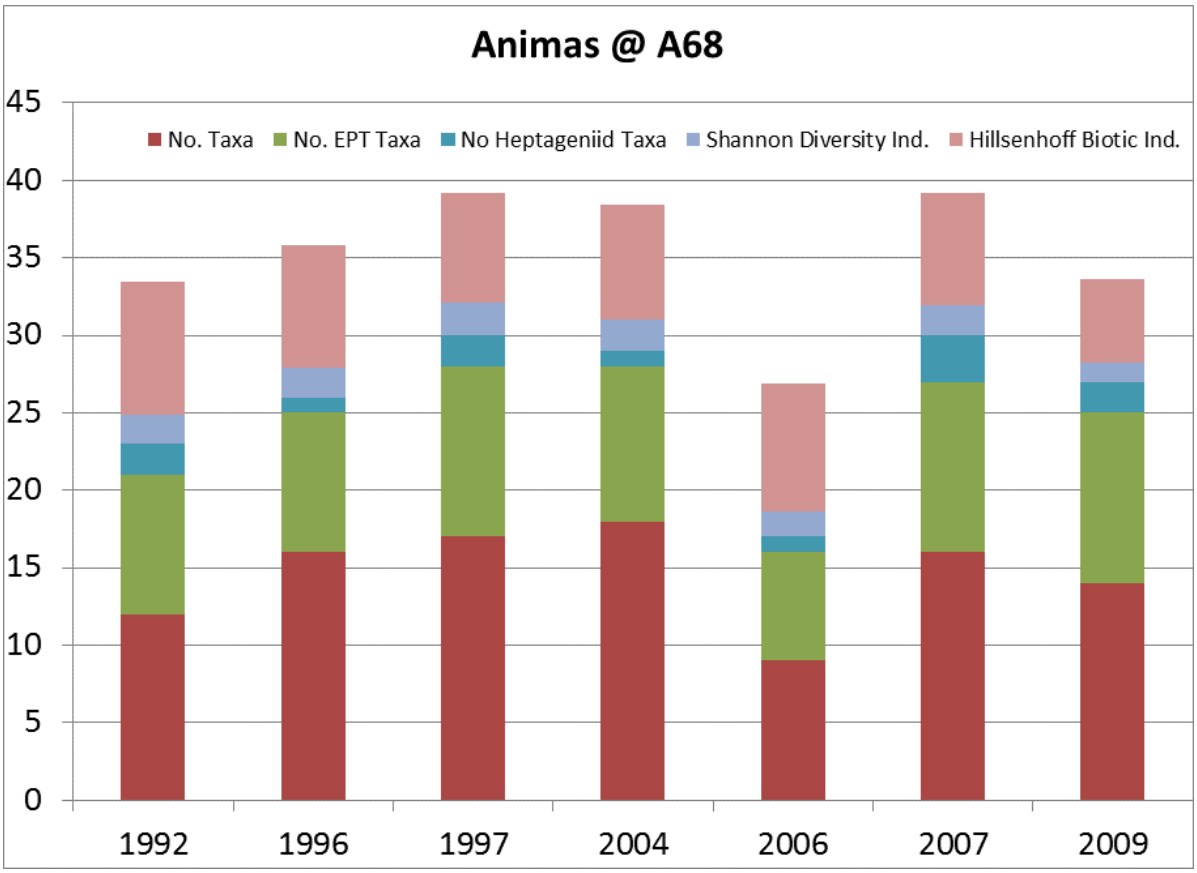
Below I discuss each sample site, comparing data collected after 2004 to the 2004 data itself and to the 96, 97 baseline data and to the CDPH&E's 1992 data. Although not reflected in the overall metric, in my analysis and discussions I give more weight to metrics in the following order: total number of Heptageniid taxa, total number of EPT taxa, Shannon-Wiener Diversity Index, total number of taxa, the HBI, and the proportions of total number.

The data collected at the Animas River at KOA campground includes the 96, 97 ARSG baseline data and post baseline data collected by the Animas Nutrient Workgroup and the Animas Watershed Partnership.



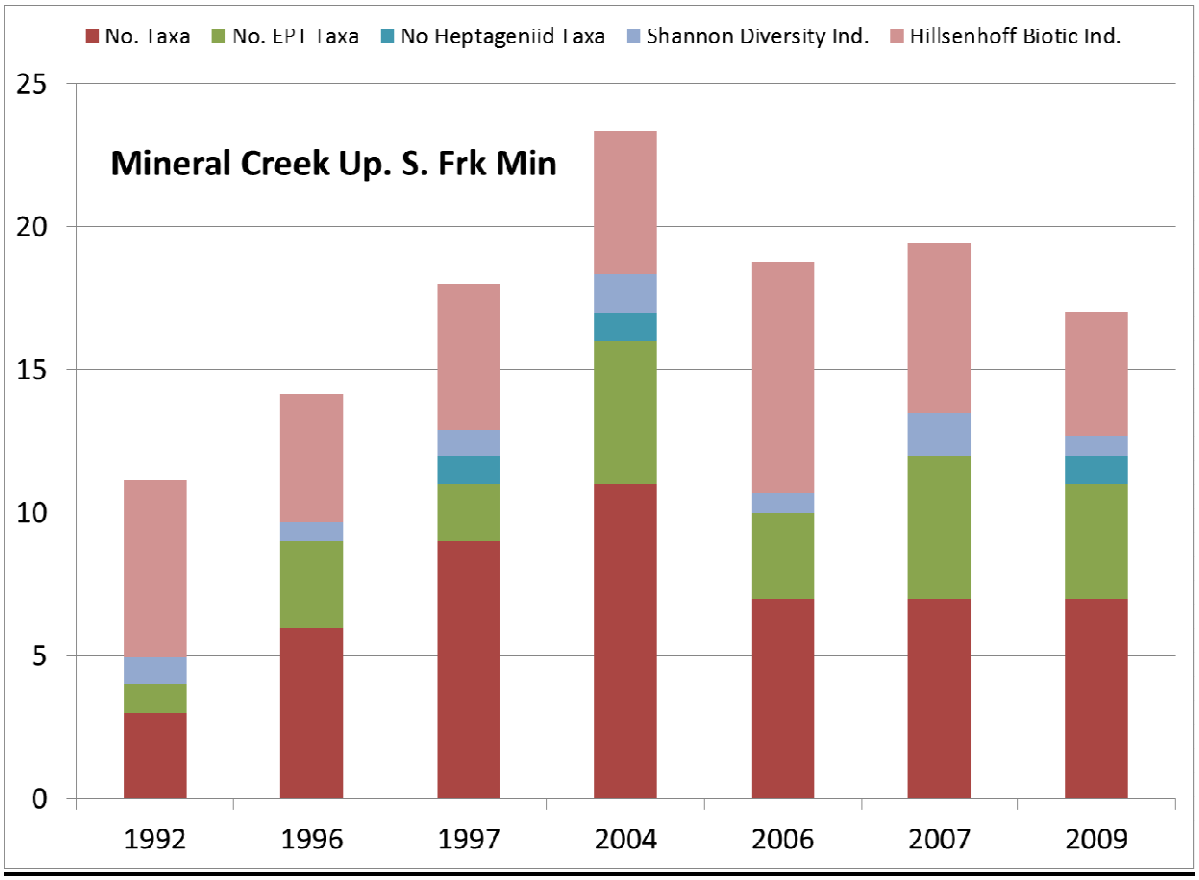
South Fork Mineral just upstream of confluence with Mineral (M28)

At this site there was a large decrease in the total number of taxa from 2004 (21) to 2009 (14) although the number of EPT taxa remained relatively constant, ranging from 12 in 2004 to 11 in 2009 and an average of 11.5 in the 96, 97 baseline data. The diversity index decreased significantly compared to the 2004 samples and decreased slightly when compared to the baseline data. The taxa in the 2009 samples had somewhat higher tolerance values resulting in the HBI increasing from 2.29 in 2004 to 3.30 in 2009 both showing improving conditiosn when compared to an average HBI of 3.97 for the 96, 97 baseline data. *Overall, the indices show slightly decreasing conditions at this site compared to the baseline and the 2004 data but relatively consistent compared to other sample sites.*



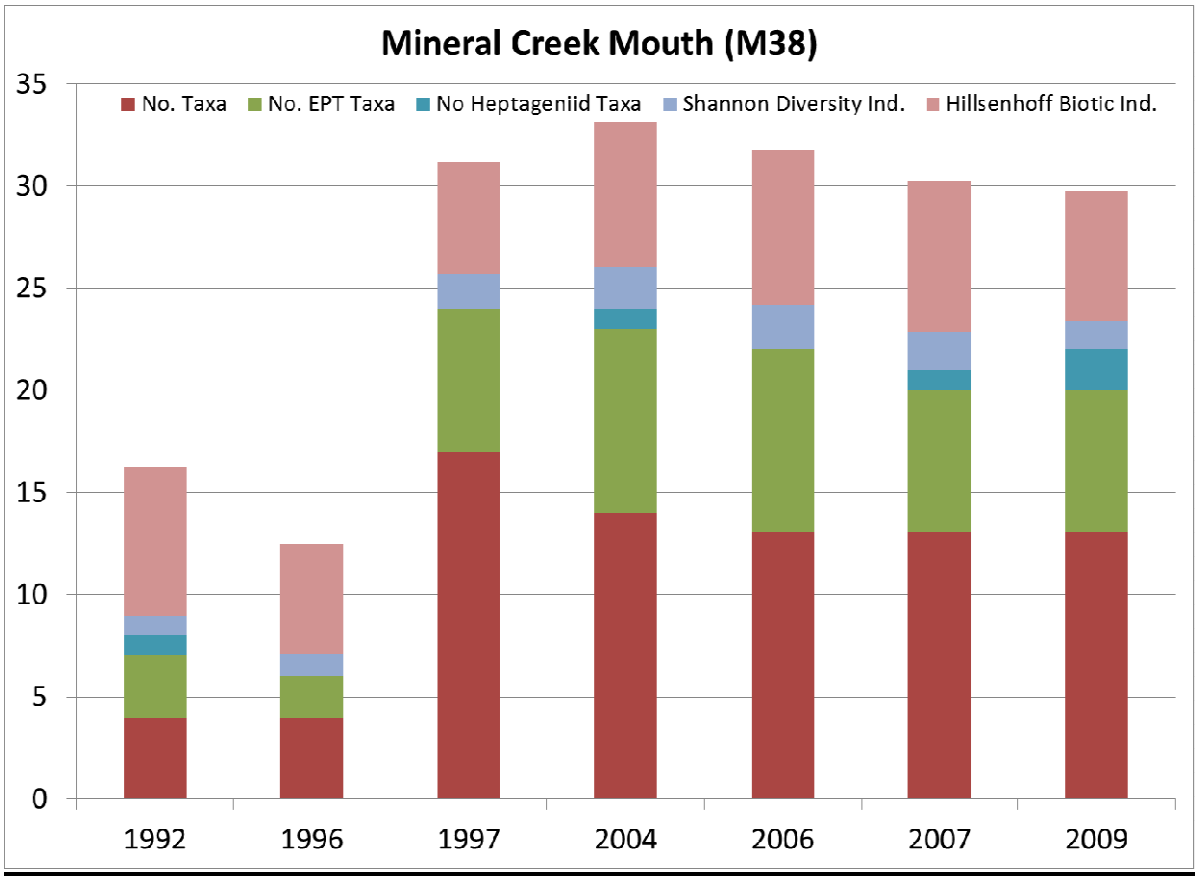
Animas River upstream of Cement Creek (A68).

At this sample site there was a decrease in the total number of taxa in the 2009 (=14) samples when compared to the 2004 (=18) although the number of EPT taxa remained the same (11 in 2009 and 10 in 2004 with an average of 10 total taxa found in the 96, 97 baseline data). Of significance indicating improving conditions at this sample site, were the 3 Heptageniid taxa found in 2007 and the 2 Heptageniid taxa found in 2009 as well as increasing numbers of EPT taxa. Both the diversity index and the HBI showed declining conditions compared to both 2004 data and baseline data. *Overall, the indices show slightly improving conditions at this site compared to the baseline data and similar conditions when compared to the 2004 data.*



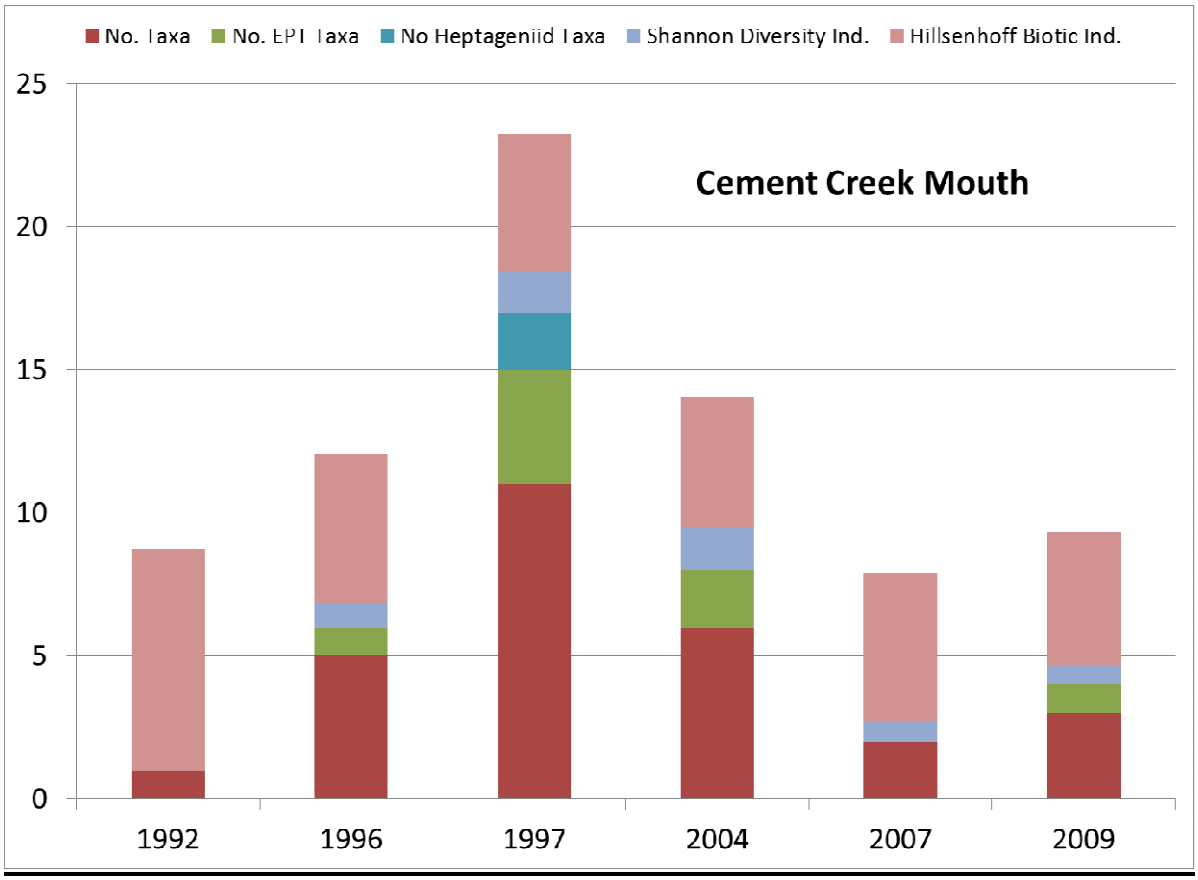
Mineral Creek upstream of confluence with S. Fork of Mineral Creek (M27)

The number of taxa found in 2009 (=7) was less than the number of taxa found in 2004 (=11), although similar to the number of taxa found in 96, 97 baseline data (average = 7.5). The number of EPT taxa in 2009 was the same as found in 2004 and greater than the number of EPT taxa found in the baseline data. The diversity index and the HBI showed similar trends to trends in the number of EPT taxa at this sample site. *Overall, the indices show slight improvement at this site compared to the baseline data and similar conditions compared to the 2004 data.*



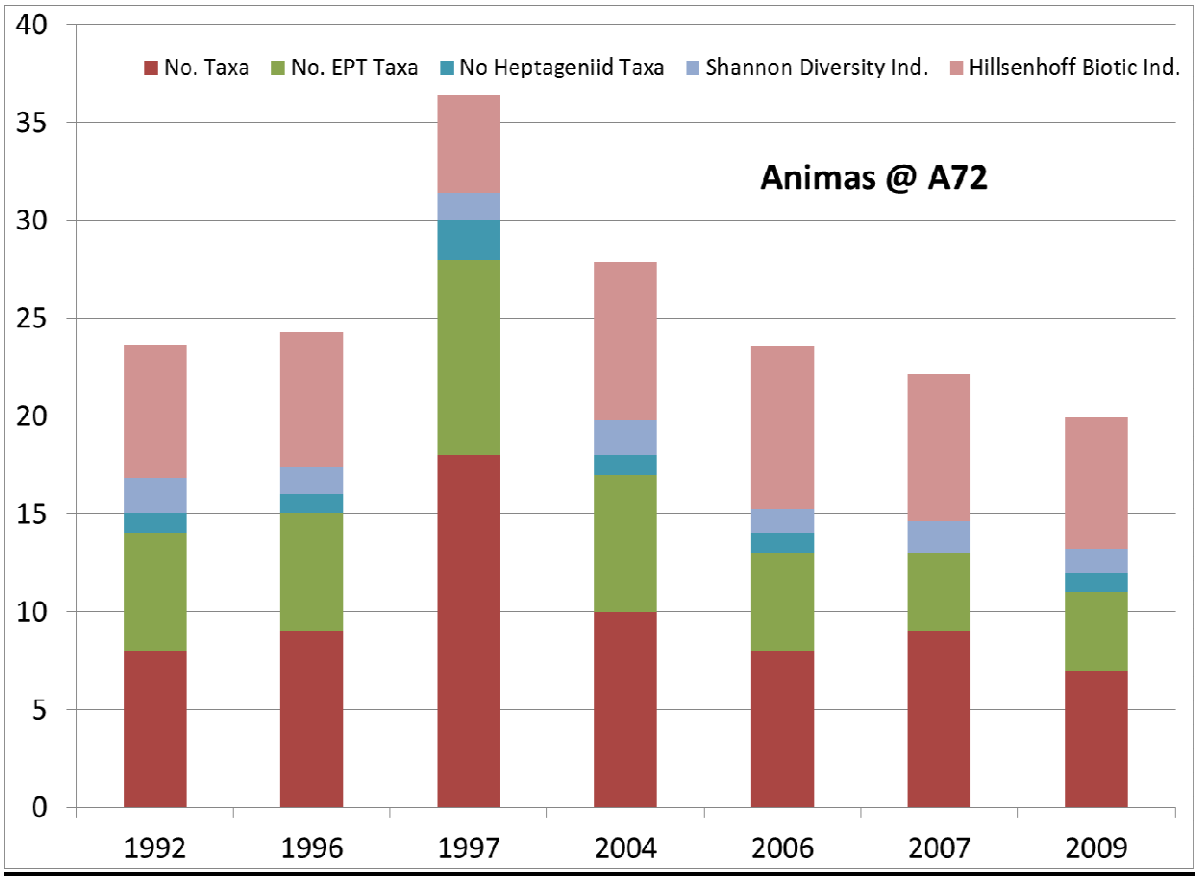
Mineral Creek Mouth (M38)

The total number of taxa in 2009 (=13) was as high as the total number of taxa found in 2004 (=14) and slightly greater than average, total number of taxa found in the 96, 97 baseline data (=10.5). Since 2004 this site has more or less sustained the number of EPT taxa. (7 in 2009, 9 in 2004) with an increase in the number of taxa when compared to the 96, 97 baseline data (= 4.5 total number of taxa) although the Shannon-Wiener diversity index has declined since 2004 and the HBI has increased. Both the diversity index and the HBI show similar or improved conditions when compared to the 96, 97 baseline data. Of significance to this sample site were the 2 Heptageniid taxa found in 2009 and the 1 Heptageniid taxa found in 2007. *Overall, the indices show improving conditions at this site compared to the baseline data and similar conditions compared to the 2004 data.*



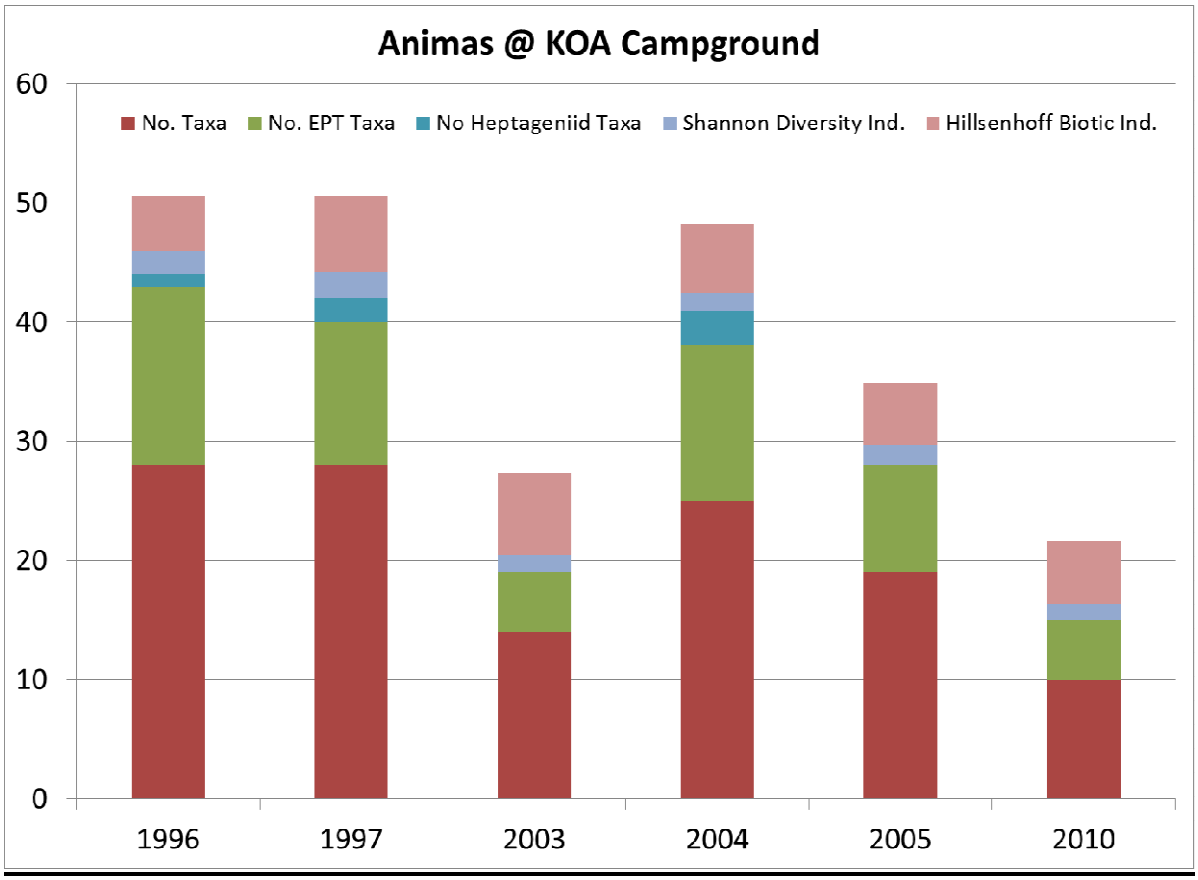
Cement Creek Mouth (CC01)

The total number of taxa (=3) and the number of EPT taxa (=1) in the 2009 samples were less than what was found in 2004 when there were 6 total number of taxa and 2 EPT taxa. The 2009 data was also less than the total number of taxa (average = 8) and the number of EPT taxa (average = 2.5) that were found in the 96, 97 baseline samples. Similar downward trends at this site were found in the diversity index and the HBI. *All indices at this site show declining conditions compared to the baseline data and compared to the 2004 data.*



Animas River @ A72

Only 7 total number of taxa were found in the 2009 samples at A72, 3 less than what were found in the 2004 samples when the total number of taxa was 10 and 6 less than the average, total number of taxa found in the 96, 97 baseline samples where the average was 13. The number of EPT taxa declined as well, from 10 in 2004 to 7 in 2009 which was slightly less than the number of EPT taxa found in the baseline data with an average of 8. The diversity index in 2009 at A72 was 1.23 compared to 1.8 in 2004. There was also an increase in the HBI from 1.89 in 2004 to 3.31 in 2009 which was less than the average HBI found in the 96, 97 baseline data of 4.04 which also indicates decreasing conditions at A72. The loss of individual EPT taxa at this site since 2004 included the complete loss of all Perlodid stoneflies and Taeniopterygidae caddisflies along with the predatory Ryacophila caddisfly. *All indices at this site show declining conditions compared to the baseline data and to the the 2004 data.*



Animas River @ KOA Campground

In 2010 the number of taxa was 10 whereas 27 were found in 2004 and 20 in 2005 along with a large decrease in the number of EPT taxa - from 13 in 2004 to 9 in 2005 and 5 in 2010. There were 3 Heptageniid taxa in the samples in 2004 but all Heptageniids were absent in the 2005 and the 2010 samples and all stoneflies were absent in the 2010 samples, The HBI increased to a high of 4.97 in 2010 compared to 2004 when it was 4.23 and increased when compared to the average of the 96, 97 baseline HBI which was 4.44. *All indices at this site show declining conditions compared to the baseline data and to the 2004 data.*

Overall Observations:

Given the declining conditions found at the mouth of Cement Creek, the Animas at A72 and the Animas at KOA Campground along compared to the relatively stable conditions of the Animas upstream of Cement Creek (A68) and improving conditions at the mouth of Mineral Creek (MC38) it is clear that water quality in Cement Creek has declined and had a deleterious effect on the Animas at A27 and possibly as far down as the Animas at KOA Campground.

Appendix 17a

Selected HQs associated with pore water and bulk sediment from the December 2012 sediment toxicity test

Appendix 17.a: Selected HQs associated with pore water and bulk sediment from the Dec. 2012 sediment toxicity test
Baseline Ecological Risk Assessment
Upper Animas River Mining District

December 2012 *Hyalella azteca* sediment toxicity test

Sampling location	Survival[a] (mean ±SE)	Signif.?[b]	Biomass[a] (mean±SE)	Signif.?[b]	Aluminum HQs			Arsenic HQs			Cadmium HQs			Copper HQs			Lead HQs			Manganese HQs			Zinc HQs		
					$PW_{initial}$	PW_{final}	SED[c]	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED
A56 ("upstream")	62.5±8.2%	Y	20.3±1.9 µg/org	Y	<1	--	<1	<1	--	**2.4**	<1	--	**1.9**	**1.5**	--	**2.1**	**2.7**	--	**16.2**	**2.8**	--	**5.0**	<1	--	**7.7**
A68	56.3±3.2%	Y	22.6±1.6 µg/org	Y	**1.7**	--	<1	<1	--	**2.5**	<1	--	**3.4**	**2.9**	--	**4.1**	**5.4**	--	**20.3**	**3.8**	--	**10.1**	<1	--	**16.6**
A72	36.3±4.2%	Y	16.1±1.7 µg/org	Y	<1	--	<1	<1	--	**1.4**	**1.4**	--	<1	<1	--	**1.3**	<1	--	**5.5**	**4.6**	--	**3.6**	<1	--	**2.1**
A73B	5.0±1.9%	Y	4.0±1.7 µg/org	Y	<1	--	<1	<1	--	<1	<1	--	**1.0**	<1	--	**1.6**	<1	--	**4.4**	**8.3**	--	**3.7**	<1	--	**2.7**
A75B	48.8±5.2%	Y	17.8±1.9 µg/org	Y	<1	--	<1	<1	--	**1.1**	<1	--	**2.1**	<1	--	**2.8**	<1	--	**3.4**	**5.2**	--	**3.7**	<1	--	**10.8**
Bakers Bridge	76.3±3.8%	Y	26.2±1.0 µg/org	Y	<1	--	<1	<1	--	**1.2**	<1	--	**3.4**	<1	--	**2.5**	<1	--	**3.7**	**4.0**	--	**7.3**	<1	--	**19.7**
CC49	0%	Y	no survival	Y	**12.9**	--	<1	<1	--	**2.0**	**3.1**	--	<1	**2.0**	--	<1	**3.4**	--	**1.6**	**3.2**	--	<1	**2.8**	--	<1
M34	8.8±3.5%	Y	5.1±2.0 µg/org	Y	<1	--	<1	<1	--	<1	<1	--	<1	<1	--	<1	<1	--	**1.2**	**4.6**	--	**1.0**	<1	--	<1

HQ = hazard quotient; PW = pore water; SED = sediment
note 1: the "initial" pore water samples were collected before the organisms were added to the test beakers
note 2: no "final" pore water samples were collected at the end of the test
note 3: the PW HQs were derived using dissolved metals data and the standard chronic surface water benchmarks or hardness-depedent benchmark equations presented in Table 3.1 of the BERA
[a] see Table 3.23 in the BERA
[b] is the result significantly different from the negative lab control?
[c] All the sediment HQs presented in this table were derived using the "effect" benchmarks presented in Table 3.1 of the BERA

Appendix 17b

Selected HQs associated with pore water and bulk sediment from the November 2014 sediment toxicity test

Appendix 17.b: Selected HQs associated with pore water and bulk sediment from the November 2014 sediment toxicity test
Baseline Ecological Risk Assessment
Upper Animas River Mining District

November 2014 *Hyalella azteca* sediment toxicity test

Sampling location	Survival[a] (mean ±SE)	Signif.?[b]	Biomass[a] (mean±SE)	Signif.?[b]	Aluminum HQs			Arsenic HQs			Cadmium HQs			Copper HQs			Lead HQs			Manganese HQs			Zinc HQs		
					$PW_{initial}$	PW_{final}	SED[c]	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED
A56 ("upstream")	43.8±9.2%	Y	14.3±3.2 µg/g	Y	**1.6**	<1	<1	<1	<1	<1	**2.7**	**2.3**	**2.3**	**5.2**	**4.5**	**1.6**	**2.2**	**3.0**	**9.2**	**6.3**	**4.8**	**7.7**	**1.1**	<1	**7.0**
A60	77.5±6.5%	N	23.1±1.9 µg/g	Y	<1	<1	<1	<1	<1	<1	**10.4**	**14.1**	**1.9**	**1.0**	<1	**1.8**	<1	<1	**12.6**	**1.8**	**5.1**	**6.2**	**2.9**	**3.8**	**4.6**
A68	70.0±10.0%	N	23.2±3.3 µg/g	Y	<1	<1	<1	<1	<1	<1	**2.1**	**2.3**	**2.2**	<1	<1	**1.4**	<1	<1	**9.7**	<1	<1	**7.9**	**1.2**	**1.2**	**5.4**
A72	70.0±4.6%	N	27.9±2.4 µg/g	Y	<1	<1	<1	<1	<1	<1	**4.4**	**3.4**	<1	<1	<1	<1	<1	<1	**3.9**	**1.8**	**6.1**	**2.8**	**1.1**	<1	**1.9**
A73	73.8±7.8%	N	21.2±2.4 µg/g	Y	<1	<1	<1	<1	<1	<1	**1.3**	**1.9**	<1	**1.2**	<1	<1	<1	<1	**3.4**	<1	<1	**2.3**	**1.5**	**1.9**	**1.6**
A75D	76.3±7.5%	N	24.9±3.2 µg/g	Y	<1	<1	<1	<1	<1	<1	**3.2**	**3.3**	<1	<1	<1	<1	<1	<1	**2.6**	**1.3**	**1.7**	**3.1**	**1.0**	**1.1**	**2.4**
Bakers Bridge	86.3±3.8%	N	30.7±2.2 µg/g	Y	**1.6**	<1	<1	<1	<1	<1	**2.4**	<1	<1	<1	<1	<1	<1	<1	**1.9**	**2.3**	**2.5**	**3.3**	<1	<1	**3.7**

HQ = hazard quotient; PW = pore water; SED = sediment
note 1: the "initial" pore water samples were collected before the organisms were added to the test beakers
note 2: the "final" pore water samples were collected at the end of the test
note 3: the PW HQs were derived using dissolved metals data and the standard chronic surface water benchmarks or hardness-depedent benchmark equations presented in Table 3.1 of the BERA
[a] see Table 3.23 in the BERA
[b] is the result significantly different from the negative lab control?
[c] All the sediment HQs presented in this table were derived using the "effect" benchmarks presented in Table 3.1 of the BERA

Appendix 18

2010 Animas River fisheries report

2010 Animas River Report

San Juan Basin

Jim White, Aquatic Biologist
Colorado Division of Wildlife
151 E. 16th Street
Durango, CO 81301



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Animas River

Animas #1&2 (Durango) Mark and Recapture Population Estimate

Date(s)	September 7-10, 2010
Gear	14 ft Raft Electrofishing boat with Smith-Root 2.5 GPP and throwable anode arrangement. VVP settings were High Range 20-25% and 60PPS.
Drainage	San Juan
Water Code(s)	Animas #1 (37982) and Animas #2 (37994)

INTRODUCTION

The Animas River is split into two management sections through the City of Durango. Animas #1 is defined as the Gold Medal Reach from the confluence of Lightner Creek just below the Highway 160 Bridge to Riviera Bridge behind Home Depot. This 4.4 mile reach of river is managed with a two-fish 16 inches or greater bag limit and artificial fly and lure only. Gold medal criteria is defined as a reach of river that consistently produces 60 pounds of trout per surface acre or more and 12 fish greater than or equal to 14 inches per surface acre of river. Rainbow trout consist of 30% of fish captured by anglers and brown trout 66%[1]; catch rates average about 0.3 fish per hour. An estimated 1,955 anglers fished the Animas River Gold Medal reach from July-September, 1997. Those anglers released all of the rainbow trout and 96% of the brown trout captured. With the increase population of Durango over the last 10+ years, the number of anglers has undoubtedly grown. Stocking on the Animas River #1 consists generally of 10k brown trout and 10k rainbow trout fingerlings each year. These fish are distributed by raft in June and July. Since 2005 approximately 10k Colorado cutthroat trout fingerlings have been stocked annually.



The Animas River #2 is managed with Standard Regulations that allow the use of bait and a 4 trout daily bag limit (no size restrictions). This 2.7 mile reach of the Animas River unofficially begins at 32nd Street and continues downstream to the Lightner Creek confluence. Anglers, estimated at 1,635, during the 1997 fishing season reported catching 45% rainbows, 54% brown trout, and 1% Snake River cutthroats. Approximately 72% of trout captured were released. This is a high percentage for a Standard Regulation

[1] 1997 Animas River Creel Census Data. Note. There were no trout stocked into the Animas River #1 and #2 in 1997 because of hatchery shortages caused by whirling disease.

water. Angler catch rates were reported at 0.44 fish per hour. Stocking over the past 10 years varies a little but generally 10k rainbow and brown trout fingerlings are stocked by raft each year in the Animas #2. Since 2005 we have been stocking approximately 10k Colorado cutthroat trout fingerlings in addition to the browns and rainbows. Because of the higher use associated with Standard Bag limits in an Urban Area, an average of 2000 catchable rainbow trout have been stocked annually.

The Animas River will be impacted by the Animas La-Plata Project. The Animas La-Plata's featured project component, Ridges Basin Dam was completed in November 2007. Limited pumping began in the fall of 2008 with full pumping of 280 cfs from the Animas River started in June 2009. Pumping was shut down in August 2009 and resumed in the spring of 2010. The reservoir, Lake Nighthorse, is now approximately 70% full.

The Bureau of Reclamation (BOR) is mitigating the impacts from pumping by stocking a total of 100,000 sub-catchable rainbow trout into the Animas River from Durango to Bondad. A Memorandum of Understanding (MOU) was signed by the Bureau of Reclamation, Southern Ute Indian Tribe (SUIT), and Colorado Division of Wildlife (CDOW) in the Fall of 2009. The purpose of this MOU is to coordinate fish management efforts on the Animas River between the signatory parties so that a quality trout fishery is maintained (defined by Gold Medal standards on waters managed by CDOW). Specific action items in this agreement include the CDOW supplying whirling disease resistant strains of rainbow trout eggs to the Fish and Wildlife Service for rearing. The BOR will pay for raising and transporting the fish to the Animas River. SUIT and CDOW agreed to stock out the fish annually and coordinate fish inventories on a biennial basis. The CDOW and SUIT will provide the BOR with a report at the end of the 2016 field season evaluating the effectiveness of the stocking program relative to existing fish populations before pumping operations began. The results and discussion presented in this report can be considered part of the coordination effort and adaptive management clauses of the MOU agreement.

METHODS

A 2-pass mark and recapture population estimate was conducted by electrofishing raft on the Animas #1 and #2 during the week of Sept. 7-10. Animas River flows ranged between 300-350 cfs during this time period. All fish were marked with by punching a small hole in the caudal fin and releasing them back to the river. The Animas #1 was Marked on 9/8 and fish were recaptured on 9/10. The Animas #2 was Marked on 9/7 and the Recapture run done on 9/9. All data were entered into the CDOW's "Jake-O-Matic" or JOM database. JOM uses the Peterson index for mark and recapture population estimates.

RESULTS AND DISCUSSION

The density (fish per mile) and biomass (lbs/acre) of trout in the Gold Medal reach of the Animas River has declined since 2002 and 2006, respectively (Table 1). The Animas River still qualifies as a Gold Medal fishery by exceeding 60 lbs/acre of trout biomass and trout density of 12 trout $\geq$ 14 inches per surface acre. This declining trend in biomass is primarily marked by a downward trend in the abundance of large (>400 mm; ~16 in) rainbows and browns since 2002 (Figure 1). The density of rainbow trout and brown trout greater than 14 inches is down about 62% from the historic average (Table 1). The abundance of trout (fish/mile) during the 2010 survey was about twice as high as the average abundance reported since 1991; however, approximately 80% of those fish were from earlier stocking of 5 inch rainbow trout (Hofer/Colorado River rainbow hybrids or HXCs). The HXC rainbows were stocked to mitigate impacts to the fishery in the Animas River.

Table 1 Trout population statistics for the Gold Medal reach of the Animas River

Animas #1 Gold Medal												
Month/Year	Oct-91	Nov-93	Sep-94	Sep-96	Sep-98	Sep-00	Nov-02	Nov-04	Sep-06	Sep-08	Sep-10	Average
All trout combined (fish/acre)	61	53	56	146	54	141	51	90	141	73	148	87
All trout combined (fish/mile)	738	641	678	1752	653	1706	617	1089	873	887	1792	972
Total trout biomass (lbs/acre)	64	51	43	128	65	144	120	96	93	75	71	89
All trout > 14 inches (fish/acre)	21	22	17	61	35	69	49	44	31	21	13	35
Rainbows> 14 inches (fish/acre)	10	9	9	38	9	28	19	33	10	10	5	16

The most striking result of this year's fish inventory on the Animas River is the noticeable decline in the density and biomass of larger rainbow trout. Length frequency analysis suggest about 43% of the biomass in the 2004 and 2006 fish surveys was attributable to the higher abundance of larger rainbow trout (Figure 1). The length frequency chart for rainbows clearly shows captures of rainbows over about 12 inches (300 mm) has been in the 8% or greater range since 2002. This year less than 2% of the rainbows captured were in that same size range and there appears to be little recruitment of Age-1+ fish (250-300 mm; Figure x) into the larger size classes of rainbows. A similar observation was made for the Animas River #2, Standard Regulation reach, just upstream (Table 2).

Brown trout (Figure 1) density and age class structure in the Gold Medal Reach appears relatively stable over the past 10 years. A relatively large cohort of Age-1+ browns are poised to recruit into the quality size (14 inch) group of fish next year (2011). Brown trout are becoming more abundant relative to rainbow trout in the Gold Medal reach. In 2006, at the peak of large rainbow abundance, there were almost 3 rainbows over 14 inches for every brown trout per mile of river. That ratio has flipped and now there is less than 0.6 rainbows for every brown trout in the Gold Medal reach of the Animas River.

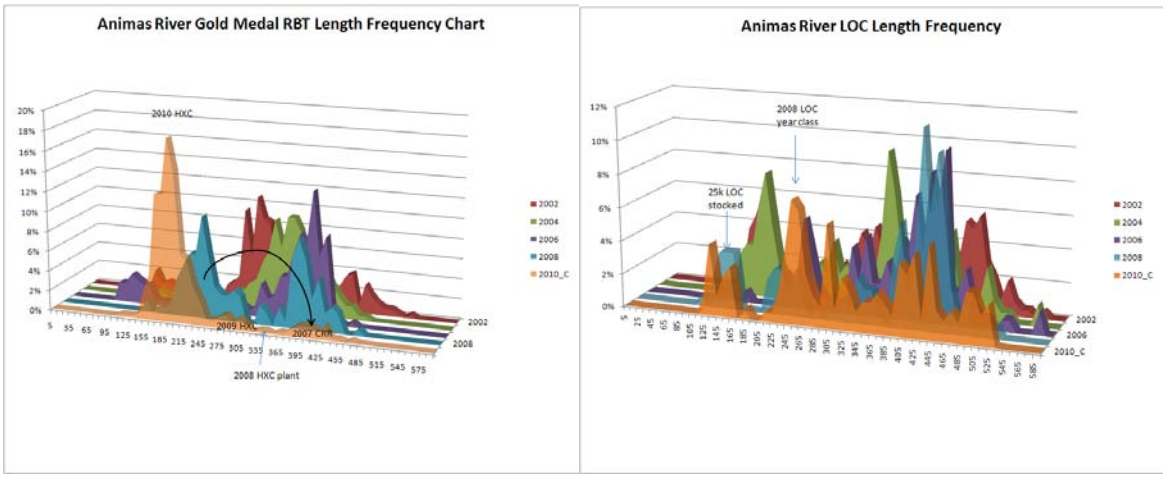


Figure 1 Length frequency charts of rainbow trout (left) and brown trout (right) captured in the Animas River Gold Medal reach during 2010 (orange area) fish inventory.

The Animas River #2, or Standard Regulation Reach, from 32nd Street Bridge to the Lightner Creek confluence has also experienced a decline in trout abundance and biomass since 2006. We recorded the second lowest biomass of trout in 11 fish inventories (Table 2). Biomass of trout has declined about 45% since 2008 is now 52% of the historic average. Larger browns (>14 inches) typically dominate the fish species composition in the Standard Regulation reach; however, both larger browns and rainbows were depressed in total numbers and quality sized fish (Figure 2).

Table 2 Trout population statistics for the Standard Regulation reach of the Animas River.

Animas #2 Standard												
Month/Year	Oct-91	Nov-93	Sep-94	Sep-96	Sep-98	Sep-00	Nov-02	Nov-04	Sep-06	Sep-08	Sep-10	Average
All trout combined (fish/acre)	147	43	122	66	38	57	130	115	84	97	56	87
All trout combined (fish/mile)	1779	520	1476	799	460	690	1573	1392	1406	1171	720	1090
Total trout biomass (lbs/acre)	115	32	56	41	28	42	99	104	115	58	32	66
All trout > 14 inches (fish/acre)	37	12	10	11	12	16	38	17	34	13	4	19
Rainbows> 14 inches (fish/acre)	3	2	2	2	6	5	10	7	11	4	0.2	5

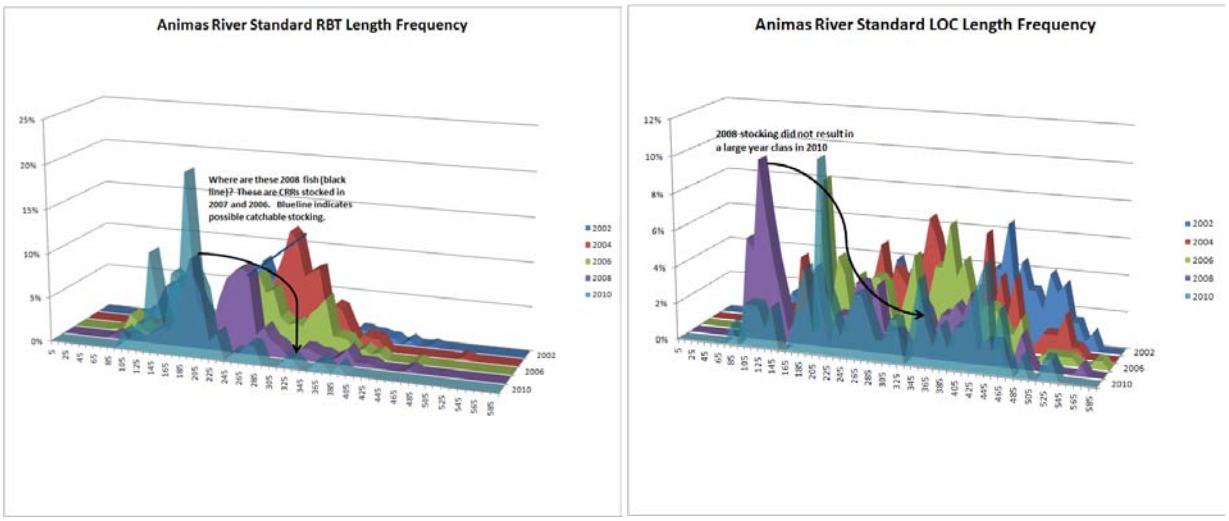


Figure 2 Length frequency charts of rainbow trout (left) and brown trout (right) captured in the Animas River Standard Regulation reach during 2010 (orange area) fish inventory.

The decline of larger rainbows, and apparent lack of recruitment into the Age 1+ or larger size groups, is probably related to the interactions between flow, temperature, water quality, and stocking. The quality of habitat for both rainbow and brown trout is typically best if river flows exceed 50% of the average annual daily flow. Average annual daily flow (1900-2005) for the Animas River in Durango is 819 cfs. "Excellent" habitat conditions are present at 410 cfs or better, "Fair" at 410-205 cfs, and "Poor" at anything below 205 cfs[2].

Baseflows in the Animas River mostly explain the fluctuation in fish biomass and abundance. When baseflows are relatively high such as during the 2004-2007 timeframe (Table 3) biomass is relatively high (Table 2 and 3). When baseflows are relatively low, such as in 2009 and 2010, biomass and abundance tends to move downwards.

High baseflows may also be more beneficial to larger rainbows relative to larger brown trout. The ratio of rainbow to brown trout greater than 14 inches is much greater during high baseflow years than in low baseflow years (Figure 3). This relationship may explain why larger rainbows in the Standard and Gold Medal reaches of the Animas are in decline. Although habitat suitability models predict these relationships, it is helpful to see our fish inventory results validate those relationships for the Animas River through Durango.

[2] Habitat Suitability Information for rainbow and brown trout from Raleigh et al. 1984 & 1986, respectively.

Table 3 Average daily flow (cfs) for the Animas River from 2000-2010.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average Base (cfs)	Rank (best-worst)
2000	190	175	236	958	2169	1155	350	271	318	327	289	230	278	9
2001	204	198	311	955	3155	2101	737	580	245	192	179	190	288	8
2002	178	154	138	322	544	358	154	134	317	302	213	180	202	12
2003	166	149	200	494	1830	1338	335	340	583	245	207	169	310	7
2004	161	171	582	1002	2450	1919	622	277	600	518	439	317	443	4
2005	318	374	521	1620	3929	3434	1447	571	344	642	323	240	470	3
2006	223	207	230	918	2136	1295	582	574	489	1595	457	316	564	1
2007	274	263	525	829	2304	2312	831	890	657	563	299	315	502	2
2008	247	235	483	1150	2592	3453	1305	477	343	257	216	186	391	5
2009	183	208	344	831	3409	1735	744	236	213	203	170	145	248	10
2009*	194	224	369	867	3420	1390	557	242	225	213	188	158	264	11
2010	159	164	200	859	2130	1920	442	572	302	277	237	220	315	6

Baseflow = July-March

Winterflow = November, December, January and February

2009 = discharge below the Pumpstation for Lake Nighthorse*

Note: 1999 baseflows averaged 600 cfs!

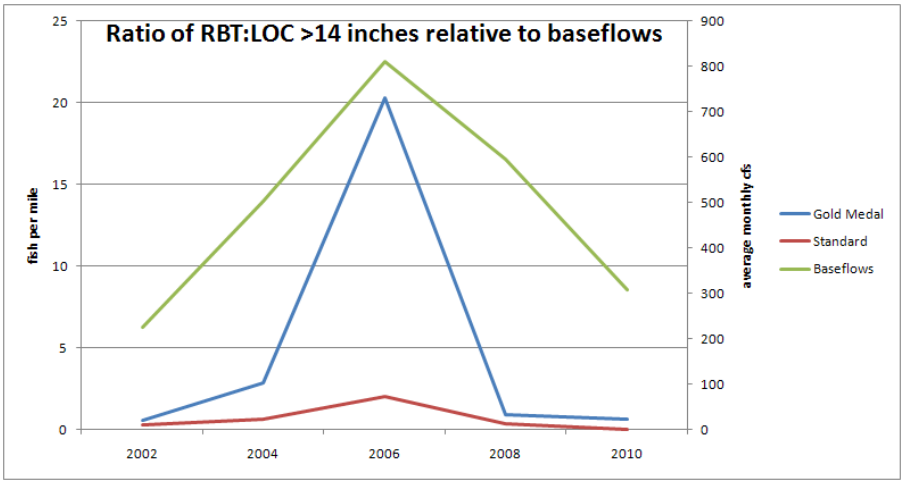


Figure 3 Relationship between baseflows and the ratio of quality rainbow and brown trout in the Animas River through Durango.

Other factors possibly limiting the biomass, density, and quality of trout observed in the Animas River in 2010 are water temperatures, stocking, and possibly increased heavy metal contamination from the Upper Animas River Basin. Low baseflows and warm water temperatures were observed through much of 2009 and 2010. Unfortunately, water temperature monitoring was not started on in the Gold Medal reach of the Animas River until August 2009 – a moot effort considering our temperature data logger was stolen! However, data collected in 2010 suggest low baseflows coupled with high ambient air temperatures created warm water conditions very stressful to salmonids (Figure 4). In mid-July 2010, trout were subjected to three days of water temperatures exceeding Colorado's coldwater temperature threshold. Fish were exposed to temperatures above 70ºF for up to 9 hours at time coming dangerously close to the upper lethal temperature of 77ºF. Similar conditions were observed in 2009 when baseflows were even further depressed naturally and by A-LP pumping operations.

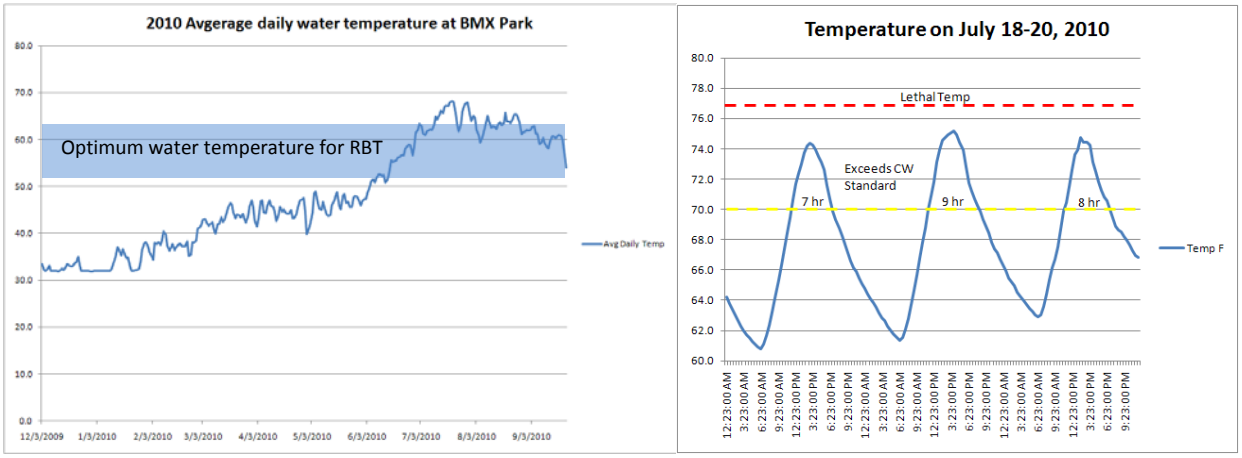


Figure 4 Average daily water temperature for the Animas River below the Animas-LaPlata pumping plant between December 2009 and September 2010 (left) and three of the warmest days in July 2010 (right). Baseflows during the July 18-20 period were 282 cfs (288 cfs above the pumping plant).

At higher water temperatures, trout do not like to move. The Animas River #2 experiences extremely heavy recreational use during the warmest days of summer from rafters, swimmers, and "tubers". If trout are disturbed and displaced by these activities, it could be very stressful and possibly lethal to some trout. We are witnessing increased use, and encouragement of this use, by building whitewater park features in the Animas and San Juan rivers. The impacts of increased recreation such as tubing during the most stressful periods for trout are not known but more study on movement and habitat use is needed.

Dissolved heavy metal concentrations since 2006 are, with increasing frequency, exceeding chronic and acute water quality standards (Table 4). Rainbow trout and mottled sculpin are very sensitive to high concentrations of zinc. Rainbow trout recruitment, density, and biomass are down since 2006 which do correspond to a rise in both chronic and acute zinc levels as well as other dissolved metals. The drop in trout biomass is most dramatic in the Standard Regulation trout section (115 lbs/ac to 32 lbs/ac). Whether that drop is caused by, or associated, with zinc toxicity is not known but rainbow trout abundance does improve downstream where presumably zinc concentrations are reduced by increasing sediments from Lightner Creek.

This year we captured the fewest mottled sculpin in the Animas #2 (Standard) in the last 10 years of sampling this section. Mottled sculpin are captured incidentally during fish inventories and total numbers of sculpin captured are probably not very indicative of the overall population status of these fish. However, with the low abundance of trout (and suckers) in this section, netters were eager to net any fish immobilized by the electrofishing boat; therefore, one would assume we would capture more sculpins, not less during this year's survey. We also saw a corresponding decline in the abundance and distribution of fish in the Upper Animas River Basin (see next Section) where metals, not habitat (i.e., baseflows) are the limiting factor.

Table 4 Percent exceedence of State water quality standards (A) & (B). Paired Data collected at Bakers Bridge (A), Trimble Bridge (B), and 32nd Street Bridge (B) (note: over 15% of chronic standard is a violation of the State's Water Quality standards, except for iron where 50% is used). Data table assembled by Peter Butler, with the Animas River Stakeholders Group (ARSG) on 11/17/10. Butler provided the following notes: Comparing data by going back in five year increments. (Notes: Additional discharges above Gladstone started around 2000-2001. They appear to have stabilized to current levels in 2005. Discharges added proportionally more zinc than cadmium. The period of 2000-2005 included extreme drought and low flow conditions. Although some remediation began in 1991, most projects were done between 1995 and 2005. Samples were essentially collected monthly, but before 1999, more intensive sampling occurred April though July - three to four samples per month.)"

Year	Zn chronic	Zn acute	Cd chronic	Pb chronic	Iron chronic
1992-1995	56%	27%	32%	3%	34%
1996-1998	42%	9%	19%	0%	29%
2002-2005	39%	17%	71%	0%	27%
2006-mid 2009	73%	41%	59%	23%	56%

(B) Paired Data for Trimble Lane and 32nd St.

	Trimble lane			32nd St.	
Year	Zn chronic	Zn acute		Pb chronic	
1992-1995	34%	6%			
1996-1998	14%	5%			
2002-2005	7%	2%		2%	
2006-mid 2009	11%	3%		17%	

Dissolved heavy metals have always been present in the Animas River #1 and #2 at levels where little trout reproduction occurs but juvenile and adult trout survival in recent times has always been adequate to provide quality fishing opportunities. Young trout and mottled sculpin were noted in low abundance near Baker's Bridge in the late 1990s when acute levels of zinc were at their lowest (Table 4). Poor water quality in Durango is probably not limiting juvenile and adult trout populations. Sub-optimal baseflows creating poor habitat conditions may be more detrimental. However, given the increase in dissolved metal concentrations, particularly zinc, one cannot rule out some population level impacts associated with dissolved metal toxicity. If toxicity events occurred, they would be most apparent on rainbow trout and sculpin populations.

Stocking may be an additional factor in the observed decline of rainbow trout in the Animas River. Fingerling stocking, and method of stocking (raft), of both rainbow and brown trout has remained relatively stable over the past 10 years. The only significant change was a switch to fingerling Hofer/Colorado River rainbows (HXC) fish in 2008 and a change to 5 inch HXCs in 2009 and 2010. Research by the CDOW on the Gunnison River suggest recruitment rates (% of Age -1+ fish) of the Colorado River rainbow strain (CRR) and Hofer crossed with CRRs are about the same (HXCs may actually do a little better than CRRs). Higher densities of HXC stocking probably does not explain an overall dip in rainbow trout numbers or recruitment. An average of 2,100 catchable rainbow trout (10+ inches) were stocked from 2003-2007. These fish were eliminated in 2009 and 2010 because of hatchery shortages. There is some indication (Figure 2) that catchables made up a significant portion of the Animas River #2 biomass and probably contributed to the Animas #1 biomass as well with catch and release so widely practiced. The absence of these catchable trout in the past two years may have some impact to total biomass but probably not a significant one.

One task with the recent fish sampling effort is to evaluate recruitment of HXC stocking in the Animas River. HXCs have been stocked by the CDOW in 2008 and by the BOR/FWS in 2009 and 2010 as part of the Animas-La Plata (A-LP) mitigation. Stocking rates for HXCs were determined by past management efforts and available habitat. Stocking rates for HXC's in the Gold Medal Reach were doubled to compensate for anticipated losses from dewatering the Animas. Stocking numbers went from 10k rainbow trout fingerlings to 20k rainbow sub-catchables. All fish were raft stocked in 2009 and 2010. In 2010, we moved our stocking point upstream to 32nd Street bridge instead of across from the A-LP pumping plant at Santa Rita Park in Durango. We did this because the Southern Ute Tribe was planning their 2010 fish inventory in late July and did not want to spend a lot of time capturing and working up newly stocked fish. Fish were also stocked above the Gold Medal reach because HXC movement in the Gunnison River is generally about 3 miles downstream after stocking; therefore, we thought we could get better distribution into the mitigation area by stocking a portion of the fish upstream.

The 2008 year class of HXC were stocked at 3.1 inches in late August. It appears that predation by brown trout and poor baseflows limited their recruitment into the 300-350 mm range (10-14 inches; Figure x). Competition between Age-1 brown and HXC trout may also have played a role in the poor recruitment of the 2008 HXC age class. In an effort to bump up a declining brown trout population we stocked 24,000 fingerlings in late June 2008. Browns and rainbows use similar habitats at that early age. Age-2+ (2008 class) browns did relatively well relative to the HXCs suggesting competition between the two may have been a factor in low HXC recruitment.

Poor baseflow conditions and high temperatures most likely limited the recruitment of Age-1+ (2009 year class) HXC stocked as mitigation for A-LP to less than 2% in the Gold Medal reach of the Animas. Although large brown trout are capable of preying on 5-6 inch stocked HXC, the sheer density of HXCs stocked relative to the population of larger brown trout suggest predation was not a controlling factor in recruitment. Many of the 2009 HXCs were captured by anglers in the late fall of 2009. Anglers reported catching very few of these 2009 HXC plants in the spring of 2010 before runoff suggesting many of these fish did not survive the winter. Domestication, brought about by genetics and hatchery life prior to stocking, may limit the survival capability of these fish during stressful times. One school of thought is to limit the exposure of these fish to hatchery life for as little time a possible and stock them out young allowing greater natural selection to occur thereby increasing the remaining fish chances of recruiting into the adult population from one year to the next. Stocking more numerous and smaller HXCs may be a management option we want to pursue next year.

The relative contribution of catchable trout to the rainbow trout biomass in the Animas River is not known. We have assumed it was low more than 1 year out because highly domesticated catchable trout do not overwinter well or tolerate natural events like spring flooding without either being displaced or dying. We have not tested this assumption in the Animas using catchable HXCs. Stocking a limited number of catchable HXCs, in addition to fingerling HXCs, may help maintain a quality fishery in the CDOW and SUIT reaches. These stocking strategies need to be vetted through the MOU partnership and a management strategy and assessment protocol implemented in 2012.

Conclusion:

- Low baseflows likely explain most of the downward trend in trout biomass. Rainbows are more sensitive to habitat alteration (warm temperatures and poorer quality riffle habitat). One would expect rainbows to be disproportionately affected by the loss of quality riffle habitat and colder water due to low baseflows relative to brown trout.
- Zinc toxicity is not likely to significantly affect rainbow trout in the Durango Area and south to the SUIT waters. However, it is worth monitoring through the Animas River Stakeholers Group and the River Watch program. Additional fry shocking may be warranted at historic sites.
- The whirling disease resistant Hofer Colorado River rainbow hybrids, or HXCs, are probably the best strain of fish to stock in the Animas River. Five inch sub-catchables may not be the best stocking size. More work needs to be done on a stocking strategy (smaller but more abundant and/or larger but less abundant stocking).

Recommendations:

- Interim sampling (i.e., do Gold Medal run in early march to determine overwinter survival)
- Evaluate option of stocking larger fish at densities compatible with the Animas River's average density (e.g., 1000 fish/mile x 3 miles in Standard Reach = 3000 fish). Mark these fish and look for them in 2012.
- Deploy more temperature loggers to assess flow and temperature impacts
- Conduct a Creel Census – last one done in 1997 (harvest changes? Angler attitude? C&R practice?)
- Coordination and communication with the Animas River Stakeholders Group (ARSG) on water quality testing
- Repeat 1996 fry shocking; mottled sculpin and trout reproduction found as high as Bakers Bridge – an absence or skewed distribution of fishes could indicate zinc toxicity
- Explore the possibility of a movement study of rainbow trout in the Animas #2 to assess recreational impacts to fish during the peak summer tubing season (2012)
- Communication: Present results to Area 15; Post results on Web; E-mail to TU and angling community and present at ART

Animas #3&4 (Upper Animas) Walk Shocking

Date(s)	September 20-22, 2010
Gear	Bank shocking array with Smith-Root 2.5 GPP. VVP settings were High Range 40-60% and 60PPS.
Drainage	San Juan
Water Code(s)	Animas #3 (38009), Animas #4 (38011), and Mineral Creek (42076)

INTRODUCTION

In 1997, the Animas River Stakeholders Group (ARSG) initiated a number of smaller mining reclamation projects aimed at improving water quality in the Animas River. The CDOW agreed to assist the ARSG by monitoring the Upper Animas River fishery at 4 different locations every five years (Figure 5). The question everyone was interested in was would remediation efforts be enough to see a biological response in the fish populations in the Animas River? A biological response in the upper Animas would be an expansion in distribution and abundance of adult trout. In the lower Animas River (Durango) we might expect better water quality conditions to create better survival of mottled sculpin, rainbow, and brown trout fry.

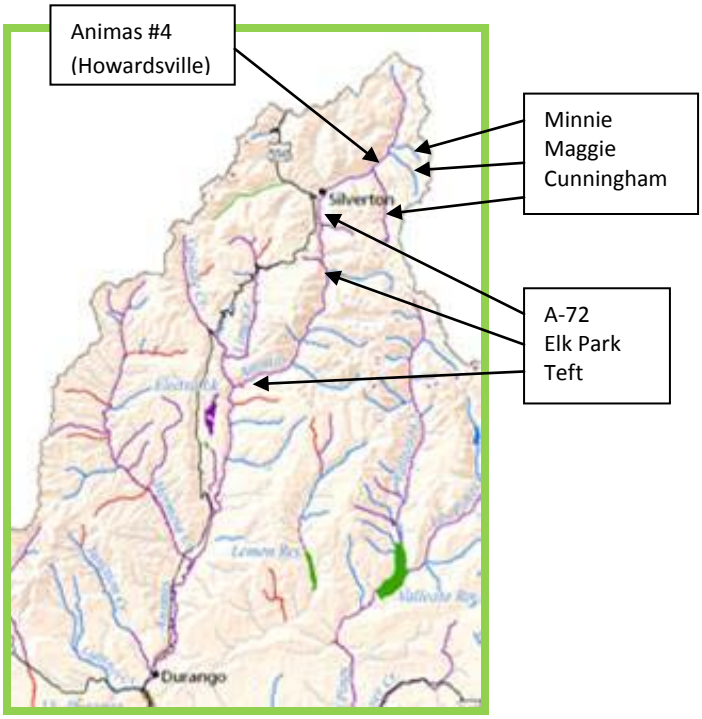


Figure 5 Upper Animas River fish sampling sites for 2009 and 2010.

METHODS

Fish were collected using a Smith-Root 2.5 GPP bank shock set up with an 5 anode array and 500 ft of cable. Two passes were done at each station unless no adult fish were captured on the first pass. All data were entered into the JOM database.

RESULTS AND DISCUSSION

A biological response (i.e., fish abundance and distribution) to mine cleanup efforts is mixed. In the Animas River #4 (above the Mineral Creek confluence with the Animas River in Silverton) we have documented increasing brook trout abundance and distribution in Howardsville, Cunningham, Maggie, and Minnie gulches (creeks; Table 5). Abundance of brook trout dramatically increased in Cunningham, Maggie, and Minnie Gulches from surveys done in the late 1980s. The Howardsville site on the mainstem of the Animas River produces a respectable 29 lbs/acre. Poor physical habitat condition appears to be the limiting factor at this site not water quality.

Table 5 Fish density estimates for seven sites in the Upper Animas River drainage.

Teft Spur (fish/mile)						Cunningham Gulch (fish/mi)		
Year	1992	1998	2005	2010		Avg. of 2 sites		
brook	349	349	338	98		Year	1987	2009
rainbow	48	24	8	0		brook	94	528
brown	0	8	23	0		cutthroat	10	84
RXN	0	16	0	0				
						Maggie Gulch (fish/mi)		
Elk Park (fish/mi)						Year	1987	2009
Year	1992	1998	2005	2010		brook	22	339
brook	88	69	81	0		cutthroat	45	21
rainbow	0	0	1	0				
A-72 USGS (fish/mi)						Minnie Gulch (fish/mi)		
Year	1992	1998	2005	2010		Year	1976	2009
brook	0	0	5	0		brook	0	442
						cutthroat	1	0
Howardsville (fish/mi)								
Year	1992	1998	2005	2010				
brook	78	559	1024	1082				
rainbow	4	0	0	0				
cutthroat	4	0	0	0				

Trout populations in the Animas River #3, below the Mineral Creek confluence, are declining in abundance and distribution (Figure 6). Brook trout are an important water quality indicator because they are much more tolerant of heavy metals than cutthroat, rainbow, or brown trout. A large water treatment project was apparently discontinued in the Gladstone area near Silverton (Cement Creek) in 2004. While there are a number of natural and anthropomorphic background sources of dissolved metals in and around the Silverton area, declines in fish abundance suggest water quality has declined significantly since 2005.

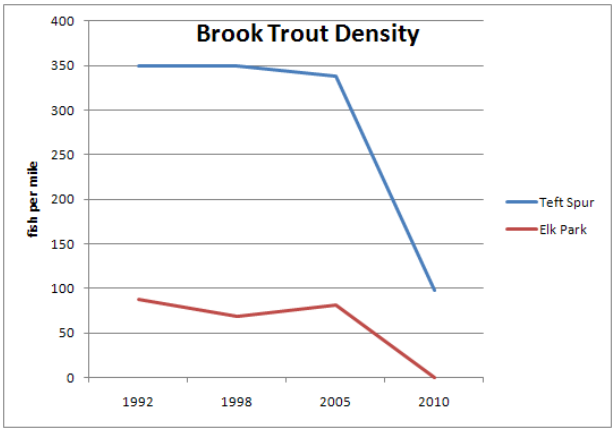


Figure 6 Brook trout density in two historic upper Animas River electrofishing sites.

CONCLUSION

- Poor physical habitat conditions are not suspected of limiting trout populations in the Upper Animas River basin. Low baseflows and warm temperatures are not significant factors in this steep gradient and colder upper reaches.

RECOMMENDATIONS

- Continue to assist ARSG with biological information
- Communicate report with ARSG and interested parties
- Approach BLM with physical habitat improvement project on the Animas River #4






Photo 1 Representative photos of the Upper Animas River fish shocking. From top right to bottom left. Loading the train at Rockwood (9am start). Top of braided section at Teft Spur. Bottom two photos are of the trip down the canyon from Silverton (7am start) to Elk Park.

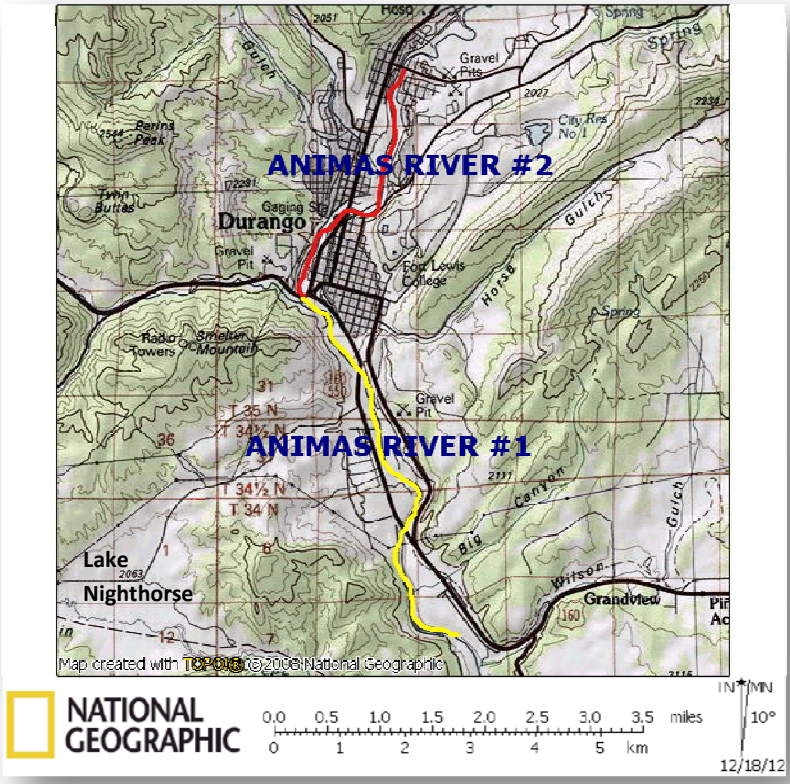
Appendix 19

2014 Animas River fisheries report

ANIMAS RIVER #1 & #2 (GOLD MEDAL AND STANDARD REACHES)

Jim N. White
Aquatic Biologist
Southwest Region

Water: Animas River
Sampling Date: 9/9/14 to 9/18/14
Gear: Raft Electrofishing (2.5 GPP with throwable anode)
Drainage: San Juan
Water Code: 37982 (#1) and 37994 (#2)



OBJECTIVE

To assess the density, biomass, and demographics of trout and native fishes in the standard (Animas #2) and special regulation (Animas #1; Gold Medal) reaches of the Animas River by 2 pass mark and recapture raft electrofishing.

HISTORY

The Animas River has a long history of poor water quality associated with historic mining in the Silverton District, pollution from the smelter processing facility in Durango, and city waste discharges directly into the river. In fact, Durango gets the majority of its water from the Florida River because at one time the water quality in the Animas River was once so bad it was unfit for domestic use. Water quality has obviously changed today but as early as the 1960s the river was thought to support only the occasional trout. Today the river through Durango supports a variety of aquatic life including caddis and stoneflies. But one does not have to travel far upstream to find ongoing impacts from historic mining in Silverton. At Bakers Bridge, located about 17 miles north of town, a number of dissolved heavy metal water quality standards are frequently exceeded and trout populations are extremely low above this point.

Water development and depletions on the Animas River were few until the Animas-LaPlata project's main feature, Ridges Basin Dam, was completed in 2007. The dam is built in just west of Durango in an off channel site on Basin Creek (see map). Limited pumping began in the fall of 2008 with full pumping of 280 cfs from the Animas River started in June 2009. The reservoir, Lake Nighthorse (named after former Colorado Senator Ben Nighthorse Campbell), is now full. The reservoir holds 120,000 acre feet of water, most of which satisfies Tribal water rights. Currently, there is little demand for the stored water so pumping operations are on hold except to replace evaporative loss. Water depletions from pumping occur in the Gold Medal reach of the Animas River (#1).

MANAGEMENT

The Animas River is split into two management sections through the City of Durango; the Animas River #1 (Gold Medal reach or GM) and the Animas River #2 (Standard Regulation reach or ST). The Animas #1, or Gold Medal Reach, starts from the confluence of Lightner Creek just below the Highway 160 Bridge and ends at Riviera Bridge behind Home Depot. This 4.4 mile reach of river is managed with a two-fish 16 inches or greater bag limit and artificial fly and lure only. The management goal is to provide anglers an excellent opportunity to capture abundant quality fish as measured by statewide Gold medal criteria. Gold Medal streams on average should consistently produces 60 pounds of trout per surface acre or more and 12 fish greater than or equal to 14 inches per surface acre of river.

Angler use and catch in the Animas River sections is estimated by conducting intensive creel surveys. In the 2012 creel census of the Gold Medal reach, rainbow trout consist of 79% of fish captured by anglers and brown trout 17%; catch rates average about 0.9 fish per hour (5,400 total fish captured). An estimated 2,124 anglers fished the Animas River Gold Medal reach from July-October in 2012, which was only about a 9% increase in angler numbers since the last census in 1997. Those anglers released virtually all of the trout captured despite regulations allowing for the harvest of 2 trout over 16 inches per angler day.

Natural reproduction of trout in the Animas River is poor and the fishery is supported by stocking fingerling fish with the goal of growing and sustaining wild trout in the river. Stocking on the Animas River #1 consists generally of 10k brown trout and 10k rainbow trout fingerlings each year. These fish are distributed by raft in June and July. Since 2005 approximately 10k Colorado cutthroat trout fingerlings have been stocked annually.

The Animas River #2, or Standard Reach (ST), is managed with standard statewide regulations on trout that allow the use of bait and a 4 trout daily bag limit (no size restrictions). This 2.7 mile reach of the Animas River unofficially begins at 32nd Street in north Durango and continues downstream to the Lightner Creek confluence just below Highway 160. The management goal for this reach of stream is to provide increased opportunity to harvest trout. However, this section is capable of supporting both the biomass and quality sized trout that the GM section does downstream. Although the regulation allows for more harvest of trout, few anglers actually take advantage of the harvest opportunity.

Angler catch and demographics are similar between the Gold Medal and Standard management sections. The 2012 creel census estimated angler numbers at 1,461, an 11% drop in anglers since 1997. Anglers reported catching 76% rainbows, 23% brown trout, and 1% Snake River cutthroats. Total fish caught was estimated at a little over 6,000 fish but 98% were released; up from approximately 72% of trout released in 1997. Catch rates were reported at 1.7 fish caught per hour by an angler, most of these were rainbows (73%).

Stocking over the past 10 years in the Standard Reach varies but generally 10k rainbow and 10k brown trout fingerlings are stocked by raft each year in the Animas #2. Since 2005 we have been stocking approximately 10k Colorado cutthroat trout fingerlings in addition to the browns and rainbows. Because of the higher use associated with Standard Bag limits in an Urban Area, an average of 2,000 catchable rainbow trout have been stocked annually.

A whirling disease resistant rainbow trout is used for stocking. Because the whirling disease (WD) resistant fish, or Hofer strain, is highly domesticated it is cross breed with a wild strain of rainbow trout to produce a hybrid WD fish. These “Hofer crosses” have been stocked since 2008 with the hope of establishing a wild and self-reproducing population of rainbows in the WD positive Animas River.

GOLD MEDAL (ANIMAS #1) RESULTS

A total of 780 fish were captured in the Gold Medal reach between Cundiff Park and the Hwy. 550 High Bridge (Table 1). The most abundant fish captured were rainbow trout (66%), followed by bluehead sucker

Table 1. 2014 Summary Report for the Gold Medal Reach of the Animas River #1.

Stream Sampling Summary Report

Water: 37982 ANIMAS RIVER #1
Station: SJ1998
Drainage: San Juan River
Date: 9/9/2014
Notes: Biennial fish inventory on 1.3 miles of the Animas River. This reach of the river is managed with a 2 fish over 16 inch bag limit and is designated as one of Colorado's Gold Medal streams. Flows were optimal on the marking run on 9/9/14 at 273 cfs but jumped to over 1200 cfs due to local flash flooding caused by Hurricane Norbert. The recapture run was done on 9/12/14 when flows dropped just below 500 cfs and the water clarity improved. GPP settings were low range, 30% of Range and 60 PPS which worked really well at 640 microseimens cond. (64F).

Coordinates at Lower End of the Sampling Station: Zone: 13s, X: 245509, Y: 4124884, Elevation: 6392 ft
Length: 6336 ft, Width: 100.00 ft, Area: 14.55 ac
Effort:, Metric:, Protocol: MARK/RECAPTURE
Gear/Methods: BTEF

PROPORTIONAL STOCK DENSITY and QUALITATIVE STOCK DENSITIES

Species	Total Number	Proportional Stock Density (%)	Percent Stock Size	Percent Quality Size	Percent Preferred Size	Percent Memorable Size	Percent Trophy Size	Maximum Size (inches)
BLUEHEAD SUCKER	108	0.00						17.91
FLANNELMOUTH SUCKER	1	0.00						20.67
BROWN TROUT	82	92.68	7.32	26.83	19.51	14.63	31.71	23.23
MOTTLED SCULPIN	51	0.00						4.72
RAINBOW TROUT	531	6.76	93.24	5.41	1.35			21.26
WHITE SUCKER	7	100.00		71.43	28.57			14.37

MEAN, MINIMUM AND MAXIMUM VALUES FOR LENGTHS AND WEIGHTS

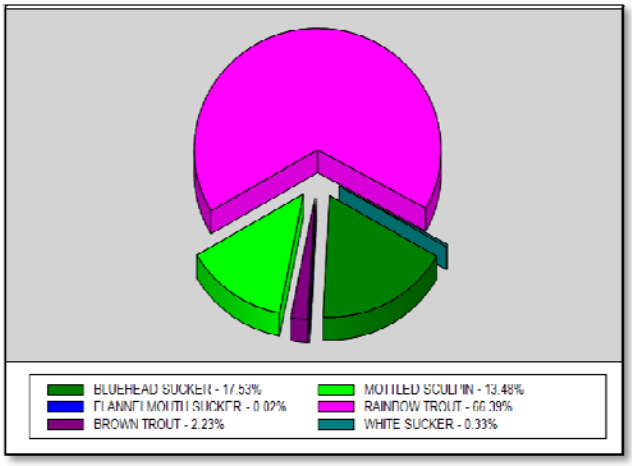
SPECIES	Total Sampled	Mean inches	Mean lbs	Minimum inches	Minimum lbs	Maximum inches	Maximum lbs
BLUEHEAD SUCKER	108	14.73	1.41	6.69	0.11	17.91	2.85
FLANNELMOUTH SUCKER	1	20.67	3.18	20.67	3.18	20.67	3.18
BROWN TROUT	82	14.66	1.58	7.87	0.19	23.23	6.00
MOTTLED SCULPIN	51	3.57		1.57	0.00	4.72	0.00
RAINBOW TROUT	531	8.22	0.28	5.91	0.07	21.26	4.12
WHITE SUCKER	7	11.82	0.81	10.24	0.49	14.37	1.53

RELATIVE ABUNDANCE and CATCH PER UNIT EFFORT

Species	Total sample	Population >= cutoff	Population all sizes	Weight Lb	Percent Number	Percent Weight	Catch per Unit Effort Number/Effort	Catch per Unit Effort Lbs/Effort
BLUEHEAD SUCKER	108	896	896	1,260.11	17.53	52.29		
FLANNELMOUTH SUCKER	1	1	1	3.18	0.02	0.13		
BROWN TROUT	82	114	115	180.45	2.23	7.49		
MOTTLED SCULPIN	51	689	689	0.00	13.48	0.00		
RAINBOW TROUT	531	3393	3422	952.23	66.39	39.52		
WHITE SUCKER	7	17	17	13.82	0.33	0.57		

RELATIVE ABUNDANCE and BIOMASS ESTIMATES

Species	Total sample	Population estimate	Weight Lb	Percent Number	Percent Weight	Biomass Lb/Acre	Num/ Acre	Num/Mile	Fish samples No/Acre < T	Fish samples No/Acre >=T	T
BLUEHEAD SUCKER	108	896	1,260.11	17.53	52.29	86.63	61.60	746.67	0	7	150
FLANNELMOUTH SUCKER	1	1	3.18	0.02	0.13	0.22	0.07	0.83	0	0	150
BROWN TROUT	82	114	180.45	2.23	7.49	12.41	7.84	95.00	0	6	150
MOTTLED SCULPIN	51	689	0.00	13.48	0.00	0.00	47.37	574.17	0	4	
RAINBOW TROUT	531	3393	952.23	66.39	39.52	65.47	233.27	2,827.50	2	37	150
WHITE SUCKER	7	17	13.82	0.33	0.57	0.95	1.17	14.17	0	0	150



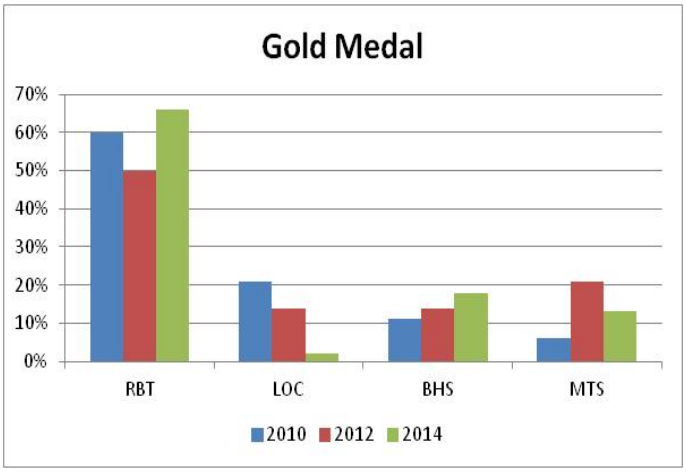


Figure 1. Percent species composition of fishes in the Gold Medal Reach during the 2014 fish survey (left) and composition since 2010 (right).

(17%), mottled sculpin (13%), and brown trout (2%; Figure 1). Brown trout showed the most precipitous drop from 20% of the catch in 2010 to only 2% of the catch this year (Figure 1; right). Although the combined biomass of trout was sufficient to reach Gold Medal (GM) standards (75 lbs), the number of quality fish per surface area was almost half of what is needed to maintain GM standards (7 fish≥14 in per surface acre; Figure 2 and Table 2).

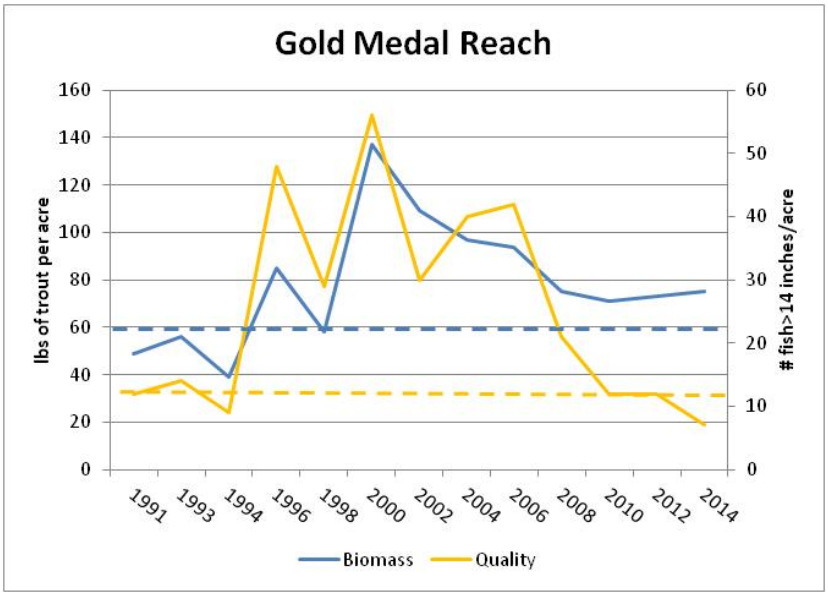


Figure 2. Biomass versus quality of trout in the Animas River Gold Medal Reach. Dashed lines are the minimum number of fish (yellow) or biomass (blue) needed to meet Gold Medal criteria for a Colorado stream.

The density of fish in the Animas River Gold Medal section was 131 fish per mile for brown trout over 6 inches and 3,104 rainbows per mile in the same size category (Table 2). Brown trout density dropped by 59% relative to 2012 while rainbow trout density increased by 40%. Most of the increases in rainbow trout numbers were from fish less than 200 mm (Figure 3).

Table 2. Historic fish survey metrics for the Animas River #1 (Gold Medal) and Animas River #2 (Standard Regulation) reaches.

Animas #1 Gold Medal	1991	1993	1994	1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	
Month/Year	Oct-91	Nov-93	Sep-94	Sep-96	Sep-98	Sep-00	Nov-02	Nov-04	Sep-06	Sep-08	Sep-10	Sep-12	Sep-14	Average
All trout combined (fish/acre)	60	55	48	134	44	131	51	90	141	73	148	210	267	112
All trout combined (fish/mile)	724	660	590	1626	530	1592	617	1089	873	887	1792	2545	3235	1289
Total trout biomass (lbs/acre)	49	56	39	85	58	137	109	97	94	75	71	73	75	78
All trout > 14 inches (fish/acre)	12	14	9	48	29	56	30	40	42	21	12	12	7	26
Rainbows> 14 inches (fish/acre)	7	4	5	31	6	21	11	29	28	10	5	3	2	12
Animas #2 Standard	1991	1993	1994	1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	
Month/Year	Oct-91	Nov-93	Sep-94	Sep-96	Sep-98	Sep-00	Nov-02	Nov-04	Sep-06	Sep-08	Sep-10	Sep-12	Sep-14	Average
All trout combined (fish/acre)	*147*	*43*	*122*	*66*	*38*	*57*	*130*	*115*	*84*	*97*	*56*	*73*	*65*	*84*
All trout combined (fish/mile)	*1779*	*520*	*1476*	*799*	*460*	*690*	*1573*	*1392*	*1406*	*1171*	*720*	*880*	*797*	*1051*
Total trout biomass (lbs/acre)	*115*	*32*	*56*	*41*	*28*	*42*	*99*	*104*	*115*	*58*	*32*	*41*	*27*	*61*
All trout > 14 inches (fish/acre)	*37*	*12*	*10*	*11*	*12*	*16*	*38*	*17*	*34*	*13*	*4*	*4*	*3*	*16*
Rainbows> 14 inches (fish/acre)	*3*	*2*	*2*	*2*	*6*	*5*	*10*	*7*	*11*	*4*	*0.2*	*0.4*	*0*	*4*

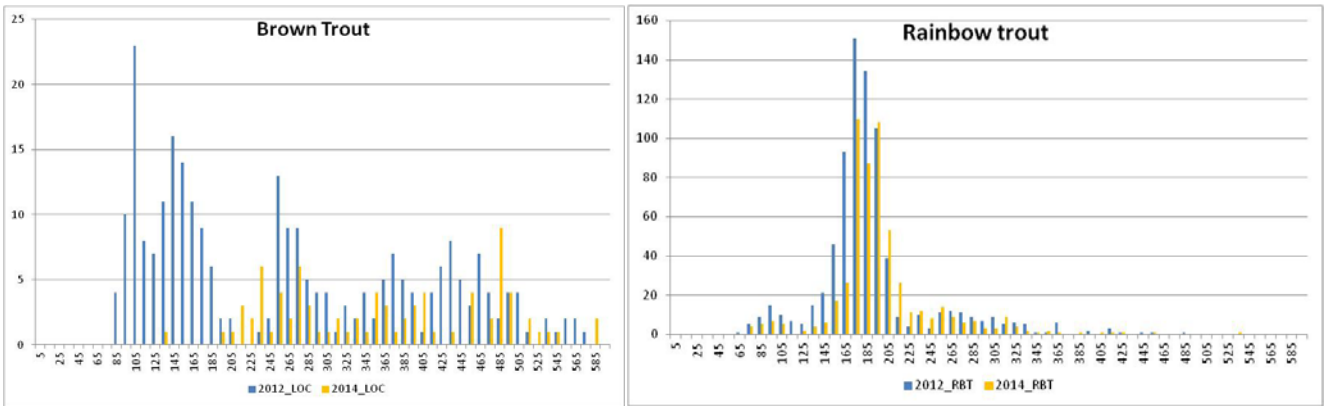


Figure 3. Length frequency of brown (left) and rainbow (right) trout captured in 2012 and 2014 fish surveys in the Gold Medal Reach.

Age-0 (80-135 mm) and Age 1 (145-180 mm) brown trout were not captured or rare in the Gold Medal reach during this years' survey (Figure 3; left-yellow bars). In 2012, both age classes were abundant (Figure 3; left-blue bars). Rainbow trout showed the opposite demographic pattern with abundant Age-0 (60-125 mm) and Age-1 (130-200) fish present but few older fish (Figure 3; right). This pattern was similar to what we saw 2 years ago in 2012.

Relative weight describes a fish's body condition relative to a standard weight of that species. Relative weights well below 100 suggest feeding conditions are not optimal; conditions above suggests under utilization of prey most likely as a result from low densities of fish (i.e., completion for food is low). Brown and rainbow trout under 300 mm averaged just at 98. Browns over 300 mm TL averaged 110 while rainbows at that same size were 97 (Figure 4). Most of the browns over 300 mm were in spawning condition which probably accounted for their higher relative weights.

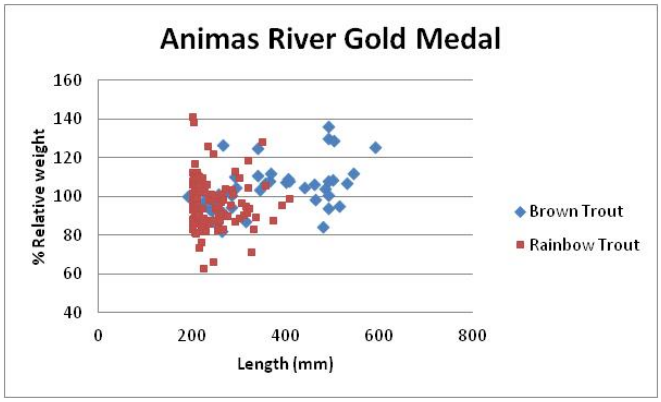


Figure 4. Relative weight of brown and rainbow trout.

STANDARD REACH (ANIMAS #2) RESULTS

A total of 358 fish were captured in the Animas River Standard Regulation reach (Animas #2; Table 3). The composition of the catch in order of relative abundance was rainbow trout (50%), mottled sculpin (17%), brown trout (15%), white sucker (13%), and bluehead sucker (4%; Table 3). The relative abundance of rainbow and brown trout and bluehead sucker has declined in this reach since 2010 (Figure 5).

Table 3. Summary report for the Animas River #2.

Stream Sampling Summary Report

Water: 37994 ANIMAS RIVER #2
Station: SJ2356
Drainage: San Juan River
Date: 9/8/2014
Notes: Biennial fish inventory on 1.3 miles of the Animas River. This reach of the river is managed with standard regulations. Flows were optimal on the marking run on 9/8/14 at 273 cfs but jumped to over 1200 cfs due to local flash flooding caused by Hurricane Norbert. The recapture run was done on 9/18/14 when flows dropped to 332 cfs and the water clarity improved. GPP settings were low range, 30% of Range and 60 PPS which worked really well at 640 microseimens cond. (64F).

Coordinates at Lower End of the Sampling Station

Zone:	X:	Y:	Elevation:
13s	244241	4129202	6510 ft

Length:	Width:	Area:
7920 ft	100.00 ft	18.18 ac

Effort: **Metric:** **Protocol:** MARK/RECAPTURE

Gear/Methods: BTEF

PROPORTIONAL STOCK DENSITY and QUALITATIVE STOCK DENSITIES

Species	Total Number	Proportional Stock Density (%)	Percent Stock Size	Percent Quality Size	Percent Preferred Size	Percent Memorable Size	Percent Trophy Size	Maximum Size (inches)
BLUEHEAD SUCKER	23	0.00						17.32
FLANNELMOUTH SUCKER	1	0.00						20.08
BROWN TROUT	74	67.57	32.43	39.19	13.51	8.11	6.76	22.44
MOTTLED SCULPIN	33	0.00						4.29
RAINBOW TROUT	194	0.00	100.00					13.39
WHITE SUCKER	28	82.14	17.86	14.29	25.00	42.86		18.50
WHITE-BLUE SUCKER HYBRID	2	0.00						16.38
WHITE-FLANNELMOUTH HYBRID	3	0.00						18.90

MEAN, MINIMUM AND MAXIMUM VALUES FOR LENGTHS AND WEIGHTS

SPECIES	Total Sampled	Mean		Minimum		Maximum	
		inches	lbs	inches	lbs	inches	lbs
BLUEHEAD SUCKER	23	14.48	1.30	11.22	0.63	17.32	2.41
FLANNELMOUTH SUCKER	1	20.08	2.83	20.08	2.83	20.08	2.83
BROWN TROUT	74	10.91	0.71	5.98	0.08	22.44	4.30
MOTTLED SCULPIN	33	3.14		1.97	0.00	4.29	0.00
RAINBOW TROUT	194	9.97	0.45	5.91	0.09	13.39	1.03
WHITE SUCKER	28	14.18	1.48	7.48	0.19	18.50	2.78
WHITE-BLUE SUCKER HYBRID	2	12.32		8.27	0.00	16.38	0.00
WHITE-FLANNELMOUTH HYBRID	3	17.45		16.14	0.00	18.90	0.00

RELATIVE ABUNDANCE and CATCH PER UNIT EFFORT

Species	Total sample	Population >= cutoff	Population all sizes	Weight Lb	Percent		Catch per Unit Effort	
					Number	Weight	Number/Effort	Lbs/Effort
BLUEHEAD SUCKER	23	70	70	91.38	4.18	9.37		
FLANNELMOUTH SUCKER	1	0	0	0.00	0.00	0.00		
BROWN TROUT	74	253	266	179.39	15.10	18.40		
MOTTLED SCULPIN	33	285	285	0.00	17.01	0.00		
RAINBOW TROUT	194	839	869	379.36	50.07	38.91		
WHITE SUCKER	28	220	224	324.94	13.13	33.32		
WHITE-BLUE SUCKER HYBRID	2	3	3	0.00	0.18	0.00		
WHITE-FLANNELMOUTH HYBRID	3	5	5	0.00	0.30	0.00		

RELATIVE ABUNDANCE and BIOMASS ESTIMATES

Species	Total sample	Population estimate	Weight Lb	Percent		Biomass Lb/Acre	Fish samples				
				Number	Weight		Num/Acre	Num/Mile	No/Acre < J	No/Acre >=J	J
BLUEHEAD SUCKER	23	70	91.38	4.18	9.37	5.03	3.85	46.67	0	1	150
FLANNELMOUTH SUCKER	1	0	0.00	0.00	0.00	0.00	0.00	0.00	0	0	150
BROWN TROUT	74	253	179.39	15.10	18.40	9.87	13.92	168.67	1	4	150
MOTTLED SCULPIN	33	285	0.00	17.01	0.00	0.00	15.68	190.00	0	2	
RAINBOW TROUT	194	839	379.36	50.07	38.91	20.86	46.15	559.33	2	11	150
WHITE SUCKER	28	220	324.94	13.13	33.32	17.87	12.10	146.67	0	2	150
WHITE-BLUE SUCKER HYBRID	2	3	0.00	0.18	0.00	0.00	0.17	2.00	0	0	
WHITE-FLANNELMOUTH HYBRID	3	5	0.00	0.30	0.00	0.00	0.28	3.33	0	0	

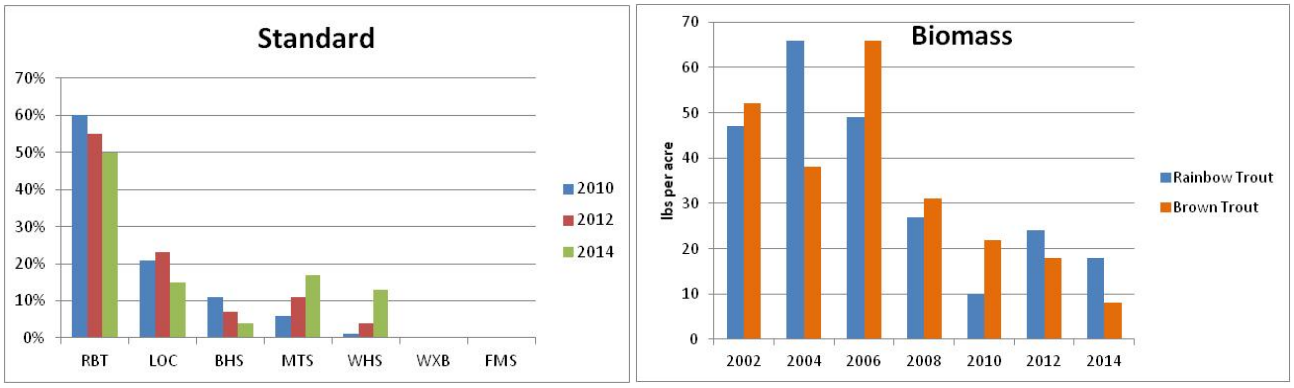


Figure 5. Percent species composition of fishes from 2010 – 2014 (left panel) and biomass of rainbow and brown trout (right panel) captured in the Standard Regulation reach of the Animas River.

Since 2002, the biomass of brown trout in the Standard reach has declined from a high of about 65 lbs per acre in 2006 to a low of only 8 lbs this year. Rainbow trout biomass has followed the same pattern from a high of 66 lbs per acre in 2004 to only 18 lbs/ac this year. The historic drop in biomass on average for rainbows was 20% and 76% for brown trout in this reach (N=22 survey years).

The estimated density or fish per mile of brown trout in the Standard reach was 169 fish per mile compared to 559 fish per mile for rainbow trout. Historic average brown trout density is 427 f/mi and for rainbows it is 476 f/mi. On a percentage basis brown trout numbers are down by about 60% while rainbow trout numbers are up about 17% over the historic average density.

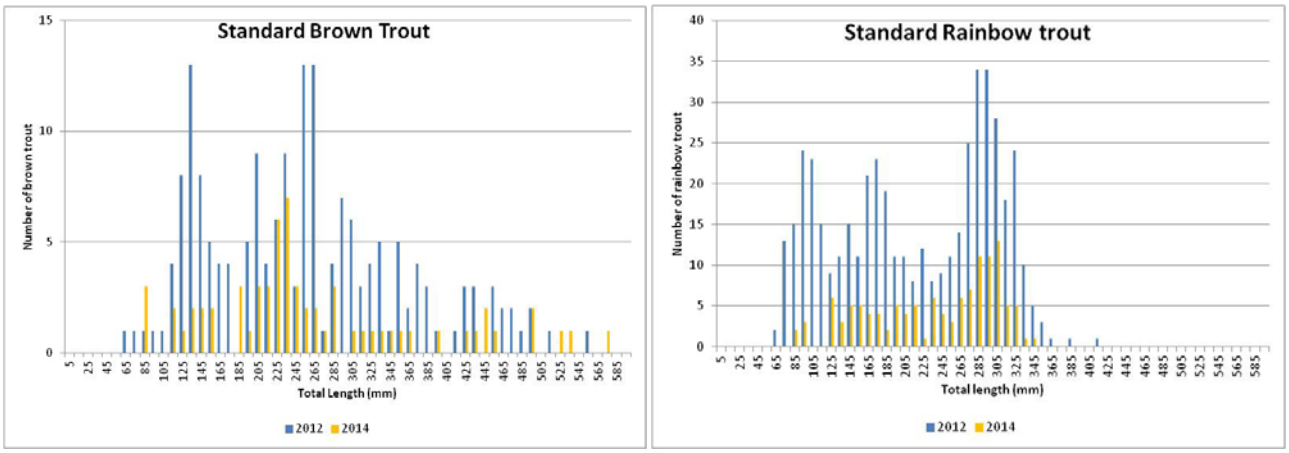


Figure 6. Length frequency for brown (left) and rainbow (right) trout in the Standard Regulation reach of the Animas River during the 2012 and 2014 fish surveys.

Young brown trout (Age-0&1), although present, were much reduced in abundance compared to 2012 (Figure 6). Older and larger browns were also less abundant than 2012. Essentially the same pattern could be seen for rainbow trout as well. Fewer fish in all age classes were captured in 2014 compared to 2012 (Figure 6; right). In the past 2 years, very few rainbow trout have exceeded the 14 inch quality standard, which holds true for the Gold Medal Reach as well.

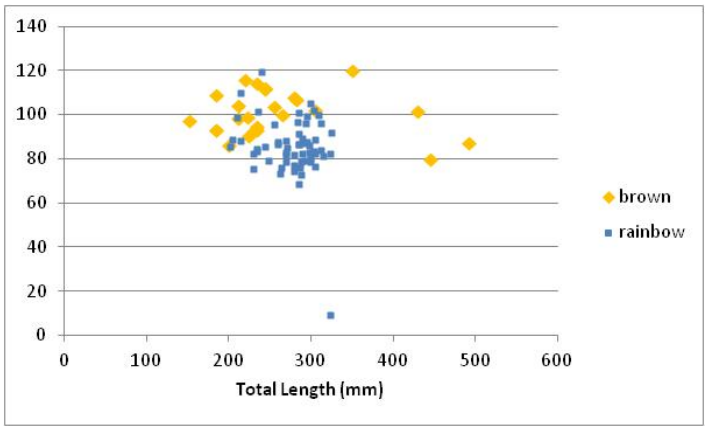


Figure 7. Relative weight index of brown and rainbow trout in the Animas River #2, Sept. 8th, 2014.

Brown trout were in average body condition with a relative weight index value of 101. However, two of the largest individuals (17.5 and 19.4 in) had a body index of 80 and 87 which is below average. Brown trout in early September should have the highest body condition factor for the year just before the spawning season begins in early October. Rainbow trout body condition averaged 86% of what would be considered a "standard" weight.

NATIVE FISH RESULTS

A total of 131 BHS, 2 FMS, 39 WHS, and 5 sucker hybrids were captured in the Animas River in 2014. On average (1993-2014 data), declines in total native suckers captured this year ranged from 38% for bluehead sucker to 84% for flannelmouth sucker. White sucker relative abundance was up about 50% from average total numbers captured in the past and hybrid suckers remained about the same as the long-term average of 5 hybridized fish capture per survey year.

Most of the bluehead suckers captured were adult fish. In 2012 we saw some evidence of young of the year or possibly Age-1 BHS around 100-145 mm but this year we did not capture any suckers in that size range (Figure 8). The two flannelmouth suckers captured were large (20+ inches) and old adult fish.

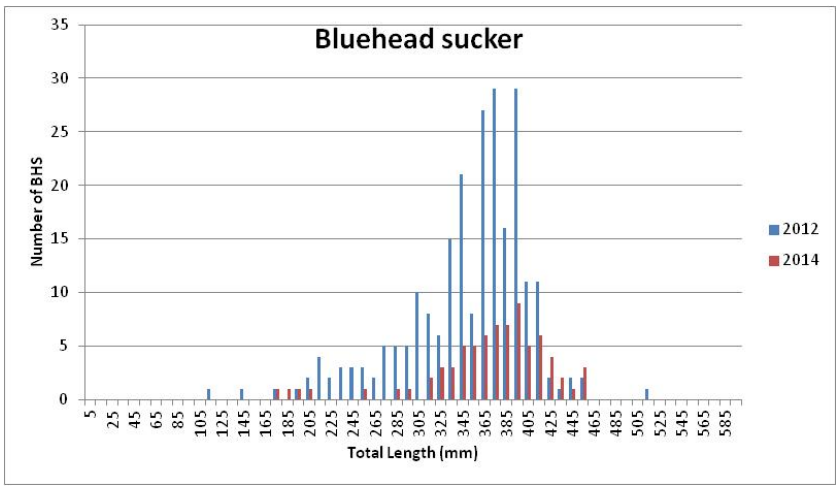


Figure 8. Length frequency chart of bluehead sucker captured in 2012 and 2014 on the Animas River #1 and #2 combined.

CONCLUSIONS

The steady decline in the number and size of trout in the Animas River since 2006 is alarming and complex. At the same time we see the density of brown trout declining we also see young rainbow trout flourishing in the Animas River but they don't seem to be able to get much past 2 years old. The biomass divide between the Standard and Gold Medal section continues to widen. These two sections are in close proximity to one another and the in-stream physical habitat is similar. Despite the different regulations allowing a more liberal harvest in the Standard reach, creel surveys suggest there is little substantial difference in harvest between the two sections yet the biomass of the Standard reach was almost 70% below what was estimated in the Gold Medal section this year. Native fishes also appear to be on the decline with total numbers of fish captured dropping from 40% for bluehead sucker to almost 80% for flannelmouth sucker.

The Animas River is a complex system with water quality impairments ranging from dissolved heavy metals, to heavy local sediment inputs, and occasional water temperature exceedences. The river is also a free flowing system subjected to all of the stochastic events a natural system can throw at it. The fish population in the Animas River reflects these variations sometimes fluctuating 3-4 times in fish density between surveys (Figure 9). However, from about 1998 through 2006 there was a period of relative stability in both trout numbers and the number of quality sized individuals in the Standard and Gold Medal reaches (albeit, brown trout numbers and biomass in the GM reach appears to be in decline from about 2000 on). The question is, "What are the underlying factors precluding the recruitment of young brown and rainbow trout into older/quality size age classes anglers expect to catch?" And, the follow-up question is; "What are the management prescriptions needed to address these limiting factors in the Animas River?"

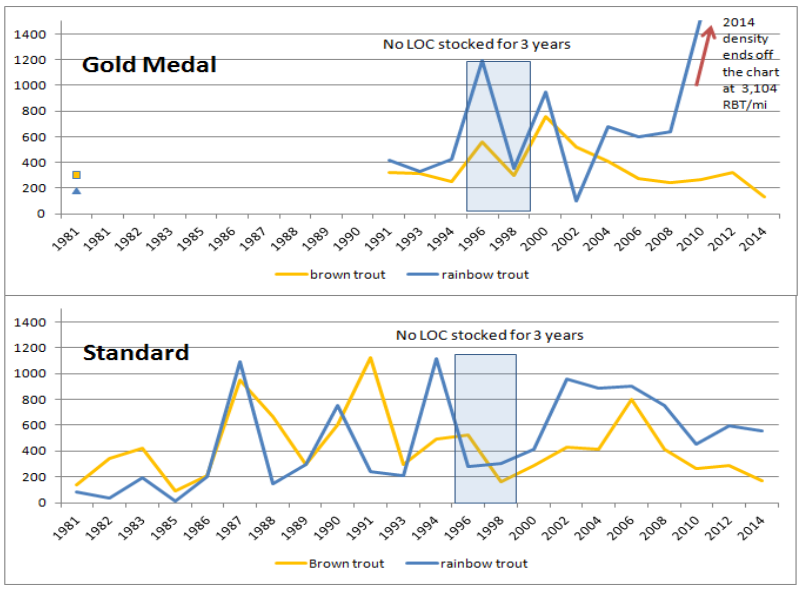


Figure 9. A historic comparison of fish density between the Gold Medal and Standard Regulation reaches on the Animas River.

There are six primary factors that may limit trout populations. These are:

1. Food or energy sources
2. Harvest
3. Physical Habitat
4. Flow Regime
5. Water Quality (dissolved metals, sediment, temperature)
6. Biotic interactions (predator/prey interactions as well as competition)

There are a several limiting factors that are unlikely to significantly influence trout densities in the Animas River. The condition factors of most trout in the Animas River is average suggesting fish are getting adequate food resources and, by extension, the macroinvertebrate community is relatively productive (however, it may not be diverse). However, gaps in food production or unmet dietary needs while trout are transitioning between Age 2 and beyond are of concern and need further investigation.

Physical habitat conditions have not changed much in the last 20 years. Improvements to the fish habitat and bank stabilization were made in 2009 just upstream of the Highway 160 bridge. However, the physical habitat was negatively altered with the installation of the Durango Whitewater Park in the winter of 2013/14 but that reach of Gold Medal water was steep with high water velocities and probably not very good habitat compared to the rest of the reach. Major physical shifts in the trout habitat in either reach do not fully explain the decline in trout density, biomass, or quality.

Angler harvest influences trout densities and demographics. In the Animas River trout harvest occurs but is not significant. A 2012 creel survey suggests the harvest rate on trout is less than 2%. Over 98% of those surveyed were catch and release anglers. Catchable trout are stocked in the Standard Reach to off-set harvest of wild fish. "Left over" or uncaught catchables are a common occurrence in our electrofishing surveys.

Flow regime describes the pattern of a series of annual discharges in the Animas River. Key points in an annual discharge curve are the duration, variation, and intensity of the spring runoff and stability of baseflows starting typically in late June or early July. In general, trout populations are sensitive to highly variable flow regimes and stable baseflows provide optimal growing conditions for trout of all age classes. For example, the Gunnison River above Blue Mesa Reservoir has a very stable trout population. The Gunnison has a similar discharge to the Animas River in terms of quantity of water and the general snowmelt pattern (Figure 10) but the variation within the hydrologic year on the Animas River can be enormous (Figure 11).

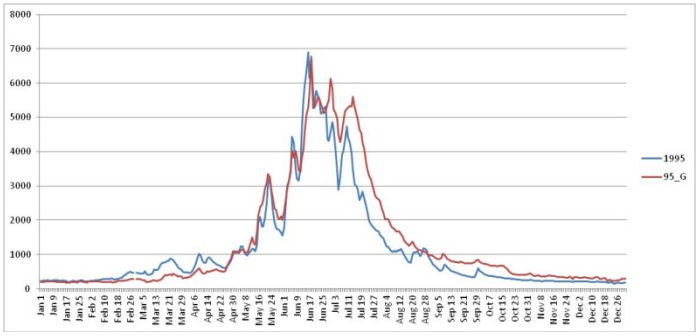


Figure 10. Annual discharge on the Animas (blue line) and Gunnison (red line) during 1995.

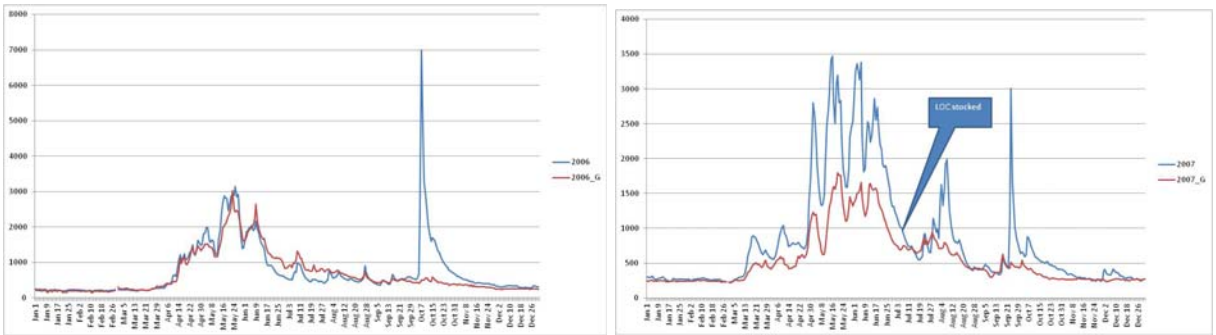


Figure 11. 2006 and 2007 water years on the Animas (blue line) and Gunnison (red line) rivers. Y axis is discharge in cubic feet per second (cfs).

There is a weak link between intra-annual variation in the Animas River discharge associated with high spring peaks and monsoonal rainfall events and the loss of some young year classes of trout. For example, in 2005 the Animas River peaked at over 8,000 cfs (the Gunnison peaked at a little over 3,000 cfs that year). Age-0 and Age-1 brown trout were relatively abundant in 2004 (same year classes of rainbows were rare). In 2006 when we checked the river those Age-0 and Age-1 trout should have been Ages 2-3 (or around 260-360 mm) and they were well represented in the catch. The weak age classes of rainbow trout seen in 2004 were observed in the lack of the Age 2&3 rainbows during the same 2006 survey. It appears the high spring peak of 2005 had little appreciable effect on trout in the Animas.

However, in 2006 we had the second highest fall flooding since 1916. That year the river peaked at 7,000 cfs on October 7th (after electrofishing surveys were completed that year but probably before the brown trout spawn). In 2008 the young fish that were subjected to the fall flood would have been Age 2&3 year classes. Those age classes in the 2008 survey are depressed (Figure 12). The intense flooding of 2006 may have depressed trout densities poised to become larger quality sized fish in the Animas River but it was not a devastating blow to the fishery.

This year our survey showed very few Age-0 or Age-1 brown trout. There were no highly unusual flooding events that occurred between 2012, when young brown trout were very abundant, and 2014 to explain the low density of these fish. To avoid discharge related losses of fish, all of the fingerling trout stocking occurs as the peak spring flows are descending at the end of June to July. Fall flooding does affect the recruitment of young fish but most of the stocked fish probably weather these events with little significant overall losses to the Animas River.

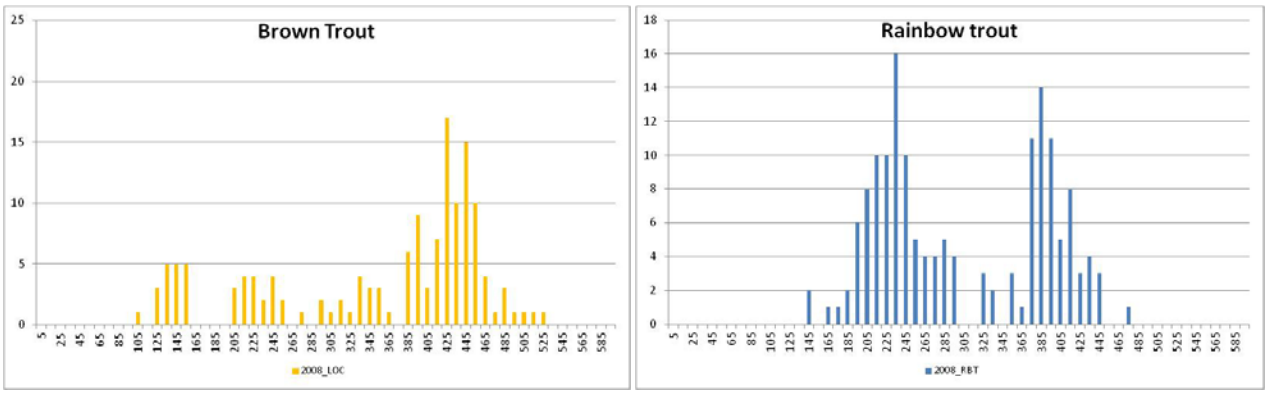


Figure 12. Length frequency charts of brown and rainbow trout in the Animas River post 2006 fall flooding.

Water quality has changed on the Animas River since about 2004. A number of mitigation efforts in the Upper Animas River since the early 1990's were successfully completed by mining companies, the Animas River Stakeholders Group (ARSG), and federal land management agencies. Initially, these projects resulted in an overall reduction of dissolved heavy metals into the Animas River. One of these projects near the headwaters of Cement Creek above Silverton included placing concrete bulkheads in the American Tunnel to staunch the discharge of metal laden water into the creek. Between 1996 and 2004, a water treatment plant operated to treat any residual mine drainage while the company completed a number of other projects to offset the residual leakage. In 2004 the treatment plant was shut down after the last bulkheads were installed and several mine adits above the bulkheads began discharging polluted water in much larger quantities than before. Dissolved zinc and cadmium levels (among others) are substantially worse now in the Animas River below Silverton than they were previously.

The decline in water quality in the upper Animas River is clearly seen in downstream fish populations. The closest reach typically occupied by fish downstream of Silverton is Teft Spur, located just upstream of the Cascade Creek confluence. Between 1992 and 2005 (N=3 sampling occasions), brook trout densities averaged 345 fish/mile and in 1998 brook, rainbow, brown, and cutthroat hybrids were present at the site. From 2010-2014 (N=2 surveys), brook trout populations average 84 fish/mi and rainbow and cutthroat hybrids have been extirpated (brown trout are extremely rare). The trout population has declined almost 80% from baseline conditions.

The decline of trout at the Teft Spur site is not the result of declining baseflows and habitat conditions in the Animas River. A baseline survey conducted in the Animas River above Silverton shows a small dip in the average density of brook trout from 649 fish/mi since 1992 to an estimated 502 fish/mile this year. Although the density of brook trout at this site dropped about 50% from the estimate in 2010 there were multiple age classes of fish present suggesting all of the conditions need for reproduction and recruitment are present. At the Teft Spur site only adult fish were captured; relatively good juvenile habitat is present at this site. The presence of a decent brook trout population above the influence of Cement Creek and a drastically reduced population of brook trout below provides good evidence that the increase in dissolved metals in the Upper Animas River is affecting the fishery.

The water quality picture in the Animas River running through Durango is complex. By the time water from the Animas River headwaters reaches Durango several large tributaries, including Cascade and Hermosa creeks, bring in high quality water with buffering properties from abundant limestone in those drainages. Currently, dissolved metal water quality standards designed to be protective of fishes are exceeded at the Baker's Bridge location 17 miles north of Durango and above the Hermosa Creek confluence, but are met at Trimble Lane (~10 miles north of town) and down through Durango. Dissolved metal water quality standards are not exceeded below Durango.

Although there is currently no measured direct connection between the discharges of heavy metal laden water in the Silverton Area and the Animas River fishery through Durango, there are substantial and additive impacts to the water quality that are occurring with increasing frequency that likely affect fish in the Animas River. An often quoted saying is that "dilution is the solution to pollution". Routine fish monitoring and stocking started in the early 1980s. The peak of the brown trout biomass and density in the Animas River was in 2000. If we compare the amount of water the Animas River produced from 1985-1999 and the proceeding 15 years afterward, you get a 22% drop in the overall amount of water in the river. The decline in the amount of water available for fish is most notable during the summer months when the peak of the growing season occurs. Since 2000, the Animas River has produced almost 40% less water during these critical baseflow months than in the preceding 15 years (Figure 13). Because of warmer springs and dust on snow events, the peak of the hydrograph has started to shift from June to May in the last 10 years leaving less snow, and water, in the higher elevations to support baseflows. The quality of water is directly affected by the quantity of water; the trout population in the Animas River is a good barometer of both variables.

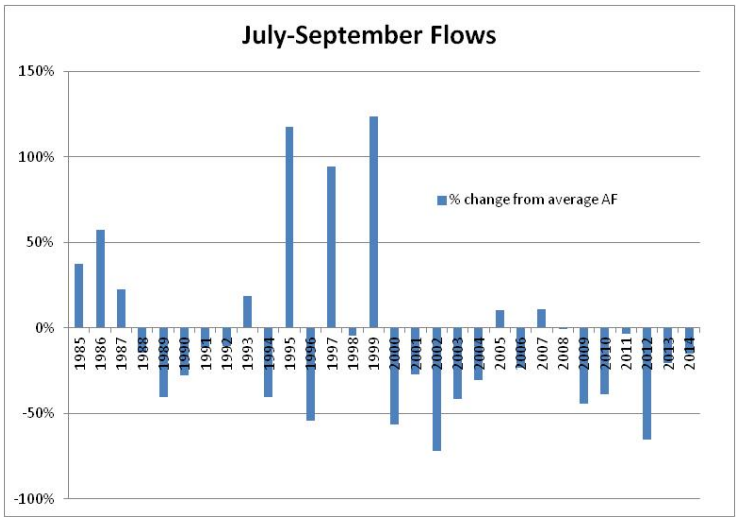


Figure 13. The sum of the acre feet of water produced by the Animas River in Durango between July and September expressed as percent change from average conditions during the same months (1916-2014).

Development and use of the Animas River has increased which can affect water quality. The population of La Plata County almost doubled from about 27,000 people in 1980 to an estimated 53,000 people in 2013. Conversion of agricultural lands to subdivisions has occurred throughout the county to accommodate the increased growth including large subdivisions in the Animas River valley north of town. Increases in inorganic nitrogen which can spur harmful algal blooms and cascading effects in pH and dissolved oxygen is often associated with agricultural use and/or increased development. Since 2003, inorganic nitrogen has increased every year, particularly in March when the snow melts off low elevation areas near the Animas (Figure 14). Increased traffic, impervious surfaces associated with roads and development, and channelizing natural drainages to accommodate land use also adds to the overall introduction of fine sediments and pollutants from city streets into the river.

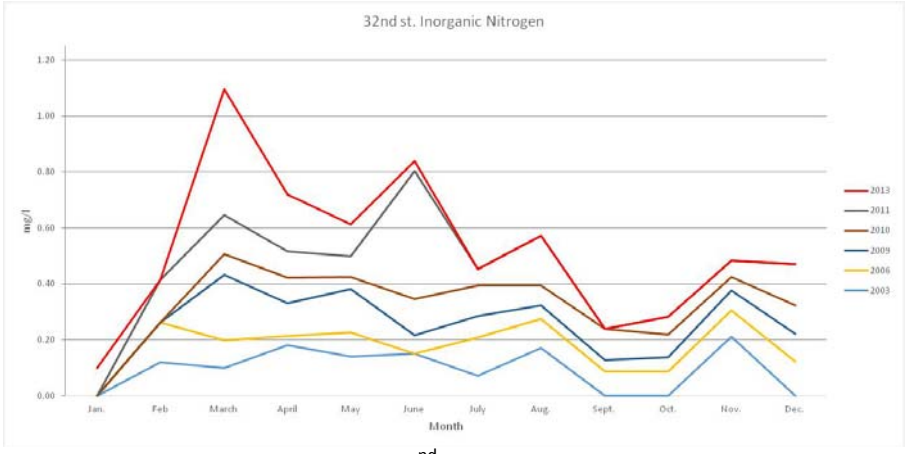


Figure 14. Inorganic nitrogen at 32nd Street Bridge in Durango, CO.

General use of the Animas River by the public has increased. The Animas River has become a focal point for both residents and visitors. The Durango Area Tourist Office estimates that over 900,000 people visited Durango in 2011 (51 times the current population of Durango). The commercial rafting industry estimates 41,000 user days a year on the River. That does not account for substantial number of private trips that occur on the river each year. Anecdotally, the popularity of tubers on the river during the low water summer months has skyrocketed. Between 1985 and 1991, I lived in Durango. The thought of tubing down the Animas River never even occurred to me or my colleagues. I do not recall ever seeing anyone tubing despite spending a lot of

time on the water in a kayak during those days. During the low water years starting around 2000 (Figure 13) local rafting companies started renting tubes because they could not navigate the river with rafts. In 2012, CPW counted tubers on the river as part of a systematic angler creel census and estimated that over 13,000 tubers went down the Animas River (mostly in the Animas River #2 section). Between mid-June to mid-August tubers outnumbered anglers 9 to 1.

The distinction between tubers and other users of the Animas River is important. Tubing occurs at low water during the summer months when trout are actively feeding and growing. Tubing is most attractive when water temperatures are warm which coincides with the most stressful part of a day for a trout. Tubers are frequently out of there tubes wading to dislodge their craft from rocks which is a disruption to the bottom sediments, invertebrate community, and fish. Rafts and kayaks are much more maneuverable and that activity occurs primarily during higher flows when much of the channel is covered with water and water temperatures are low. Finally, tubers directly compete for space with anglers on the river (Figure 14).



Figure 14. Fly fisherman and tubers on the Animas River.

Trout need clean, cold water with sufficient depth, water velocity, and cover to thrive. The cumulative effects of less water, more pollutants, and more activity in the river run counter to good trout production. The demographics and use of the Animas River through Durango is different than it was 15 years ago. Increases in land and water development (i.e., Animas-La Plata pumping for Lake Nighthorse) as well as climate change will continue to negatively affect the trout fishery in the Animas River unless mitigation efforts succeed in countering some of these effects.

Questions about the strain, size, number, and biological interactions of recently stocked “Hofer Crosses” or HXC rainbows are often brought up at community meetings. The HXC rainbow trout is a wild rainbow crossed with a highly domesticated but whirling disease (WD) resistant fish. The goal of using this fish is to establish a wild population of whirling disease resistant fish in the river and reduce the overall loading of WD spores in the Animas. Anglers often associate the decline in the Animas River fishery with the stocking of these rainbow trout started in 2009 as mitigation for the Animas-La Plata project (Lake Nighthorse). Questions about inferior fitness of the rainbow trout strain are typically cited. However, CPW is starting to see gains in rainbow trout populations in the Gunnison, Arkansas, S. Platte, Rio Grande, and Poudre rivers using HXCs. Most notably, the expression of the “wild” part of the genome over the domestic Hofer part in Colorado streams that support natural reproduction is occurring. Although recruitment of HXCs is typically low (around 1%- 2%), it does not appear that the general fitness of the HXCs are vastly different than previously used strains of fish in the Animas River or any other river in Colorado.

Stocking on the Animas River Standard and Gold Medal reaches is necessary to compensate for poor natural reproduction by trout. Stocking numbers have not appreciably changed much since recommendations based on CDOW research were made in the early 1990s. The average number of rainbow and brown trout stocked from 1996-2008 was about 25,930 RBT/year and 26,200 LOC/year. After Animas-La Plata project mitigation stocking of HXCs started in 2009 we stock about 5,000 more rainbows per year than before. Since 2009 brown trout stocking has declined about 24% on a typical year. The number of brown trout stocked is highly dependent on a wild spawntake that occurs every year in North Delany Butte Reservoir. Variability in wild spawntakes (i.e., number of eggs/fish produced for stocking) is normal. Stocking rates in other Colorado Rivers range typically from 100 to 250 fish per surface acre. Because there is so little natural reproduction, CPW stocks the Animas at the upper end at 227 fish/surface acre.

Since 2009 the average size of rainbow trout stocked has increased from 3.0 inches to 3.9 inches. Brown trout stocked size has changed since 2006 from an average size of 4.7 inches to 3.1 inches. The decline in the average sized stocked brown trout in the Animas River is a result of increasingly short hatchery space (it takes less space to raise smaller fish) due to an ever increase in the demand for new conservation and management stocks of trout. A review of the research conducted by Barry Nehring in the late 1980s, suggest stocking larger brown trout improves recruitment from 1% up to 25%. However, Nehring did not find as clear a correlation between the size of rainbow stocked and recruitment. Most managers recommend stocking larger rainbows in a river occupied by large brown trout to avoid excessive predation. The erosion in the size of brown trout stocked in the Animas River is a variable we will address this year.

A number of aquatic managers in Colorado have manipulated the sizes of HXCs stocked based on the relationship between larger fish and increased domestication behaviors. The general consensus emerging from these investigations are stocking lots of very small 1 to 1.5 inch fish in fry habitat promotes the development of wild fish resulting in better recruitment and higher density rainbow trout populations unless fry habitat is limited and you have a large established brown trout population. If you have relatively limited fry habitat and lots of brown trout, then stocking 5-6 inch HXCs appears to work better (i.e., Arkansas River). The Animas River falls into the latter category: not much fry habitat and lots of large browns (at least back in 2008 that was the case). So looking back, stocking larger HXC was a sensible strategy. In the last several years, we have moved to stocking a smaller HXC based primarily on availability but also based on the notion that you get a wilder less domesticated fish if you stock them smaller. With the decline in the density of brown trout, and despite the lack of high quality fry habitat, this should have been a fruitful stocking strategy given what we know about HXCs now. And, it turns out, rainbow trout density and recruitment is up but bottlenecks right around Age 2 fish (Figure 3). Both large (5-6 inch) and relatively small (3 inch) HXCs have been stocked in the Animas River with little success at getting them up to quality size (14 inches).

Competition between young rainbow and brown trout may occur in the Animas River but to what extent is not known. They both occupy similar habitats but juvenile brown trout are much more tied to instream cover than rainbow trout. With low baseflows, there may be a competitive edge for young rainbow trout over brown trout particularly when the rainbows are stocked at a larger size. In other Colorado streams, predation by larger brown trout on young rainbow trout is a controlling factor on recruitment. With the density of larger browns so low on the Animas, it may explain why we see such high numbers of young rainbows but it does not explain the lack of rainbow trout recruitment beyond 2 years when most are not as susceptible to predation. The biological interactions between newly stocked rainbow and stock brown trout is difficult to tease apart but it is unlikely the rainbows have as big a competitive edge over the young browns as observed in this year's survey results.

MANAGEMENT RECCOMENDATION SUMMARY

1. Management: Continue to manage the Animas River #1 (GM reach) as category 406 "Coldwater special regulation stocked stream". Continue to manage the Animas River #2 (ST reach) as a category 405 "regularly stocked with any fry/fingerling/subcatchable salmonids" with standard regulations applied. Continue to monitor and assess on even years and coordinate with SUIT.
2. Stocking: continue to stock 10,000 HXC and 10,000 LOC fingerlings by raft each year in each section. Use A-LP mitigation HXCs for stocking. Stock HXCs post-runoff at 3 inches or less. Help S. Ute's mark HXCs with coded wire tags at Basin Creek site. Stock LOC post runoff at 5 inches or more. Mark larger brown trout prior to stocking with an adipose clip. Target fry/juvenile habitat when stocking. With HXC's instill olfactory predation avoidance behavior by sacrificing a few fish in the holding tank just prior to stocking.
3. Regulations: No change. Special regulations are not warranted in the ST regulation reach and the 16 inch minimum with a 2 fish limit is not limiting the population of large trout in the Animas River.
4. Habitat Improvement: Focus on water quality improvements. Continue to advocate for cleanup efforts in the Silverton Area by working with the EPA and stakeholder groups to obtain fishery data useful in mitigation negotiations with the mining companies Important fishery data include:
    a. Population estimates of juvenile and adult fish in historic upper Animas River sites
    b. Continue to monitor temperature
    c. Repeat of 1996-1999 fry shocking at 7 sites from High Flume Canyon to Baker's Bridge (collaborate with CPWs, Dan Kowalski and the S. Ute Indian Tribe)
    d. Collect fish for heavy metals tissue analysis (collaborate with CPWs, Pete Cadmus, and EPA, CDPHE, WQCD, and other stakeholder groups)
    e. Collect macroinvertebrate samples as water quality indicators (collaborate with Pete Cadumus, EPA, WQCD, CDPHE, and other stakeholder groups)
    f. Review 404 permit applications and mitigate impacts to habitat with instream cover projects
5. Access/ Facilities: Continue working with the Animas River Task Force on Animas River issues.
6. Information and Education: Continue disseminating updated information internally and to stakeholder groups. Manage expectations of fishery; i.e., drought and low flows are hard on fish.
7. Other: replace old regulation signs



Photo 1. Large brown captured in 2014 on the Animas River.



Photo 2. Nice rainbow capture just below High Bridge in the GM section, 2014.



Photo 3. Raft stocking the Animas.



Photo 4. Pete Deren (netting) and Dan Cammack throwing trode during 2014 mark and recapture survey.



Photo 5. Steph Schuler moving fish, Kara Hellige (ACOE) watches an approaching storm, and Mike Japhet is weighing a measuring fish. Jerry McBride (Durango Herald) looks on.



Photo 6. Pete Deren holds a large brown in a rainstorm; Dan Cammack looks on.



Photo 7. Drayton Harrison (back turned) talks to Steve McClung (right) and Mike Japhet during a downpour. New Mercury Building in background.



Photo 8. High water precluded recapture run on Animas #2 until 10 days later on 9/18.



Photo 9. Recaptured bluehead sucker.

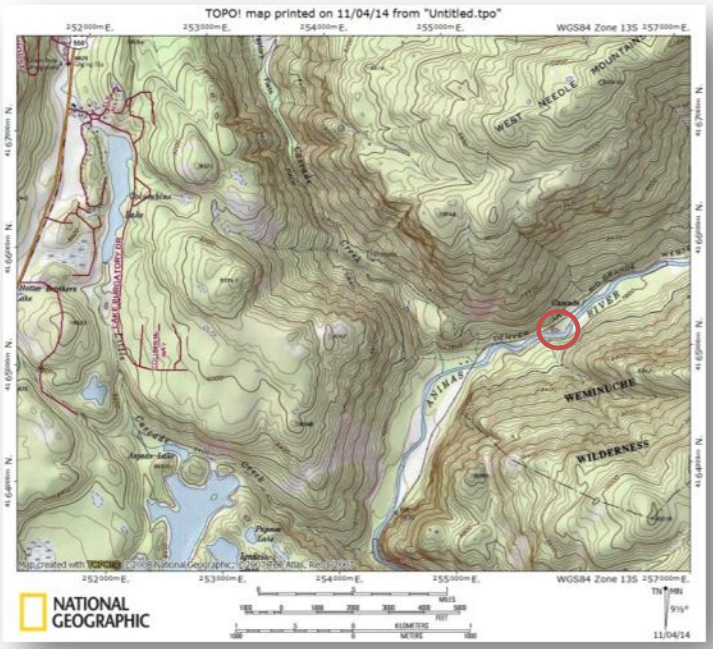


Photo 10. Large flannelmouth sucker captured behind Durango High School.

ANIMAS RIVER #3 (Teft Spur)

Jim N. White
Aquatic Biologist
Southwest Region

Water: Animas River #3
Sampling Date: 9/24/14
Gear: Bank Electrofisher
Drainage: San Juan
Water Code: 38009



OBJECTIVE

To assess the fish population in an 800 ft reach of the upper Animas after documented declines in the Animas River water quality.

HISTORY

The upper Animas River is heavily impacted by dissolved heavy metals including zinc, copper, cadmium, arsenic, lead, and iron (among others; Photo 1). The source of these metals is both mining and natural. Fish densities are extremely low below Silverton (Cement Creek), but there is a relatively robust brook trout population that occurs above town in the main stem of the Animas near Howardsville.

The Animas River Stakeholder Group (ARSG), federal agencies, and mining companies have completed some mitigation measures to limit the pollution with varying success. The largest of these measures failed in 2004 and water quality now is worse than it was before those measures were put in place. The EPA designated the upper Cement eligible for "Super Fund" clean up funding but the town of Silverton is opposed to the designation. Currently, the EPA plans to spend $1.5 million to plug the worse mine adits in the Cement Creek headwaters.

There are four historic fish sampling sites in the Upper Animas that are routinely monitored for presence/absence and abundance of fishes. From upstream to downstream these are Howardsville (4 miles NE of Silverton, A72 (just below Silverton and the Mineral Creek confluence), Elk Creek Spur (site located just above the confluence with Elk Creek, and Teft Spur (1/2 mile upstream of Cascade Creek confluence – see map). These sites have been monitored 5 times since 1992. Stations are monitored by bank shocking a 1,000 ft section of stream and a 2 pass removal estimator is used to calculate density

and biomass. Rail transportation is required to get into the Teft Spur and Elk Park Wye stations (Photo 2).

RESULTS

Only Teft Spur and Howardsville sites were sampled this year and no sites were sampled last year. Flows from recent monsoonal storms pushed the river up past 200 cfs in both 2013 and 2014 (Figure 1). However, we were able to safely wade the Teft Spur site on 9/24/14 when the river was running 261 cfs below Silverton. The Teft Spur site is located in a side-channel off the main stem of the Animas River which would not be safe to wade at most flows (Photo 3 and 4).

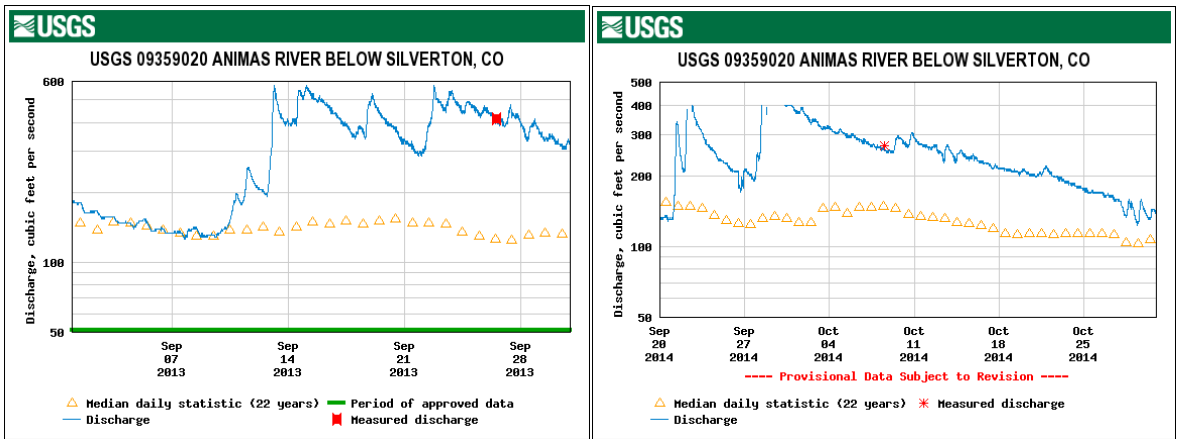


Figure 1. Flows at the Silverton (A-72) gauge during a planned 2013 shocking effort and during this year's effort. Flows need to be below about 175 cfs to safely wade the Elk Creek and A-72 sites.

A total of 9 brook trout and 2 brown trout were captured in this 700 ft electrofishing station during 2 passes (Table 1). With the exception of 1 juvenile brook trout all of the fish were adults (Figure 2). Brook trout relative weight was 96 and brown trout relative weight was 107. Relative weights should be higher than 100 for adult fish this time of year because of the impending spawning season. No rainbow, cutthroat, or cutbows were captured.

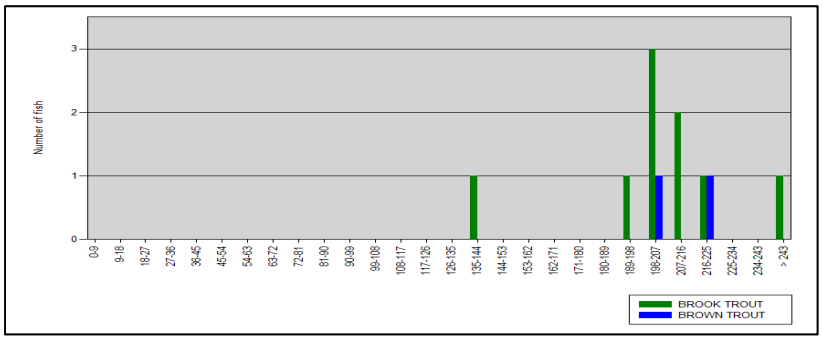


Figure 2. Length frequency of brook and brown trout captured at the Teft Spur site, September 24, 2014.

Table 1. Combined summaries of trout captured at the Teft Spur site.

Stream Sampling Summary Report

Water: 38009 ANIMAS RIVER #3
Station: SJ0058
Drainage: San Juan River
Date: 9/24/2014
Notes: Purpose of survey was to periodically monitor the fish community relative to improving or degrading water quality conditions in the Upper Animas River. Five anodes were used to shock this 700 ft long side channel. Water discharge at the A72 gauge was 257 cfs; high due to recent rains but the side channel is wadeable at these levels. We used two large motorcars and a trailer to get personnel and equipment to the site (starting at Silverton and going downstream).

Coordinates at Lower End of the Sampling Station
Zone: 13
X: 255440
Y: 4165047
Elevation: 7714 ft
Length: 700 ft
Width: 65.00 ft
Area: 1.04 ac
Effort:
Metric:
Protocol: TWO-PASS REMOVAL
Gear/Methods: BKEF

PROPORTIONAL STOCK DENSITY and QUALITATIVE STOCK DENSITIES

Species	Total Number	Proportional Stock Density (%)	Percent Stock Size	Percent Quality Size	Percent Preferred Size	Percent Memorable Size	Percent Trophy Size	Maximum Size (inches)
BROOK TROUT	9	0.00	100.00					9.92
BROWN TROUT	2	0.00	100.00					8.78

MEAN, MINIMUM AND MAXIMUM VALUES FOR LENGTHS AND WEIGHTS

		Mean		Minimum		Maximum	
SPECIES	Total Sampled	inches	lbs	inches	lbs	inches	lbs
BROOK TROUT	9	8.03	0.21	5.59	0.07	9.92	0.36
BROWN TROUT	2	8.43	0.26	8.07	0.21	8.78	0.30

RELATIVE ABUNDANCE and CATCH PER UNIT EFFORT

					Percent		Catch per Unit Effort	
Species	Total sample	Population >= cutoff	Population all sizes	Weight Lb	Number	Weight	Number/Effort	Lbs/Effort
BROOK TROUT	9	9	9	1.99	78.95	79.59		
BROWN TROUT	2	2	2	0.51	17.54	20.41		

RELATIVE ABUNDANCE and BIOMASS ESTIMATES

				Percent		Biomass			Fish samples		
Species	Total sample	Population estimate	Weight Lb	Number	Weight	Lb/Acre	Num/ Acre	Num/Mile	No/Acre < T	No/Acre >=T	T
BROOK TROUT	9	9	1.99	78.95	79.59	1.91	8.62	67.89	0	9	130
BROWN TROUT	2	2	0.51	17.54	20.41	0.49	1.91	15.09	0	2	120

CONCLUSIONS

The average density of brook trout at the Teft Spur site dropped by 76% since 2005 (Figure 3). With the exception of 2 brown trout captured this year, rainbow, brown, and cutthroat hybrids have been virtually extirpated.

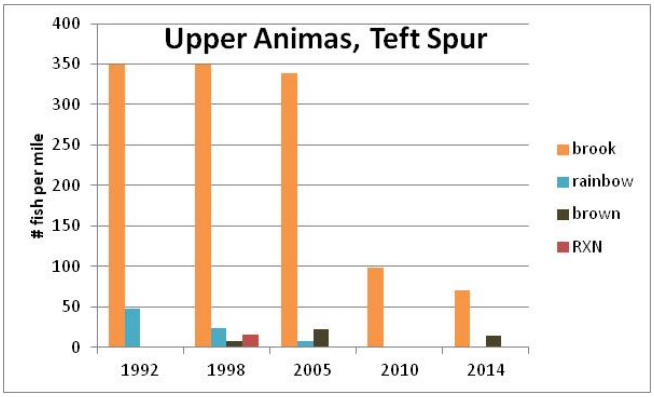


Figure 3. Density (fish/mi) of trout captured at Teft Spur since1992.

Brook trout are the most tolerant of dissolved heavy metal pollution and rainbow trout are the least tolerant. The steep and sudden decline in brook trout density and loss of rainbow trout coincides with the measured increase in dissolved toxic heavy metals in the Animas River below Cement Creek.

MANAGEMENT RECCOMENDATION SUMMARY

Management: Manage as a 302 or Wild salmonid recreation stream. Continue to periodically monitor fish population at Teft Spur.
Stocking: Stocking not recommended.
Regulations: Standard Regulations; no change.
Habitat Improvement: Work with EPA to improve water quality in Silverton by providing needed data to demonstrate downstream conditions.
Access/ Facilities: None.
Information and Education: Use data to illustrate the harmful effects of toxic dissolved heavy metals on fish populations and specific fish species.



Photo 1. Heavy metal laden water pouring out of the Bonita Mine near Silverton.



Photo 2. Equipment and personnel transportation.



Photo 3. Mid-station in the Teft Spur side channel.



Photo 4. Top of side channel at Teft Spur. Steve McClung in foreground.



Photo 5. Brook trout captured in reach.

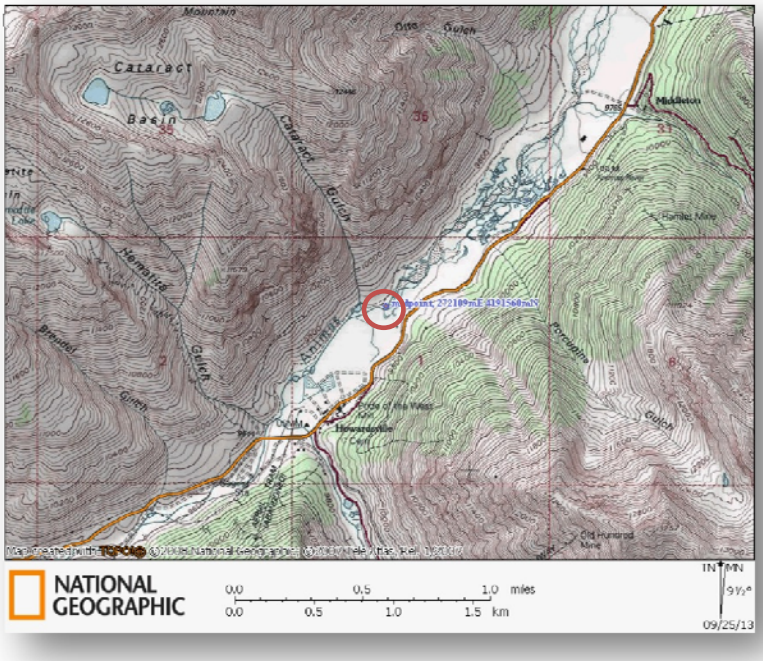


Photo 6. Brown trout captured in reach.

ANIMAS RIVER #4 (Howardsville)

Jim N. White
Aquatic Biologist
Southwest Region

Water: Animas River #4
Sampling Date: 9/25/2014
Gear: Bank Electrofisher
Drainage: San Juan
Water Code: 38011



OBJECTIVE

To assess baseline fishery above the worst dissolved heavy metal discharges in Cement Creek.

HISTORY

A short section of river above Howardsville (see map at right) is capable of supporting brook trout. This section of the Animas River historically was heavily impacted by in-channel disturbance from nearby mining activities as well as acid mine drainage and dissolved heavy metals. However, the water quality and habitat conditions have improved since monitoring efforts began in 1992. The reach, as well as nearby Cunningham, Maggie, and Minnie (Gulches) creeks, now supports reasonably high densities of brook trout for streams at this elevation.

RESULTS

A total of 162 brook trout were captured. No other species of trout was present. The density estimate was 501 fish per mile, down about 54% from the 2010 estimate. The lower density of trout resulted in higher condition factors for the brook trout. Relative to other brook trout populations, trout in 2010 were about 85% of their weight versus 102% this year. Improved relative weights suggest a density of about 500-600 fish per mile is probably close to the carrying capacity of this reach of stream.

Multiple age classes of brook trout were present in both 2010 and 2014 (Figure 1). A relatively abundant class of Age 0 fish were captured this year suggesting spawning conditions were good in the fall of 2013.

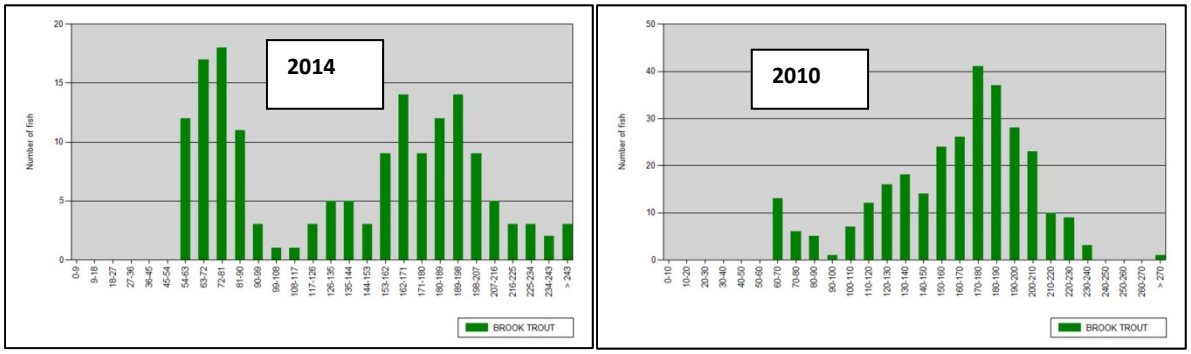


Figure 1. Length frequency of brook trout in 2014 and 2010 just upstream of Howardsville.

Table 1. Summary report for the Howardsville reach on the Animas River above Silverton.

Stream Sampling Summary Report

Water: 38011 ANIMAS RIVER #4
Station: SJ0057
Drainage: San Juan River
Date: 9/25/2014
Notes: Purpose of survey was to assess a population of brook trout in the upper Animas River drainage relatively unaffected by poor water quality. Stream discharge at the Howardsville gauge was 73 cfs.

Coordinates at Lower End of the Sampling Station

Zone:	X:	Y:	Elevation: 9681 ft
13	271942	4191509	

Length:	Width:	Area:
1000 ft	41.00 ft	0.94 ac

Effort: Metric: Protocol: TWO-PASS REMOVAL

Gear/Methods: BKEF

PROPORTIONAL STOCK DENSITY and QUALITATIVE STOCK DENSITIES

Species	Total Number	Proportional Stock Density (%)	Percent Stock Size	Percent Quality Size	Percent Preferred Size	Percent Memorable Size	Percent Trophy Size	Maximum Size (inches)
BROOK TROUT	85	0.00	100.00					9.72

MEAN, MINIMUM AND MAXIMUM VALUES FOR LENGTHS AND WEIGHTS

SPECIES	Total Sampled	Mean inches	Mean lbs	Minimum inches	Minimum lbs	Maximum inches	Maximum lbs
BROOK TROUT	85	7.40	0.17	5.91	0.08	9.72	0.41

RELATIVE ABUNDANCE and CATCH PER UNIT EFFORT

Species	Total sample	Population >= cutoff	Population all sizes	Weight Lb	Percent Number	Percent Weight	Catch per Unit Effort Number/Effort	Catch per Unit Effort Lbs/Effort
BROOK TROUT	85	95	172	16.29	100.25	100.00		

RELATIVE ABUNDANCE and BIOMASS ESTIMATES

Species	Total sample	Population estimate	Weight Lb	Percent Number	Percent Weight	Biomass Lb/Acre	Num/ Acre	Num/Mile	Fish samples No/Acre < T	Fish samples No/Acre >=T	Fish samples T
BROOK TROUT	85	95	16.29	100.25	100.00	17.31	100.93	501.60	82	90	150

CONCLUSIONS

Brook trout density declined in 2014 relative to the last survey done in 2010 (Figure 2). Although this was a steep drop the body condition of the fish suggest it was not due to a loss in primary productivity in the stream associated with metal toxicity. With very limited fishing opportunities in the Silverton area, and lots of angling pressure, harvest may explain some of the drop in brook trout density at this location.

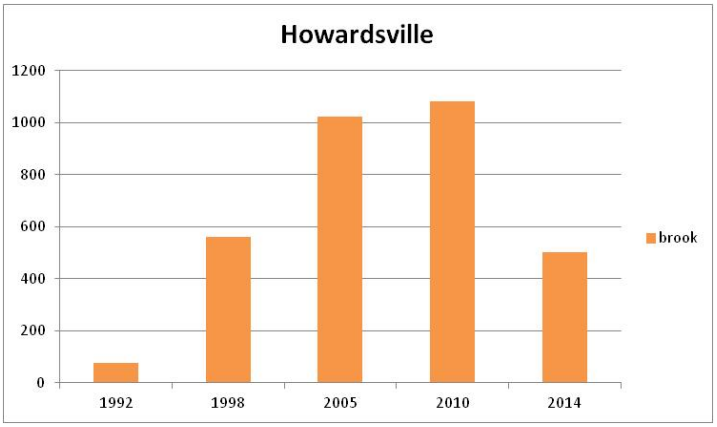


Figure 2. Long-term trends in brook trout density (trout per mile) at the Howardsville site, Animas River.

MANAGEMENT RECCOMENDATION SUMMARY

Management: Manage as a 302 Wild salmonid recreation stream.
Stocking: Not recommended.
Regulations: Standard Regulations; no change.
Habitat Improvement: Work with BLM to establish more adult holding water through habitat improvement projects. Incorporate woody debris and undercut banks in designs.
Access/ Facilities: None.
Information and Education: Highlight relatively abundant brook trout population in close proximity to heavily polluted waters coming from the Cement Creek area and the capability of expanded brook trout numbers near the Mayflower site if clean-up efforts succeed.



Photo 1. Heavy metal laden water pouring out of the Bonita Mine near Silverton.



Photo 2. Mid-point of survey site; Howardsville buildings in background.



Photo 3. Looking downstream from mid-station.



Photo 4. Electrofishing above mid-point.



Photo 5. Top of station – typically 1000 ft plus the stretch of the anode array.

Appendix 20

Historic Multi-Metric Index (MMI) scores for the Animas River

Animas River MMI Results - 2014

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**A53**	Sample Date:	10/11/2014
Waterbody Name:	**Upper Animas River**		
Location:	Abv. Cunnigham		
Latitude:	37.83641982	Reference Status:	Not Reference or Degraded
Longitude:	-107.59762286	BenSampID: 1	RepNum: 1
Biotype:	2		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	44.2

Metric Name	Metric Value	Metric Score
Total Taxa:	18	50.0
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	9	N/A
Chironomidae Pct:	15.5	N/A
Sensitive Plains Fammilies Pct:	33.0	N/A
Predator+ Shredder Taxa:	7	50.0
Clinger Taxa:	7	41.2
Clinger Taxa adjuested with Elevation:	7	N/A
Insect Taxa:	16	N/A
Non-Insct % of taxa:	11.1	N/A
Ephemeroptera Pct:	18.2	25.2
BeckBI:	18.0	54.5
Dominant01 Taxon Pct:	26.7	N/A
Sprawler Pct:	23.8	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**A55**	Sample Date:	9/24/2014
Waterbody Name:	**Upper Animas River**		
Location:	Howardsville Gauge		
Latitude:	37.832874	Reference Status:	Not Reference or Degraded
Longitude:	-107.59958648	BenSampID: 2	RepNum: 1
Biotype:	2		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	52.5

Metric Name	Metric Value	Metric Score
Total Taxa:	19	52.8
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	10	N/A
Chironomidae Pct:	2.0	N/A
Sensitive Plains Fammilies Pct:	29.9	N/A
Predator+ Shredder Taxa:	6	42.9
Clinger Taxa:	8	47.1
Clinger Taxa adjuested with Elevation:	8	N/A
Insect Taxa:	16	N/A
Non-Insct % of taxa:	15.8	N/A
Ephemeroptera Pct:	40.6	56.3
BeckBI:	21.0	63.6
Dominant01 Taxon Pct:	18.8	N/A
Sprawler Pct:	7.7	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**A56**	Sample Date:	9/24/2014
Waterbody Name:	**Upper Animas River**		
Location:	Abv. Arastra		
Latitude:	37.82779502	Reference Status:	Not Reference or Degraded
Longitude:	-107.62379115	BenSampID: 3	RepNum: 1
Biotype:	2		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	49.2

Metric Name	Metric Value	Metric Score
Total Taxa:	18	50.0
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	11	N/A
Chironomidae Pct:	2.5	N/A
Sensitive Plains Fammilies Pct:	22.2	N/A
Predator+ Shredder Taxa:	9	64.3
Clinger Taxa:	9	52.9
Clinger Taxa adjuested with Elevation:	9	N/A
Insect Taxa:	17	N/A
Non-Insct % of taxa:	5.6	N/A
Ephemeroptera Pct:	10.8	15.0
BeckBI:	21.0	63.6
Dominant01 Taxon Pct:	59.0	N/A
Sprawler Pct:	2.9	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**A60**	Sample Date:	9/25/2014
Waterbody Name:	**Upper Animas River**		
Location:	Blw. Arastra		
Latitude:	37.82719229	Reference Status:	Not Reference or Degraded
Longitude:	-107.6266552	BenSampID: 4	RepNum: 1
Biotype:	2		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	52.8

Metric Name	Metric Value	Metric Score
Total Taxa:	22	61.1
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	9	N/A
Chironomidae Pct:	21.2	N/A
Sensitive Plains Fammilies Pct:	20.1	N/A
Predator+ Shredder Taxa:	9	64.3
Clinger Taxa:	10	58.8
Clinger Taxa adjuested with Elevation:	10	N/A
Insect Taxa:	19	N/A
Non-Insct % of taxa:	13.6	N/A
Ephemeroptera Pct:	11.5	15.9
BeckBI:	21.0	63.6
Dominant01 Taxon Pct:	32.3	N/A
Sprawler Pct:	7.6	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**A68**	Sample Date:	9/25/2014
Waterbody Name:	**Upper Animas River**		
Location:	14th St. Gauge		
Latitude:	37.81120197	Reference Status:	Not Reference or Degraded
Longitude:	-107.659167	BenSampID: 5	RepNum: 1
Biotype:	2		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	39.4

Metric Name	Metric Value	Metric Score
Total Taxa:	17	47.2
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	8	N/A
Chironomidae Pct:	31.4	N/A
Sensitive Plains Fammilies Pct:	10.1	N/A
Predator+ Shredder Taxa:	5	35.7
Clinger Taxa:	7	41.2
Clinger Taxa adjuested with Elevation:	7	N/A
Insect Taxa:	15	N/A
Non-Insct % of taxa:	11.8	N/A
Ephemeroptera Pct:	15.5	21.6
BeckBI:	17.0	51.5
Dominant01 Taxon Pct:	31.4	N/A
Sprawler Pct:	8.5	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**CC49**			Sample Date:	9/25/2014
Waterbody Name:	**Cement Creek**				
Location:	Abv. Animas Confluence				
Latitude:	37.80963817	Reference Status:	Not Reference or Degraded		
Longitude:	-107.66067559	BenSampID: 12		RepNum: 1	
Biotype:	2				

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	1.1

Metric Name	Metric Value	Metric Score
Total Taxa:	2	5.6
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	0	N/A
Chironomidae Pct:	100.0	N/A
Sensitive Plains Fammilies Pct:	0.0	N/A
Predator+ Shredder Taxa:	0	0.0
Clinger Taxa:	0	0.0
Clinger Taxa adjuested with Elevation:	0	N/A
Insect Taxa:	2	N/A
Non-Insct % of taxa:	0.0	N/A
Ephemeroptera Pct:	0.0	0.0
BeckBI:	0.0	0.0
Dominant01 Taxon Pct:	80.0	N/A
Sprawler Pct:	20.0	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**M34**	Sample Date:	9/25/2014
Waterbody Name:	**Mineral Creek**		
Location:	at Gauge		
Latitude:	37.8028	Reference Status:	Not Reference or Degraded
Longitude:	-107.6722	BenSampID: 14	RepNum: 1
Biotype:	2		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	25.4

Metric Name	Metric Value	Metric Score
Total Taxa:	12	33.3
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	6	N/A
Chironomidae Pct:	9.8	N/A
Sensitive Plains Fammilies Pct:	76.5	N/A
Predator+ Shredder Taxa:	4	28.6
Clinger Taxa:	5	29.4
Clinger Taxa adjuested with Elevation:	5	N/A
Insect Taxa:	11	N/A
Non-Insct % of taxa:	8.3	N/A
Ephemeroptera Pct:	3.9	5.4
BeckBI:	10.0	30.3
Dominant01 Taxon Pct:	60.8	N/A
Sprawler Pct:	3.9	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**A72**	Sample Date:	9/25/2014
Waterbody Name:	**Animas River**		
Location:	Blw. Silverton		
Latitude:	37.79027049	Reference Status:	Not Reference or Degraded
Longitude:	-107.66757775	BenSampID: 6	RepNum: 1
Biotype:	2		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	16.8

Metric Name	Metric Value	Metric Score
Total Taxa:	9	25.0
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	3	N/A
Chironomidae Pct:	41.4	N/A
Sensitive Plains Fammilies Pct:	50.9	N/A
Predator+ Shredder Taxa:	3	21.4
Clinger Taxa:	3	17.6
Clinger Taxa adjuested with Elevation:	3	N/A
Insect Taxa:	8	N/A
Non-Insct % of taxa:	11.1	N/A
Ephemeroptera Pct:	3.4	4.8
BeckBI:	5.0	15.2
Dominant01 Taxon Pct:	37.9	N/A
Sprawler Pct:	0.9	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**A73**	Sample Date:	10/16/2014
Waterbody Name:	**Upper Animas River**		
Location:	Abv. Elk Creek		
Latitude:	37.72215833	Reference Status:	Not Reference or Degraded
Longitude:	-107.65482777	BenSampID: 7	RepNum: 1
Biotype:	2		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	30.7

Metric Name	Metric Value	Metric Score
Total Taxa:	11	30.6
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	5	N/A
Chironomidae Pct:	0.0	N/A
Sensitive Plains Fammilies Pct:	84.5	N/A
Predator+ Shredder Taxa:	6	42.9
Clinger Taxa:	7	41.2
Clinger Taxa adjuested with Elevation:	7	N/A
Insect Taxa:	10	N/A
Non-Insct % of taxa:	9.1	N/A
Ephemeroptera Pct:	3.9	5.4
BeckBI:	11.0	33.3
Dominant01 Taxon Pct:	71.3	N/A
Sprawler Pct:	3.9	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**A75EC**	Sample Date:	10/16/2014
Waterbody Name:	**Elk Creek**		
Location:	Abv. Animas River		
Latitude:	37.72175555	Reference Status:	Not Reference or Degraded
Longitude:	-107.65443055	BenSampID: 10	RepNum: 1
Biotype:	2		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	66.0

Metric Name	Metric Value	Metric Score
Total Taxa:	25	69.4
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	12	N/A
Chironomidae Pct:	0.9	N/A
Sensitive Plains Fammilies Pct:	6.5	N/A
Predator+ Shredder Taxa:	12	85.7
Clinger Taxa:	9	52.9
Clinger Taxa adjuested with Elevation:	9	N/A
Insect Taxa:	24	N/A
Non-Insct % of taxa:	4.0	N/A
Ephemeroptera Pct:	18.1	25.1
BeckBI:	32.0	97.0
Dominant01 Taxon Pct:	62.6	N/A
Sprawler Pct:	64.4	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**A75CC**			Sample Date:	10/16/2014
Waterbody Name:	**Cascade Creek**				
Location:	Abv. Animas				
Latitude:	37.59824909	Reference Status:	Not Reference or Degraded		
Longitude:	-107.77610081	BenSampID: 8		RepNum: 1	
Biotype:	1				

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI: 63.0

Metric Name	Metric Value	Metric Score
Total Taxa:	24	N/A
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	13	100.0
Chironomidae Pct:	13.5	81.4
Sensitive Plains Fammilies Pct:	15.8	25.5
Predator+ Shredder Taxa:	10	71.4
Clinger Taxa:	11	N/A
Clinger Taxa adjuested with Elevation:	11	44.0
Insect Taxa:	21	N/A
Non-Insct % of taxa:	12.5	55.5
Ephemeroptera Pct:	54.9	N/A
BeckBI:	22.0	N/A
Dominant01 Taxon Pct:	24.0	N/A
Sprawler Pct:	0.7	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**A75D**	Sample Date:	10/16/2014
Waterbody Name:	**Animas River**		
Location:	Abv. Cascade Creek		
Latitude:	37.59793423	Reference Status:	Not Reference or Degraded
Longitude:	-107.77532681	BenSampID: 9	RepNum: 1
Biotype:	1		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	52.8

Metric Name	Metric Value	Metric Score
Total Taxa:	21	N/A
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	7	36.7
Chironomidae Pct:	16.3	77.1
Sensitive Plains Fammilies Pct:	34.2	55.3
Predator+ Shredder Taxa:	10	71.4
Clinger Taxa:	7	N/A
Clinger Taxa adjuested with Elevation:	7	10.4
Insect Taxa:	19	N/A
Non-Insct % of taxa:	9.5	66.1
Ephemeroptera Pct:	24.8	N/A
BeckBI:	18.0	N/A
Dominant01 Taxon Pct:	32.7	N/A
Sprawler Pct:	7.9	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**Bbridge**	Sample Date:	9/26/2014
Waterbody Name:	**Animas River**		
Location:	Bbridge-Durango Resort		
Latitude:	37.4589	Reference Status:	Not Reference or Degraded
Longitude:	-107.79955	BenSampID: 11	RepNum: 1
Biotype:	1		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	51.5

Metric Name	Metric Value	Metric Score
Total Taxa:	17	N/A
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	5	45.6
Chironomidae Pct:	4.0	95.8
Sensitive Plains Fammilies Pct:	22.4	36.3
Predator+ Shredder Taxa:	6	42.9
Clinger Taxa:	6	N/A
Clinger Taxa adjuested with Elevation:	6	30.5
Insect Taxa:	15	N/A
Non-Insct % of taxa:	11.8	58.1
Ephemeroptera Pct:	52.9	N/A
BeckBI:	13.0	N/A
Dominant01 Taxon Pct:	52.0	N/A
Sprawler Pct:	4.5	N/A

Colorado Department of Public Health and Environment

Water Quality Control Division

Benthic Macroinvertebrate Bioassessment Report

StationID:	**James R**	Sample Date:	9/26/2014
Waterbody Name:	**Animas River**		
Location:	James Ranch		
Latitude:	37.422021	Reference Status:	Not Reference or Degraded
Longitude:	-107.810336	BenSampID: 13	RepNum: 1
Biotype:	1		

Predictive Model Results

O/E (p>half):	Model Test:

Multimetric Index Model Results

MMI:	57.5

Metric Name	Metric Value	Metric Score
Total Taxa:	19	N/A
Ephemeroptera + Plecoptera Taxa (adjusted with Elevation):	6	56.9
Chironomidae Pct:	7.9	90.0
Sensitive Plains Fammilies Pct:	16.1	26.0
Predator+ Shredder Taxa:	10	71.4
Clinger Taxa:	9	N/A
Clinger Taxa adjuested with Elevation:	9	56.6
Insect Taxa:	16	N/A
Non-Insct % of taxa:	15.8	43.8
Ephemeroptera Pct:	44.9	N/A
BeckBI:	13.0	N/A
Dominant01 Taxon Pct:	43.8	N/A
Sprawler Pct:	1.7	N/A

APPENDIX 20
Historic Multi-Metric Index (MMI) Scores for the Animas River

Animas Metric Scores Red = impairment for aquatic life use

Biotype 1

Bbridge	9/26/2014
EP Taxa	45.6
Percent Chironomidae	95.8
Sens. Plains Families	36.3
Predator-Shredder Tax	35.7
Clinger Taxa	30.5
Non-Insect Percent	52.5
Shannon Diversity	2.28
HBI	3.91
MMI Score	**49.4**

	Surber	Kicknet		Kicknet	
A75D	10/28/1996	10/3/1997	10/1/2004	10/28/2010	10/16/2014
EP Taxa	58.1	47.4	47.4	36.7	36.7
Percent Chironomidae	28.7	82.3	88.1	85.2	77.1
Sens. Plains Families	18.0	17.3	53.9	49.0	55.3
Predator-Shredder Tax	71.4	64.3	28.6	28.6	64.3
Clinger Taxa	10.4	18.9	35.9	18.9	10.4
Non-Insect Percent	81.3	66.1	79.1	100.0	80.2
Shannon Diversity	3.04	3.18	3.28	2.96	3.00
HBI	4.08	2.76	1.92	1.66	2.37
MMI Score	**44.7**	**49.4**	**55.5**	**53.1**	**54.0**

	Surber	Kicknet	Kicknet			
James R	11/2/1996	9/19/1997	9/15/2003	10/1/2004	10/10/2005	9/26/2014
EP Taxa	78.3	78.3	14.2	78.3	56.9	67.6
Percent Chironomidae	42.7	82.4	90.0	95.6	76.6	86.3
Sens. Plains Families	66.0	34.1	12.7	14.0	5.2	22.2
Predator-Shredder Tax	71.4	71.4	28.6	50.0	50.0	42.9
Clinger Taxa	65.1	65.1	31.1	65.1	48.1	48.1
Non-Insect Percent	83.8	40.7	100.0	81.3	79.1	76.3
Shannon Diversity	2.83	3.34	2.11	2.27	2.29	2.43
HBI	4.52	3.30	2.79	3.63	4.02	4.31
MMI Score	**67.9**	**62.0**	**46.1**	**64.1**	**52.6**	**57.2**

	Surber	Kicknet		Kicknet	
A75CC	10/28/1996	10/3/1997	10/1/2004	10/28/2010	10/16/2014
EP Taxa	57.6	46.9	46.9	68.3	89.7
Percent Chironomidae	53.5	79.0	98.6	83.2	81.4
Sens. Plains Families	23.0	21.7	59.0	38.7	25.5
Predator-Shredder Tax	64.3	57.1	78.6	64.3	57.1
Clinger Taxa	69.5	44.0	69.5	35.4	44.0
Non-Insect Percent	47.3	34.1	60.4	83.8	51.5
Shannon Diversity	4.13	3.79	3.55	3.53	3.44
HBI	4.11	3.35	3.40	1.93	3.05
MMI Score	**52.5**	**47.1**	**68.8**	**62.3**	**58.2**

Animas Metric Scores Red = impairment for aquatic life use

Biotype 2

	Kicknet
A53	10/11/2014
Total Taxa	44.4
Predator-Shredder Taxa	42.9
Clinger Taxa	41.2
Percent Ephemeroptera	25.2
Beck's Biotic Index	48.5
Shannon Diversity	2.93
HBI	2.32
MMI Score	**40.4**

	Kicknet	Kicknet	Surber	Kicknet		Kicknet	Kicknet	
A72	10/11/1992	11/15/1996	11/15/1996	9/9/1997	10/1/2004	10/7/2006	10/24/2010	9/25/2014
Total Taxa	22.2	25.0	11.1	38.9	27.8	22.2	16.7	22.2
Predator-Shredder Taxa	28.6	35.7	14.3	28.6	35.7	21.4	14.3	14.3
Clinger Taxa	23.5	23.5	11.8	35.3	35.3	23.5	11.8	17.6
Percent Ephemeroptera	28.9	1.2	0.0	3.4	16.3	5.1	0.0	4.8
Beck's Biotic Index	30.3	33.3	9.1	36.4	33.3	21.2	12.1	15.2
Shannon Diversity	2.65	2.11	1.56	2.05	2.60	1.80	2.11	1.91
HBI	3.17	2.71	4.56	6.71	1.45	1.54	3.48	3.46
MMI Score	**26.7**	**23.8**	**9.3**	**28.5**	**29.7**	**18.7**	**11.0**	**14.8**

	Kicknet	Surber	Kicknet		
A73	10/8/1992	10/29/1996	10/3/1997	10/1/2004	10/16/2014
Total Taxa	27.8	41.7	36.1	41.7	30.6
Predator-Shredder Taxa	21.4	42.9	35.7	50.0	42.9
Clinger Taxa	29.4	41.2	35.3	52.9	41.2
Percent Ephemeroptera	3.9	3.6	17.5	3.3	5.4
Beck's Biotic Index	39.4	42.4	42.4	51.5	33.3
Shannon Diversity	1.51	2.68	2.76	2.99	1.61
HBI	1.24	2.66	2.00	2.49	1.28
MMI Score	**24.4**	**34.3**	**33.4**	**39.9**	**30.7**

	Kicknet	Kicknet	Surber	Kicknet		Kicknet	Kicknet	Kicknet	
A68	10/8/1992	10/23/1996	11/15/1996	9/9/1997	10/1/2004	10/7/2006	10/30/2007	10/24/2010	9/25/2014
Total Taxa	30.6	33.3	16.7	33.3	44.4	22.2	38.9	47.2	41.7
Predator-Shredder Taxa	35.7	35.7	21.4	35.7	42.9	28.6	42.9	57.1	28.6
Clinger Taxa	35.3	29.4	23.5	35.3	41.2	23.5	47.1	52.9	41.2
Percent Ephemeroptera	63.8	18.5	20.9	68.9	14.7	25.2	14.1	32.6	21.6
Beck's Biotic Index	42.4	33.3	18.2	42.4	45.5	27.3	45.5	57.6	48.5
Shannon Diversity	2.67	2.10	2.76	3.07	2.95	2.37	2.87	3.16	2.69
HBI	1.01	2.18	2.10	2.55	2.38	1.61	2.67	1.98	4.66
MMI Score	**41.6**	**30.1**	**20.1**	**43.1**	**37.7**	**25.4**	**37.7**	**49.5**	**36.3**

A60	9/25/2014
Total Taxa	52.8
Predator-Shredder Taxa	50.0
Clinger Taxa	47.1
Percent Ephemeroptera	17.0
Beck's Biotic Index	60.6
Shannon Diversity	3.15
HBI	4.05
MMI Score	**45.5**

A56	9/24/2014
Total Taxa	47.2
Predator-Shredder Taxa	50.0
Clinger Taxa	52.9
Percent Ephemeroptera	15.0
Beck's Biotic Index	63.6
Shannon Diversity	2.22
HBI	4.26
MMI Score	**45.8**

	Kicknet	
A55	10/8/1992	9/24/2014
Total Taxa	33.3	55.6
Predator-Shredder Taxa	35.7	50.0
Clinger Taxa	47.1	47.1
Percent Ephemeroptera	91.1	56.9
Beck's Biotic Index	39.4	63.6
Shannon Diversity	1.86	3.56
HBI	0.59	1.69
MMI Score	**49.3**	**54.6**

	Surber	Kicknet		
A75EC	10/29/1996	10/3/1997	10/1/2004	10/16/2014
Total Taxa	41.7	30.6	30.6	63.9
Predator-Shredder Taxa	35.7	28.6	42.9	78.6
Clinger Taxa	35.3	29.4	41.2	52.9
Percent Ephemeroptera	59.6	71.9	28.9	25.1
Beck's Biotic Index	42.4	39.4	48.5	100.0
Shannon Diversity	2.88	2.10	1.83	2.27
HBI	2.15	1.05	1.51	1.58
MMI Score	**42.9**	**40.0**	**38.4**	**64.1**

	Kicknet	Surber/Kick	Kicknet		Kicknet	Kicknet	Kicknet	
M34	10/8/1992	11/15/1996	9/9/1997	10/1/2004	10/7/2006	10/30/2007	10/24/2010	9/25/2014
Total Taxa	8.3	11.1	47.2	36.1	38.9	36.1	25.0	27.8
Predator-Shredder Taxa	7.1	14.3	42.9	35.7	50.0	35.7	35.7	21.4
Clinger Taxa	11.8	5.9	29.4	41.2	23.5	29.4	17.6	29.4
Percent Ephemeroptera	34.7	0.0	1.9	36.8	11.1	1.3	0.0	5.4
Beck's Biotic Index	15.2	6.1	39.4	39.4	39.4	33.3	18.2	30.3
Shannon Diversity	1.06	1.55	2.92	3.11	3.54	2.73	2.35	1.96
HBI	1.50	4.67	4.79	2.53	2.92	2.47	2.95	1.84
MMI Score	**15.4**	**7.5**	**32.2**	**37.8**	**32.6**	**27.2**	**19.3**	**22.9**

CC49	9/25/2014
Total Taxa	2.8
Predator-Shredder Taxa	0.0
Clinger Taxa	0.0
Percent Ephemeroptera	0.0
Beck's Biotic Index	0.0
Shannon Diversity	0.00
HBI	6.00
MMI Score	**0.6**

Attachment 2

Biological Technical Assistance Group Draft Aquatic Ecological Risk Assessment Comments, Agency Responses, and Actions

United States Forest Service (USFS) Comments

USFS #1 Aquatic BERA General Comment: EPA's physical and biological assessments address the particulars of the individual indicators that go into an overall assessment, be it a risk assessment or a condition assessment, and that's true for the Mineral Creek and Animas River assessment. However, we see a primary drawback in failing to distinguish among the sub-basis in the upper Animas River.

> *Agency Response #1: The Bonita Peak Mining District (BPMD) Aquatic baseline ecological risk assessment (BERA) was conducted as prescribed in the October 2016 Final BERA Work Plan ([BERA Work Plan], EPA, 2016a). All exposure units (EUs) were defined in the BERA Work Plan. EUs include specific reaches in select sub-basins. EUs were selected as part of a collaborative effort with EPA and the BTAG; which included USFS staff. It is beyond the scope of the current Aquatic BERA to add or adjust EU reach boundaries beyond what was agreed upon and conducted. EPA respectfully acknowledges this comment but has decided not to add or adjust the current Aquatic BERA EUs.*

USFS #2 Aquatic BERA General Comment: The streams of the upper Animas River basin are affected [by] surface water that has come in contact with mineralized materials, either naturally as a result of mining activities. Mineral-affected water originates in the upper reaches of Mineral and Cement Creeks, and from other tributaries of the upper Animas River proper. The tributaries contain high levels of metals and acidity that are carried downstream to the Animas River. The BPMD Aquatic "total" risk BERA describes, but does not assess, the differences between sources of natural contamination and mine-influenced water and its related contamination. Rather, it evaluates the total risk from all sources combined. Although this presents a comprehensive overview of the cumulative watershed effects of the multiple sources of impairment, by failing to distinguish metal contamination and abiotic impairment from natural sources from those of anthropogenic origin, it risks setting unrealistic – and potentially unattainable objectives for remediation of water quality.

> *Agency Response #2: The BPMD BERA Work Plan (EPA, 2016a) specifically stated that risk characterization would represent total risk that incorporates exposure from both mine and background impacted areas and not incremental risk that attempts to separate exposure and risks from mine and background impacted areas for each EU evaluated. Therefore, as stated by the reviewer, current Aquatic BERA exposure estimates provide a comprehensive overview of risks for each EU. This approach was selected as part of a collaborative effort with EPA and the BTAG; which included USFS staff when developing the BERA Work Plan. EPA notes that the current "total" risk approach follows applicable agency risk assessment guidance (EPA, 2002b; 2018c). In fact, EPA (2002a) specifically states that both release- and background-related sources should be carried through the entire risk assessment and that risks associated with naturally occurring sources should be discussed qualitatively during risk characterization. Therefore, quantification of incremental risks is not consistent with standard agency guidance and*

will not be conducted. However, the Aquatic BERA was revised throughout to better describe the use and evaluation of ecological risks for six reference EUs that are not impacted by BPMD Superfund site mine features. The current revision describes how the reference EU receptor exposure and risk assessment information is used to characterize potential background conditions with respect to assessment EUs risks. This analysis is reflected in a newly added background risk characterization section (Section 9.8) per EPA (2002b) guidance.

EPA notes that most of the Aquatic BERA reference EUs were also selected by Mast et al. (2007) when conducting a background water quality characterization study for the BPMD watershed. As reported in Mast et al. (2007), the large size of the assessment area, myriad of mine features within it, and complex underlying geology complicate quantification of general background conditions. Given these inherent challenges, thorough differentiation of risk between background versus mining sources is highly uncertain and spatially variable and is best accomplished using a location-specific analysis. EPA is planning on conducting quantitative analysis of background contributions on a site-by-site basis during later stages of the remedial investigation/feasibility study (RI/FS) process. This analysis will use environmental data collected on a finer geographic scale than that used in the Aquatic BERA; as described in the current Aquatic BERA. Therefore, the concern regarding the development of unattainable remediation objectives due to the failure to consider abiotic impairment, specifically from natural sources, will ultimately be addressed.

USFS #3 Aquatic BERA General Comment: The complexity of the underlying geological input of trace metals to the Upper Animas River certainly presents challenges to determining background concentrations of metals contributed to the system and complicates the BERA process. However, determination of the contributions of natural geological features to background water quality in the Upper Animas River would avoid the setting of water quality goals for remediation that exceed reasonable attainable objectives. Least-disturbed (referred to "reference") tributary watersheds may inform reference condition, but their representativeness should be assessed.

Agency Response #3: EPA respectfully acknowledges this comment and recognizes that management decisions should and will consider potential influences from background conditions. However, while the Aquatic BERA is intended to guide remediation goals, it is not the sole source of information supporting the future RI/FS process for this site. EPA anticipates future discussions and analysis will occur further into the RI/FS process that will be aimed at accounting for site-specific background conditions at this site. Please refer to Agency Response #2 above and revised Aquatic BERA text for more information on this subject.

USFS #4 Aquatic BERA General Comment: Natural disturbance regimes (in this case, metals leaching from hydrothermally altered rock) may be "least disturbed" and serve as background or "reference" conditions for systems of that type. Moreover, the sub-basin geology of Mineral Creek and Cement Creek differs from that of the Animas River. The study by Mast et al. (2007)

identifies source of metal released from weathering of altered rock from unmined areas that contribute significant concentrations of aluminum, iron and other species of concern. Some reaches within the Mineral Creek identified as representing least-disturbed conditions, exceed chronic or acute water quality standards for aluminum, cadmium, copper, lead and zinc at various times. As such, water quality in "reference" reaches in the upper Animas River may have background acid rock drainage that limit aquatic life. Consideration of those differences should factor into the setting of remediation goals for water quality. It should be noted that 2014 data, at a minimum, indicate that water quality standards at A72 statistically may be met (prior to starting operation of the Interim Water Treatment Plant at Gladstone in 2015.

> *Agency Response #4: EPA respectfully acknowledges this comment and recognizes that management decisions should and will consider potential influences from background conditions. As discussed in previous USFS comment responses, EPA has decided that background conditions will be quantified on a site-specific basis later in the RI/FS process, and as such, the current Aquatic BERA does not attempt to differentiate exposure risks from potential background and mine impacted areas.*

USFS #5 Aquatic BERA General Comment: Chemical. There is abundant evidence that many reaches of the upper Animas River watershed are chemically impaired. These include some of the most upstream tributaries of Mineral Creek, Cement Creek and the Animas River that have not been substantially affected by mining activity. This includes the Mineral Creek headwaters, Mill Creek, Crystal Creek, and Red Tributary (Middle Fork Mineral Creek), Clear Lake Creek (South Fork Mineral Creek), and the South Fork of Mineral Creek above the Bandora Mine.

The BERA evaluation of chemical impairment elsewhere is comprehensive. Surface water, sediment pore water and sediment toxicity reflect widespread impairment from multiple sources.

> *Agency Response #5: EPA agrees with this comment and acknowledges that the Aquatic BERA evaluates risks for EUs with varying levels of anthropogenic and natural contamination impacts and potentially variable exposure conditions. However, sampling locations selected to represent EUs are often at the most downgradient location on respective reaches. Assessments based on these sampling locations attempt to characterize risks associated with all sources above each location. As stated in previous responses, the current Aquatic BERA does not attempt to differentiate risks between potential background- and mine-related contamination exposures. Such analysis is better suited for smaller spatial scales than those evaluated in the current Aquatic BERA. EPA has many years of environmental sampling data for hundreds of sampling locations throughout the BPMD. These datasets will be the basis for site-specific analyses later in the RI/FS process.*

USFS #6 Aquatic BERA General Comment: Habitat. The methods and analyses are widely applied and consistent with many habitat assessments of the requirements of resident salmonids in cold-water stream systems. There is a reasonable expectation of fish presence in stream segments with gradients of less than 10% slope, but only where other habitat features (cover, channel geomorphology, substrate heterogenicity and embeddedness, suitable spawning

substrates for resident fish, temperature, connectivity among segments) occur. In particular, where habitat impairment by chemical or physical factors occurs, the persistence of fish populations may be questionable.

The upper Animas River and Mineral Creek watersheds are affected by multiple abiotic stressors from historic mining activity (mine tailings and waste rock adjacent to streams) and natural disturbance related to weathering and drainage of surface and groundwater in hydrothermally altered rock drainage; an extensive road network with culverts that may affect aquatic organism passage. Terrain and the country rock may also contribute to unstable, highly mobile substrates. It is noted that was a bias to sampling only locations of optimum habitat and not representation of the whole Exposure Unit.

> *Agency Response #6: The Aquatic BERA primarily relies on fish habitat and presence/absence information published in USGS (2018). As pointed out by the reviewer, survey site selection was biased toward stream reaches with optimum habitat which may be impacted by uncharacterized or characterized physical and chemical impacts. The current Aquatic BERA and USGS (2018) authors also make this point and conclude that selected survey reaches may not be representative of entire EU reaches in which they were conducted. The Aquatic BERA methods and uncertainty section text was revised to better describe the USGS (2018) study attributes and potential biases. Text was also added to the Aquatic BERA clarify that potential chemical and physical fish community impacts may co-occur and be indistinguishable from one another. Given this, EPA understands that any fish community-based remedial actions should consider consequences associated with all potential stressors/limitations that could impact remediation goals.*

USFS #7 Aquatic BERA General Comment: Biological. A review of historical fish collections and sampling by USGS and USFS found fish in several segments of Mineral Creek and its tributaries. This includes parts of the main stem that might be considered "impaired". Subsequent collections at some of those same locations have failed to capture any fish. The only fish captured in Mineral Creek during 2016 and 2017 electrofishing surveys were Brook Trout. Because of their recreational and economic value, other species of native trout are a focus of the basin in the past. Their apparent absence from recent surveys suggested that impairment that may not affect nonnative Brook Trout, a species tolerant of mine influenced water, or with limited habitat, native species are out competed by nonnative Brook Trout. The document did not address the presence or absence of native fish species, as the focus of the discussion was on trout. The document should clarify whether native fish species were detected and provide survey data sheets if available.

> *Agency Response #7: The current Aquatic BERA summarizes fish survey results obtained from USGS (2018) and historical sources; primarily Animas River Stakeholders Group ([ARSG]2000) summary of over 40 years of historic fish surveys. Results are summarized on a species-specific basis in Aquatic BERA Table 9.10. As stated in the reviewer's comment, trout were observed in lower and middle mainstem Mineral Creek and South*

Fork Mineral Creek by USGS (2018) in 2016. EPA respectfully points out that rainbow trout (another non-native species) were also observed.

The current Aquatic BERA does not specifically focus on risks to native trout or attempt to differentiate fish community risks with respect to whether individual fish species are native to the watershed. However, fish community risk discussions that identify which species are not native to the BPMD watershed are present throughout the Aquatic BERA. The current Aquatic BERA also provides a species-specific summary of fish survey results in Table 9.10. This table reports that potentially native cutthroat trout were observed in a few BPMD EUs; Cunningham Creek (EU-08) and Maggie Gulch (EU-R3). Native fish species are also identified and discussed when describing Durango Reach fish communities. The Aquatic BERA also provides trout species-specific acute toxicity thresholds to partially explain current trout species distributions; see Aquatic BERA Figures 9-1 through 9-3. EPA respectfully acknowledges the reviewers request to focus fish community risks on presence/absence of native fish but will not change the current, holistic fish community assessment approach. Such an approach provides an unbiased assessment of current fish community risks and is in line with Colorado Parks and Wildlife (CPW) management goals for watershed segments supporting non-native trout species.

USFS #8 Aquatic BERA General Comment: It would be helpful and clarifying to include a summary discussion of historical fish populations in the BPMD, both pre-mining when available and also during historical mining operations. This would provide important context to the reader.

Agency Response #8: The current Aquatic BERA does not specifically summarize information on fish communities from surveys conducted before historical mining operations. USFS provided EPA a list of historical fish-related accounts that dated back to 1878; contents of Appendix 7B in ARSG (2000). The current Aquatic BERA cites historic data from Appendix 6 in ARSG (2000) that were obtained from numerous, dedicated fish surveys in the region. The USFS-provided Appendix 7B historical fish-related accounts are not specific enough in time, space, and content to be a defensible source of information to support the Aquatic BERA. Instead the Aquatic BERA relies on other information sources, such as Church et al. (1999) to qualitatively describe pre-mining biological conditions.

USFS #9 Aquatic BERA General Comment: Habitat features that could support trout and other species does not mean that it will. The extent and magnitude of chemical impairment throughout Mineral Creek is likely to impose significant stress, included acute exposure, on any fish. High metal concentrations associated with Brown's Gulch and Middle Fork of Mineral Creek are unlikely to support permanent populations of fish.

Agency Response #9: EPA acknowledges this comment, however please note that there are no clear action items associated with it.

USFS #10 Aquatic BERA General Comment: Gradient (slope >10%) and cold stream temperatures that affect reproduction may explain the absence of native fish from the extreme

headwaters of Mineral Creek. Relating this "intrinsic potential" of stream reach habitats in the upper Animas River to water quality could provide insight into the restoration potential of resident aquatic resources, particularly if background water quality can be discerned. Doing so would allow the agencies to identify source of anthropogenic mine influenced water that contribute most of degraded water quality and impairment of aquatic resources. Spatial analysis of the habitat and other abiotic water quality factors would contribute to an understanding of the potential for restoration of connectivity of fish habitats in the upper Animas River.

> *Agency Response #10: The Aquatic BERA encompasses over 100 river miles. Assessing available habitat throughout the entire study area would require a tremendous amount of resources that are currently unavailable. EPA has not finalized restoration goals for the BPMD and doing so is beyond the scope of a typical BERA. Therefore, restoring connectivity of fish habitats may or may not be a goal for this site. It should be recognized that EPA has collected water and sediment chemistry data throughout the BPMD over the last 10 years from additional monitoring stations not assessed in the current Aquatic BERA. These data will be used to inform future RI/FS remediation efforts. This may include conducting mass-balance analyses to understand the relative contributions of metals from natural and anthropogenic sources. Again, this type of analysis is beyond the scope of a typical BERA. EPA respectfully acknowledges this comment but will not expand the scope of habitat characterization conducted for the current Aquatic BERA.*

USFS #11 Aquatic BERA General Comment: The State's suggestion that amphibians represent exposure receptor is valid. There are multiple pathways of exposure – direct contact with water, direct contact with surface features of mining, and ingestion of insects, particularly emergent aquatic invertebrates. [However, it's worth noting that extirpation does not reflect inhospitable conditions due to mining.]

> *Agency Response #11: EPA agrees that amphibians are relevant aquatic receptors for the BPMD site. As suggested there are multiple, relevant exposure pathways for this receptor group. Unfortunately, there is little toxicity information to assess exposure and associated risks for this receptor group. Nevertheless, the Aquatic BERA was revised to include amphibians risk analyses. They are now assessed with water-column aquatic receptors under Assessment Endpoint #2 (Maintain a stable and healthy water-column invertebrate and fish community) using already established surface water acute and chronic ecological screening values (ESVs). This action is supported by the fact that amphibian toxicity test results are incorporated into EPA water quality aquatic life criteria guidance datasets, when available. Note that it is generally accepted that amphibians are less sensitive to site COPECs than invertebrate and fish receptors (ENSR, 2004). Revisions were made throughout the text if the Aquatic BERA to reflect the addition of amphibians.*

USFS #12 Aquatic BERA General Comment: In addition, the analysis focuses on acute toxicity (i.e. mortality) to aquatic organisms. We suggest it would be helpful to include a discussion of long-term effects to the aquatic organisms outlined in the draft BERA from metal exposure, such

as reproductive effects, congenital abnormalities and other toxicity related effects. There is significant research in this area that would be helpful to summarize in the document.

> *Agency Response #12: EPA agrees that a discussion of long-term, nonlethal effects of metal exposure on aquatic organisms would be beneficial. The Aquatic BERA now contains a new Section 5.2 (Adverse effects of metal exposure) that summarizes adverse non-lethal effects to aquatic organisms (benthic macroinvertebrates [BMIs], fish, amphibians, and wildlife) acutely and chronically exposed to metals.*

United States Bureau of Land Management (BLM) Comments

BLM #1 Aquatic BERA General Comment: Table ES-1, Final Risk Characterization Summary for Each Assessment Endpoint and Exposure Unit, was distributed at the July 18, 2018, BTAG meeting to concisely convey concluding judgements about risk. While highly useful to risk assessment specialists as a summary of finding for the numerous measurement endpoints used to assess risk, the audience for this kind of summary information is most importantly decision-makers and the public. These stakeholders may not have the time or the training to wade through the entire document to make well-informed judgements. Accordingly, it is vitally important that a top-line visually summary such as this, and its supporting text, effectively integrates all of the information pertinent to making judgements about risk and remedy needs. As presented, the visual impact of substantial magenta and red cells miscommunicates actual risk that is knowingly attributable to historic mine related release of toxic chemicals.

The following additional factors should be incorporated into the table and supporting text:

- The physical habitat limitations should be identified. For example, Burrows Gulch is presently shown to be at high risk across many metrics. However, its physical habitat quality is rated as "poor" in Table 9.11 of the Aquatic BERA.

- The risk assessment is silent on what "poor" means and how it relates to interpreting risk. If a stream segment is considered poor habitat quality, do the Assessment Endpoints provided on pages 12-14 apply?

    - Assessment Endpoint 1 and the aquatic invertebrate component of Assessment Endpoint 2 are questionable due to insufficient assessment provided by the Aquatic BERA.

    - Assessment Endpoints 2, at least for fish, do not apply.

    - Assessment Endpoints 3-7, addressing various terrestrial wildlife classifications having different aquatic insect, fish, and aquatic plant diets, apply with perhaps greatly reduced assumptions about intake rates and exposure in the absence of healthy biota populations.

Agency Response #13: As stated by the reviewer, Table ES-1 attempts to provide a global summary of the Aquatic BERA risk characterization results. EPA acknowledges that the table is missing information on physical habitat quality associated with BMI and fish habitat assessments. This information was added to the revised Table ES-1, when available, to aid in interpretation of risk characterization results. The same habitat quality information was also added to Table 9.11 (Summary of [USGS 2018] Fish Thermal Suitability and Habitat Assessment Results) and supporting Aquatic BERA text to specifically describe how BMI and fish habitat quality were ranked. Finally, the color scheme used in Table ES-1 to differentiate risk categories was revised to greyscale. In-line with this comment, all tables with similarly colored risk categories were revised to greyscale.

EPA also notes that the current Aquatic BERA risk characterization approach and Table ES-1 format is similar to that used by Besser et al. (2007) in their ecological risk assessment on impacts of historical mining on aquatic ecosystems for the Animas River watershed; including use of a total risk characterization approach and risk-based color-coded graphics. Like the current Aquatic BERA, Besser et al. (2007) did not attempt to qualify exposure to important aquatic receptors with respect to habitat quality. EPA respectfully acknowledges the reviewer's concerns but will not revise the current Aquatic BERA in response to the habitat quality portion of this comment.

BLM #2 Aquatic BERA General Comment: Table 9.11 identifies many stream reaches where only non-native Brook trout can survive due to cold water temperatures at high elevations. While risk to such species can be identified within the body of the report, we propose that they be removed as a measurement endpoint and not be carried into Table ES-1. The State of Colorado and the US Forest Service stated at the July 18 BTAG meeting that the Brook trout is considered an invasive species because it displaces other native species. Ongoing programs seek eradication from select stream reaches. Detailed information on this issue should be included in the body of the Aquatic BERA and carried forward to the top-line summary and Table ES-1.

Agency Response #14: The current Aquatic BERA evaluates risks to fish communities without consideration of whether the fish species that are or may be present in the study area are native to the area. While the Aquatic BERA discusses potential risks and sensitivity of native and non-native fish, this document is not intended to make decisions regarding fisheries management or potential remediation actions. Furthermore, there is no precedent for excluding non-native trout from risk characterization analyses. In fact, non-native trout were specifically factored into many EPA Region 8 Superfund site remedial actions, such as California Gulch (Weston, 1994) and Eagle Mine (NewFields, 2013). Risk to brook trout was also specifically assessed by the Besser et al. (2007) risk assessment for aquatic biota of the Animas River watershed. Finally, the CDPHE (2017) aquatic life classification indicator goals for the Animas River reaches between Minnie Gulch and Cement Creek and Mineral Creek to Deer Park Creek are specifically based on the protection of brook trout. EPA respectively acknowledges the reviewer's comment

but has decided not to remove brook trout from the current Aquatic BERA fish community risk measurement endpoint risk evaluation based on the arguments presented.

BLM #3 Aquatic BERA General Comment: The draft Assessment of Fish Habitat Parameters within the Upper Animas River and Selected Tributaries (fish habitat report) prepared by the U.S. Geological Survey (USGS) and U.S. Environmental Protection Agency (EPA), dated April 19, 2018, should be completed and incorporated by reference. We hereby incorporate by reference and resubmit as Attachment 1, BLM's comments on the fish habitat report. A primary concern expressed in these comments is that existing fish habitat assessments are biased high (i.e. suggesting more health than is generally true) because the selection of assessment points was biased to locations more likely to contain fish.

Agency Response #15: The USGS (2018) Assessment of Fish Habitat Parameters within the Upper Animas River and Select Tributaries report is now finalized and cited as such in the Aquatic BERA. The final report considered comments from external and internal reviewers, including BLM staff that were also involved in establishing survey site-selection methodology. The Aquatic BERA was updated to reflect changes made in the final report. EPA respectfully points out that the current Aquatic BERA discusses uncertainties associated with the biased selection of survey locations (Section 9.8.1). The uncertainty description was edited to communicate that results might be biased high with respect to the evaluation of habitat in locations where fish were most likely to be found.

BLM #4 Aquatic BERA General Comment: The final conclusion of BLM's review of the fish habitat report is also worth repeating here as a more general comment on the Aquatic BERA:

"… in other streams where fish are absent (e.g., Burrows Gulch, North Fork Animas below Burrows Gulch, California Gulch, Placer Gulch, West Fork Animas) surface water toxicity was observed and surface water HQs were elevated. In these streams, runoff from abandoned mines or background acid rock drainage may be responsible for the absence of trout. However, habitat characteristics and low water temperature also limit trout in these streams. Because the two stressors (chemical and habitat) are confounded, it is not possible to say which is responsible for the absence of trout, or if both are equally responsible. Consequently, if the chemical stressor is removed through remediation, it cannot be concluded that the streams would then be capable of supporting trout because habitat constraints still would be present. The forthcoming ecological risk assessment should include a discussion of the multiple stressors affecting fish in the Upper Animas River watershed."

Agency Response #16: EPA concurs with this recommendation and an additional uncertainty description was added to Section 9.8.1 and the executive summary to address this comment.

BLM #5 Aquatic BERA General Comment: Work to date should, but does not, address natural fish barriers that can preclude upstream fish migration and that result in insufficient stream reach to sustain a "stable and healthy" fish population (i.e. Assessment Objective 2).

Agency Response #17: EPA acknowledges that fish barriers can impact connectivity of fish populations. This point is specifically described as an uncertainty in Section 9.8.1. As stated in EPA's response to USFS comment #10, the Aquatic BERA encompasses over 100 river miles. Assessing all potential habitat within the study area would require tremendous amount of resources which are currently unavailable. EPA anticipates that any fish-based remedial actions, if selected, would require additional analysis and identification of habitat limiting features. This could include natural fish barriers and/or other habitat features that could be detrimental to the sustainability of fish populations. Text was revised in the uncertainty analysis to specifically state that additional habitat assessments would be needed to assess feasibility of fish community-based remediation goals.

BLM #6 Aquatic BERA General Comment: The BPMD is fairly unique in the breadth and magnitude of naturally elevated metals concentrations. Accordingly, natural background should be assessed and integrated into the conclusions and not relegated to a statement of uncertainty. The last bullet on page 19 of the Aquatic BERA provides this statement of uncertainty:

"Mainstem Mineral Creek and the reaches in the upper Animas River watershed may never have supported viable aquatic life communities, even before mining activities started in the 19th century (Church et al., 2007). Since these habitats may have always been naturally impaired, risks identified in this BERA may not reflect negatively on current conditions in those two waterways. This situation represented a major uncertainty, which would have to be considered as part of any future risk management decision-making. Despite this uncertainty, it appeared highly likely that BPMD mining activities have substantially increased exposure, and hence risk, to metals by aquatic receptors to levels beyond those that would have occurred without mining. This scenario becomes less certain when evaluating aquatic risks in reaches far downgradient from the BPMD NPL sites."

This statement makes competing claims: "may never have supported viable aquatic life" versus "highly likely that BPMD mining activities have substantially increased exposure, and hence risk, to metals by aquatic receptors". This conflicted text reveals a fundamental technical flaw with the design and scope of the risk assessment that has important implications to interpretation of the results. A fundamental principle of risk assessment is there must be exposure to cause risk. If certain stream reaches never supported aquatic life, there is no exposure and thus no risk, regardless of metals concentrations.

Agency Response #18: The first part of this comment was addressed by adding a new Background Conditions subsection to the current Aquatic BERA Risk Characterization Section 9. This section summarizes previous BPMD background investigations and actions that will be taken to incorporate potential impacts from background contamination sources in future remedial studies and actions. The Aquatic BERA was also revised to include a discussion on using exposure and risk results from reference sites to characterize potential background conditions.

With respect to the second part of this comment, EPA revised the uncertainty analysis section to better articulate that pre-mining conditions may not have supported healthy aquatic communities, but mining activities likely increased aquatic receptor exposure and risks from metals and acidic drainage. Added text also incorporates a recommendation for background analyses when considering remedial actions for the above stated reasons. EPA respectfully points out that naturally and anthropogenically impacted BPMD watershed reaches have the potential to support impoverished aquatic communities composed of a limited numbers of pollution tolerant species. Additionally, fish and many BMI species are highly mobile. Notwithstanding the presence of physical or chemical barriers, mobile species can freely move about the BPMD. Therefore, these species can be potentially exposed in any of the EUs evaluated in the current Aquatic BERA; regardless of the past and current contamination conditions. Finally, the Aquatic BERA specifically acknowledges that piscivorous wildlife risks are evaluated for all EUs, even where fish are absent. This uncertainty and respective biases are discussed in Section 9.8.2.

BLM #7 Aquatic BERA General Comment: The information needed to correctly interpret the significance of natural background in limiting aquatic habitat and, therefore, to understanding exposure and risk at the BPMD is not provided in the Aquatic BERA. Moreover, we propose that a significant amount of useful information has been generated by numerous high-quality studies conducted by the USGS, as captured in *Integrated Investigations of Environmental Effects of Historical Mining in the Animas River Watershed, San Juan County, Colorado*, Church, S.E., von Guerard, Paul, and Finger, S.E., eds., 2007.

Key conclusions from this work that should be carried forward into the Aquatic BERA include, but are far from limited to:

- "This [BPMD] geologic setting resulted in elevated background levels of acid and toxic metals in some stream reaches (Mast and others, this volume, Chapter E7) that are incompatible with establishment of diverse and productive aquatic communities. Even in streams less affected by high background levels of acid and metals, the high altitude of the watershed and barriers to colonization by some stream biota contributed to a relatively depauperate aquatic community. Only a very few native fish species occurred upstream from the Animas River canyon before European settlement" (Impacts of Historical Mining on Aquatic Ecosystems—An Ecological Risk Assessment, page 90).

- "Several trace metals, including zinc, copper, and manganese, were present [in the Animas River watershed] at concentration that exceeded aquatic-life standards at many of the background sites. Zinc, the metal most toxic to fish in the Animas River watershed study area, reached concentrations as high as 14,400 ug/L and was detected in more than one-half of background samples" (Characterization of Background Water Quality, page 382).

- "Although large amounts of metals and acidity could be removed by remediation of sources in the upper Cement Creek basin, changes in metal loads at the mouth of Cement Creek would be small because much of the metal loading comes from ground-water-fed iron bogs and sedge marshes" (Summary and Conclusions from Investigation of the Effects of Historical Mining in the Animas River Watershed, San Juan County, Colorado, page 15).

- "Contributions [of contaminated sediments] from the mines and mills in Cement and Mineral Creeks are discernible, but small. The effect of streambed sediment at the confluences of these two creeks mixing with sediment from the Animas River is also overwhelmed by the dominant contribution from the Sunnyside Eureka Mill", (Trace Elements and Lead Isotopes in Modern Streambed and Terrace Sediment—Determination of Current and Premining Geochemical Baselines, page 639).

When physical habitat limitations and natural background limitations within the BPMD are properly carried forward into ES-1, many table cells would warrant a "not applicable" designation or perhaps a level of risk where reduced terrestrial exposure is applicable. Alternatively, development and application of the appropriate hydrogeochemical models might allow for summary judgements of upstream water and sediment quality on exposure and risk at designated downstream points of compliance where "healthy and sustained" aquatic life might be expected to exist absent historic mining influences.

> *Agency Response #19: EPA respectfully acknowledges the concern regarding the importance of identifying background or natural occurring impacts to available habitat and receptor exposure risks. As stated in previous responses to comments, the Aquatic BERA will not attempt to differentiate between natural and anthropogenic impacts. EPA notes that the current Aquatic BERA approach is similar to what was published by Besser et al. (2007); Besser et al. (2007) did not attempt to identify or parse out background exposure risks or habitat limitations in their risk assessment of the Animas River watershed. Given this, EPA has decided not to dismiss risks to aquatic receptors potentially impacted by poor habitat or water quality; natural or anthropogenic.*
>
> *EPA notes that a Background Conditions Section 9.8 was added to the current Aquatic BERA that cites additional supporting conclusions and risk assessment methodology published in the Church et al. (2007) Professional Paper 1651 series reports where applicable.*

BLM #8 Aquatic BERA General Comment: BLM suggests that a more thorough effort be made to achieve consensus on Aquatic BERA findings and how they are presented and communicated to inform judgements and decision-making before a final Aquatic BERA is drafted.

> *Agency Response #20: EPA agrees that stakeholder and BTAG member group consensus on Aquatic BERA findings and respective use in decision-making is important. EPA is considering all comments made on the external review draft Aquatic BERA. As evident in the respective comment responses, not all comments will be addressed as suggested; the*

most substantial being identification and characterization of background versus anthropogenic impacts to aquatic receptor exposures and habitat quality for stated reasons. EPA acknowledges that information regarding how the Aquatic BERA results will be used in future site-remedial decision-making and drafting cleanup objectives was lacking in the review draft. Efforts were made to incorporate this information, where appropriate, throughout the revised Aquatic BERA.

The State of New Mexico Office of Natural Resource Trustee (NM ONRT) and Navajo Nation (NN) Joint Comments

NM ONRT/NN #1 Aquatic BERA General Comment #1: In general, we commend the approach taken to expand the Aquatic BPMD BERA beyond the Upper Animas River to address more comprehensively the extent of BPMD-sourced contaminants post-Gold King Mine (GKM) spill.

Agency Response #21: EPA acknowledges this comment. No action items are associated with this comment.

NM ONRT/NN #2 Aquatic BERA General Comment #2: Overall, this document would benefit from additional detailed background contextual information on how the BERA fits into the Remedial process; specifically, an introductory statement about the overall goal of the BERA process and how the information in the BERA will be used going forward. While it states that results will inform management decisions, we believe the document would benefit from additional specificity in this regard; for example, about how EPA plans to use these data, particularly given uncertainties associated with actual natural background concentrations and bioavailability, and availability of suitable habitat for aquatic-dependent biota.

Agency Response #22: EPA has added requested information on how the Aquatic BERA fits into the overall RI/FS process for the BPMD Superfund site in Section 1.1. Descriptions of how background conditions will be characterized when developing future remedial actions are provided in a new Background Conditions Section 9.8 and throughout the current Aquatic BERA.

NM ONRT/NN #3 Aquatic BERA General Comment #3: The BPMD BERA is currently written in a combination of present and past tense, which can confuse the reader due to the number of documents and publications referenced. We would highly recommend that the text be updated so that analyses and results presented in the BPMD BERA are referred to in the present tense, while other documents, such as the 2015 Upper Animas BERA and other previously completed documents be referred to in the past tense.

Agency Response #23: The Aquatic BERA text was revised to present tense except when describing past work or previous assessment activities.

NM ONRT/NN #4 Aquatic BERA General Comment #4: If EPA believes the BPMD BERA and the Upper Animas BERA should provide "continuity" (i.e. they are intended to be

complementary), we recommend the document be updated to provide a synthesis and summary of these component documents' collective conclusions. The current presentation comes across as a bit disjointed, and makes the BPMD BERA appear to be a stand-alone BERA; which we do not believe is EPA's intent. Further, we believe that the continuity of the two documents would be improved by addressing the following inconsistencies:

a. The Upper Animas exposure units (EUs) were not reevaluated post-GKM for hazard quotient (HQ)-based or toxicity testing even though Attachment 2 (BERA Addendum) concludes that post-GKM exposures were higher.

b. Piscivorous mammals were not assessed in the Upper Animas BERA but were assessed in the BPMD BERA. (In addition, the selection of raccoon as the representative receptor is unclear. Why not use, for example, mink, which is indicated as "known to occur" in San Juan County.)

c. There seems to be a different approach between the Upper Animas BERA and BPMD BERA in terms of how each calculates (or does not calculate) risk to wildlife. In the Upper Animas BERA, EPA does not characterize wildlife risk in EUs where food sources (benthic macroinvertebrates (BMI)/fish) are naturally absent, whereas the BPMD BERA does calculate risk to wildlife in EUs where food sources are absent (using estimated concentrations), and the risk is then characterized as hypothetical. We would recommend using the modeled approach used in the BPMD BERA consistently across the two documents.

> *Agency Response #24: The current Aquatic BERA was substantially revised to better incorporate Upper Animas BERA findings and specifically includes respective risk characterization findings in summary tables and text. Although assessment methods are very similar between the two BERAs, there are slight differences that limit direct comparison of results. The newly added Section 6.9 identifies these differences and actions taken to homogenize results between the two BERAs. Results from these actions are summarized in the Aquatic BERA. Note that revisions do not include a reevaluation of risks for Upper Animas BERA EUs potentially impacted by the GKM release. Also note that revisions are only documented in the Aquatic BERA summary tables and text and in Attachment 3 but not in the Upper Animas BERA.*
>
> *The reviewed version of the Aquatic BERA used information obtained from the BERA Addendum to support that exposures and risks were not permanently affected by the GKM release. This information was used to support the contention that Upper Animas BERA updates were unwarranted. The BERA Addendum and respective Section 3 summary text were removed from the current Aquatic BERA and replaced with a new GKM release aquatic community impacts section (Section 3.3). This new section summarizes results reported in two EPA published reports that investigated GKM release contaminants fate and transport and biological impacts (EPA, 2017a; 2018a). The reports determined that the GKM release did not significantly change the Animas River aquatic communities from conditions that occurred prior to the event. While elevated for a maximum of about nine months after the release, aquatic receptor exposures to metals in surface water and sediment were not different from those evaluated in the Upper*

Animas BERA. This information was used to justify EPA's decision not to update the Upper Animas BERA using post-GKM release data.

With respect to the comment regarding clarification on selection of raccoon over mink for assessing risks to piscivorous mammals, raccoon was selected and specified as a model wildlife receptor in the BERA Work Plan. Raccoon are common in the BPMD and have readily available food chain model parameters needed to derive respective dietary exposures.

NM ONRT/NN #5 Aquatic BERA General Comment #5: We note that in a number of instances throughout the BERA, depauperate or absent fish and benthic macroinvertebrate populations are defined as naturally occurring phenomena in certain areas (see, for example, text in section 3.3.1, or the first bullet in section 9.8.1). Such statements are inconsistently cited. In addition, where they are cited, they refer to a USGS report by Church et al. (2007)[1]. We note that this report, itself, cites relevant statements to an earlier report by Church et al. from 1999[2]. These cited reports, in fact, significantly caveat statements about the presence or absence of fish and are limited to discrete geographic areas. We would therefore recommend that caveats made in cited publications be carried through into the BERA text, as appropriate. Further, please exercise caution in generalizing information from these reports to geographic areas throughout the BPMD, as opposed to the specific areas to which the studies refer.

Agency Response #25: EPA addressed this comment by citing Church et al. (1999) and individual chapters in the Church et al. (2007) publication throughout the Aquatic BERA and Upper Animas BERA where appropriate.

NM ONRT/NN #6 Aquatic BERA General Comment #6: Section 3.3 of the BPMD BERA, provides a summary of the BERA Addendum (Attachment 2) conclusions regarding GKM spill-related aquatic community impacts, however there is an emphasis here on the spill-related spike/plume effects. We note, though, that the spike/plume data are not included in the Addendum analysis. The fact that these data are excluded from the analysis in the Addendum should be clarified in the summary provided in the main report.

Agency Response #26: The BERA Addendum and supporting text was completely removed from the current Aquatic BERA. Therefore, this comment is no longer relevant.

NM ONRT/NN #7 Aquatic BERA General Comment #7: Section 3.3 of the BPMD BERA, which provides a summary of the BERA Addendum (Attachment 2) conclusions regarding GKM

[1] Church, S.E., P. von Guerard, and S.E. Finger. 2007. Integrated Investigations of Environmental Effects of Historical Mining in the Animas River Watershed, San Juan County, Colorado: U.S. Geological Survey Professional Paper 1651, 1,096 p.

[2] Church, S.E., Fey, D.L., Brouwers, E.M., Holmes, C.W., and Blair, Robert, 1999, Determination of pre-mining geochemical conditions and paleoecology in the Animas River watershed, Colorado, in Morganwalp, D.W., and Buxton, H.T., eds., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the Technical Meeting, Charleston, South Carolina, March 8–12, 1999, Volume 1, Contamination from hard-rock mining: U.S. Geological Survey Water Resources Investigations Report 99–4018A, p. 19–30.

spill-related aquatic community impacts, also emphasizes the three supporting lines of evidence[3], but does not emphasize the details of the primary analyses, the statistical analysis of pre- and post-GKM sediment, or surface water data. We believe that the BPMD BERA would be improved if it more accurately characterized the analyses presented in the Addendum (Attachment 2).

> *Agency Response #27: The BERA Addendum and supporting text was completely removed from the current Aquatic BERA. Therefore, this comment is no longer relevant.*

NM ONRT/NN #8 Aquatic BERA General Comment #8: Section 3.3 of the BPMD BERA, which provides a summary of the BERA Addendum (Attachment 2) conclusions regarding GKM spill-related aquatic community impacts, notes on page 44 (page 45 of pdf) that "No significant increases in metals concentrations were identified in post-spill sediment samples collected at any of the Animas River reaches." Please review reporting by Kate Sullivan (U.S. EPA) at the 2018 Animas River Conference, which was held in Farmington, NM, in 2018. She presented at that meeting, and indicated sediment with elevated metal concentrations did persist and was only washed downstream during subsequent monsoon events. Please edit as necessary to reflect available data.

> *Agency Response #28: The BERA Addendum and supporting text was completely removed from the current Aquatic BERA. Therefore, this comment is no longer relevant. EPA notes that the BERA Addendum was effectively replaced with a summary of two EPA (2017a, 2018a) drafted GKM release reports; the fate and transport and biological data reports. Kate Sullivan's presentation was based on the fate and transport report. As such, requested edits were made when describing results from this report.*

NM ONRT/NN #9 Aquatic BERA General Comment #9: We recommend that the uncertainty characterization be edited to improve clarity and consistency. Uncertainties are currently characterized as "small", "minimal", "moderate", or "major" without any support for such statements in some places, and then as bias direction in other locations. Please provide decision criteria or a detailed explanation for how these categories are defined as "small" versus "moderate", etc. Ideally, statements about uncertainty magnitude should be supported by actual data. Alternatively, or perhaps in addition, please revise this text to focus on identifying the likely direction of any bias (e.g., as likely to underestimate, or overestimate risk).

> *Agency Response #29: The uncertainty analysis text has been revised, where appropriate, to provide additional details on magnitude and direction of any biases.*

NM ONRT/NN #10 Aquatic BERA General Comment #10: It is unclear if dissolved or total metals concentrations were used in the Upper Animas BERA for purposes of estimating water ingestion in food chain modeling for wildlife. This should be clarified; and total metals concentrations should be used for purposes of modeling water ingestion, if available.

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[3] The three supporting lines of evidence include the Mountain Studies Institute (MSI) benthic macroinvertebrate survey data, and the results of two Colorado Parks and Wildlife (CPW) fish studies.

Agency Response #30: The Upper Animas BERA uses available total recoverable metals analytical data to estimate water ingestion exposure for all wildlife receptors evaluated. This is stated in Section 4.4.2.1 in the Upper Animas BERA (Attachment 1 of the Aquatic BERA). For additional clarity on this subject, the Aquatic BERA Section 3.2 text was revised to specifically state that unfiltered surface water is used to estimate wildlife exposure.

NM ONRT/NN #11 Aquatic BERA General Comment #11: The use of only 10-day sediment exposures (amphipod) and 96-hour surface water (juvenile rainbow trout) toxicity tests limit our understanding of the long-term chronic effects resulting from BPMD sourced contaminants. We recommend additional toxicity testing with longer exposure durations to more accurately characterize risks associated with chronic effects that aquatic fish and BMI are likely to encounter downstream.

Agency Response #31: EPA respectfully acknowledges the request for additional long-term toxicity testing to assess chronic effects of BPMD contamination. However, EPA questions the utility of additional testing in assessing risks. First, significant toxicity was observed in about a third of the 96-hour trout and many of the 10-day amphipod tests. Additional testing would not change the risk conclusions that EUs impacted by low pH and elevated metals are toxic to fish and benthic invertebrates. Additionally, the Aquatic BERA assess risks to fish and benthic invertebrates using additional lines of evidence (measurement endpoints) that integrate long term exposure to site contaminants. Examples include fish and benthic invertebrate field surveys and calculation of chronic water quality criteria HQs. Therefore, no additional long-term aquatic toxicity testing to assess the chronic effects of BPMD contamination is planned at this time.

NM ONRT/NN #12 Aquatic BERA General Comment #12: We note that although some sediment toxicity testing reports are included as appendices, sediment toxicity testing results from field sample collections occurring in October 2016 and September 2017 are not included as appendices to the BPMD BERA. We recommend making these results available for review[4].

Agency Response #32: EPA will ensure that the final versions of the two sediment toxicity testing reports are uploaded to the BPMD BTAG FTP site with the Aquatic BERA. The full citations for these reports are as follows:

U.S. Environmental Protection Agency. 2017. Bonita Peak Mining District Superfund Site, San Juan County, CO 10-Day Acute Sediment Toxicity Testing Report. Prepared by TechLaw, Inc. EPA Region 8 Environmental Services Assistance Team. May.

[4] These results appear to be published in the two following reports, cited in the BPMD BERA, respectively.
U.S. Environmental Protection Agency. 2017c. Bonita Peak Mining District Superfund Site, San Juan County, CO 10-Day Acute Sediment Toxicity Testing Report. Prepared by TechLaw, Inc. EPA Region 8 Environmental Services Assistance Team. May.
U.S. Environmental Protection Agency. 2018b. Bonita Peak Mining District Superfund Site, La Plata County, CO 10-Day Acute Sediment Toxicity Testing Report. Prepared by TechLaw, Inc. EPA Region 8 Environmental Services Assistance Team.

U.S. Environmental Protection Agency. 2018. Bonita Peak Mining District Superfund Site, La Plata County, CO 10-Day Acute Sediment Toxicity Testing Report. Prepared by TechLaw, Inc. EPA Region 8 Environmental Services Assistance Team. December

NM ONRT/NN #13 Aquatic BERA General Comment #13: We question whether the geographic extent, specifically the downstream extent of the BERA is adequate. The furthest downstream reaches evaluated (Durango) demonstrated risk, indicating the likelihood that additional downstream locations might also experience risk. We highly recommend that risk should be characterized downstream from release sources at least until no risk from site contamination can be demonstrated. Alternatively, the justification for the current geographic extent should be bolstered and caveated.

Agency Response #33: The downriver extent of the current Aquatic BERA is about 50 river miles down from the BPMD at Silverton, CO. EPA respectfully acknowledges the request to expand the Aquatic BERA even further down the Animas River but will not extend the risk assessment EUs beyond Purple Cliffs (EU-DR02) in Durango, CO because of the following reasons: a) First, the amount of environmental data available for the Animas River downriver from EU-DR02 is relatively sparse; b) Collection of additional environmental data, toxicity testing information, and aquatic community surveys needed to extend the assessment would take a considerable amount of time and resources to complete; c) Current risks are comparably much lower in EU-DR02 than seen in the upper Durango reach (EU-DR01) and much lower than in BPMD EUs; d) While low to moderate risks were identified for some measurement endpoints, respective contaminants may not be unique to BPMD sources. This represents a considerable uncertainty regarding the use of spatially distant risk information in supporting RI/FS activities in the BPMD; and e) Finally, the Animas River habitat changes and aquatic communities change from cold to warm water downriver from Durango. This would make Durango EU to BPMD EU comparisons even more difficult to justify. In order to partially address this comment, text was added to the Aquatic BERA Section 1.1 to further explain why the current geographic extent was chosen.

NM ONRT/NN #14 Upper Animas Addendum General Comment #1: It is not clear how this "stand-alone" report fits into the scope of the BERA, or why it is included. Please include additional text in the BPMD BERA and in the BERA Addendum to explain how these results are relevant in the context of the BERA.

Agency Response #34: The BERA Addendum and supporting text was completely removed from the current Aquatic BERA. Therefore, this comment is no longer relevant.

NM ONRT/NN #15 Upper Animas Addendum General Comment #2: The GKM spill plume/spike data were not included in the post-spill data set; they were either excluded (A72, Bakers Bridge), or not available (no data for Canyon, A68 not impacted by GKM [reference reach]). We suggest that the plume/spike data be included in the post-spill dataset, or referenced as a subset of the post-spill dataset.

Agency Response #35: The BERA Addendum and supporting text was completely removed from the current Aquatic BERA. Therefore, this comment is no longer relevant.

NM ONRT/NN #16 Upper Animas Addendum General Comment #3: The BERA Addendum (Attachment 2) relies on three additional lines of evidence[5]. The BERA Addendum concludes that despite the increased metal concentrations identified quantitatively post-GKM spill, their "actual effects" on fish and BMIs were negligible based on the results of these three independent lines of evidence. Detailed descriptions of the methods and results used for establishing these are not included in the BERA, just a summary of data results as related to the present study. Publication information and peer-review status are not provided for the data or any related reports. In addition, one of the two CPW studies is referenced as a personal communication. Please rely on publicly-available information, whenever possible, and please make this information used to support the BERA readily available for public review.

Agency Response #36: The BERA Addendum and supporting text was completely removed from the current Aquatic BERA. Therefore, this comment is no longer relevant.

NM ONRT/NN #17 Upper Animas Addendum General Comment (from Attachment 2 Table): The Upper Animas BERA and the BERA Addendum did not evaluate the potential for storm events to influence water quality. We suggest further consideration for how storm events may influence the BERA's risk characterization given data available related to increased concentrations of metals associated with storm events.

Agency Response #37: The BERA Addendum and supporting text was completely removed from the current Aquatic BERA. This report was effectively replaced by summaries of two EPA (2017a, 2018a) GKM release reports. The EPA (2017a) fate and transport report summary (Section 3.3.1) provides a discussion of storm event-related fate and transport processes that occurred after the GKM release.

NM ONRT/NN #18 Specific and Editorial Comments: Table list of specific comments provided to EPA titled; *Attachment 2: Joint Comments by the State of New Mexico Office of the Natural Resources Trustee (NM ONRT) and Navajo Nation (NN) on the 2018 Draft Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment | September 21, 2018*. Note that the second to last comment in the Attachment 2 joint comments table was deemed substantial enough to be included as a separate comment with response (see NM ORNT/NN #17 above).

[5] The three supporting lines of evidence include the Mountain Studies Institute (MSI) benthic macroinvertebrate survey data, and the results of two Colorado Parks and Wildlife (CPW) fish studies.

Attachment 2: Joint Comments by the State of New Mexico Office of the Natural Resources Trustee (NM ONRT) and Navajo Nation (NN) on the 2018 Draft Bonita Peak Mining District Aquatic Baseline Ecological Risk Assessment | September 21, 2018

Section	PDF Page Number*	Paragraph Number	Line Number	Comment
TOC	2	Section 3	title line	Misspelling, "prevouis".
TOC	2	Section 3	title line	Misspelling, "assessmnets".
TOC	5	-	-	Figure ES-1 and Table ES-1 are not listed in the List of Figures or List of Tables.
ES.1	11	3	1	Figure ES-1 as referenced does not appear to be included.
ES.1	12	1	4	Remove one of the repeated "thats".
ES.1	12	1	6	Insert "the", in at [the] upstream.
ES.1	12	-	-	3.1. The summary of the BPMD BERA EUs is difficult to follow in both the Executive Summary and in Section 1.4. Needs clarification.
ES.1	12	1	-	In Mineral Creek watershed, there are 8 total EUs, but only EU01-EU06, the 2 reference sites are not given EU numbers, but are included in the EU totals; Durango reach EU totals do not include reference site, which is inconsistent; either clarify that reference locations are not EUs or give them an EU number, and be consistent in approach to totaling the number of EUs for each reach.
ES.1	12	2	1	Animas River watershed EUs plus references only add up to 16, not 17 as stated.
ES.1	12	3	1	Durango Reach- reference not included in EU total; should be 3 to be consistent with Mineral Creek and Animas River summaries.
ES.2	12	-	-	4.2. ES.2 Assessment and Measurement endpoints introduced before CSM described; perhaps introduce the CSM in the ES before ES.2.
ES.2	14	2	8	Revise "Literature-source" to "Literature-sourced".
ES.2	15	1	3	Please provide a citation and a rationale (e.g., "due to current chemical condition"; "because of of underlying habitat quality", etc.).
ES.3	15	-	-	Several references to the 20 COPECs evaluated are made throughout the text of the BPMD BERA; however the 20 COPECs are not listed or clearly stated in the Executive Summary or early in the Introductory report text. We recommend providing a table of COPECs early in the text or a reference to its location.
ES.4	19	5	1	Suggest deleting either the word "surveys" or "assessments".
ES.4	20	5	3	Missing open parentheses. Presume asterisk is a typo.
ES.4	21	1	2	Suggest rewording to: "...increased aquatic receptor exposure to, and hence risk from, metals to levels...".
ES.4	21	1	3	The document does not clarify or provide citations for why measured exposures and calculated risks in lower reaches are deemed less certain. Explanations or rationale should be affirmatively stated with supporting citations.
ES.4	21	5	11	Suggest deleting the word potentially. It is without question that the lack of analytical data creates uncertainty in the analysis.
ES.4	22	2	7	Suggest deleting or revising this last sentence. The sensitivity of H. azteca does not tell you anything about the uncertainty associated with the lack of knowledge about the sensitivity of the specific species that are present (i.e. the applicability or goodness of fit of the H. azteca model to the system). All you can say is that the H. azteca model was sufficiently sensitive to be used as a test organism. Instead it would be more informative to say something about the potential direction of bias associated with this uncertainty, since it is unclear what the risk manager should do with the characterization of uncertainty in species sensitivity as "small" in ongoing decision making, particularly related to adaptive management and early remediation.
ES.4	22	3	6	Suggest rewording this last sentence. Something akin to "Because reproductive effects can occur at lower exposures, and more severe effects were found at the majority of sites, it is not expected that additional toxicity testing for chronic and reproductive effects would provide additional information about incidence of toxicity, except in the eight reaches where 10-day toxicity tests failed to identify toxicity."
ES.4	22	4	2	Revise, "where" not were.
ES.4	22	4	5	Revise, "than" not that.

* PDF Page Number refers to the page number in the "June 2018 BPMD Aquatic BERA External Draft.pdf" document, not the number listed on the page of each report.

Section	PDF Page Number*	Paragraph Number	Line Number	Comment
ES.4	23	5	6	Should this say "characterized" instead of "realized"?
ES.4	24	3	1	Either insert "were" after TRVs , "TRVs were applied", or delete "and" after the word mammals.
ES.4	24	3	4	Revise, receptor should be singular.
ES.4	24	6	4	Suggest swapping the order of aluminum and low pH to make it clear that "low" is only modifying pH... in other words say "greatest risks were associated with high concentrations of lead and zinc in sediments, and aluminum and low pH in surface water."
ES.4	25	1	4	Again, list metals first, and finish with "low pH" to make it clear that you are not saying that metal concentrations were low.
ES.4	25	2	8	Revise, habitats should be plural.
1.1	26	2	8	"identifies" (present tense)? Suggest using the present tense throughout this and subsequent paragraphs to clarify that it is referring to this document.
1.1	26	2	9	Revise, insert "to" after "referred".
1.1	26	2	11	Watersheds (plural)?
1.1	26	2	14	Suggest rewording this final sentence to read something like "This BERA, in conjunction with the attached Upper Animas BERA, provide a complete assessment of aquatic ecological risks from BPMD contamination."
1.3	28	8	6	Revise, insert "be" after "will not".
1.3	28	8	9	Revise, "complimentary" to "complementary".
1.3	28	8	11	Suggest saying "...potentially impacted by contaminants and other environmental conditions related to BPMD Superfund site mine features." as EPA is in fact assessing risk from contaminants where they have come to be located.
1.4	30	7	6	Again-- mixing of past and present tense. Suggest using present tense whenever referring to this document for the sake of clarity.
2.1	34	4	3	Insert "a", "as a Superfund site".
2.2	35	2	1	Please provide the general dates or years of these surveys, or provide a specific reference.
2.2	35	2	3	Suggest "mining-related" not "site-related".
2.2	35	2	9	"Functioning" is vague descriptor of community quality. We suggest saying something like "...found viable BMI and trout communities in..." or discuss comparability to reference locations.
2.3	35	3	1	Suggest replacing "A threatened and endangered (T&E) species list" with "A list of species federally listed as threatened or endangered" (to segregate from any state listings).
3		-	title line	Misspellings in title, "prevoius" and "assessmnets".
3.1	37	4	9	Insert "the" in "below the Silverton reach".
3.1.1	38	1	2	Again, consider using "viable" or other more explanatory adjective in place of "functioning".
3.1.1	38	1	4	Please edit or provide a citation for the sentence "As mentioned earlier, it is believed that fish have never existed in this drainage due to naturally occurring metals concentrations". The previous statement to which this sentence is referring identified lack of fish as resulting from a combination of both naturally occurring and mining-related contamination. Naturally occurring should only be used to refer to conditions in the absence of human-related activities--please also see our overall comment on designation of naturally occurring populations of fish (comment # 5 in Attachment 1).
3.1.1	38	3	6	use of "lesser", relative to what?
3.1.1	39	5	5	Should the words "individual and" be deleted here? If individual sampling location were considered distinct EUs, there would be seven total, not five.
3.1.1	39	6	7	Typo, "exposer" should be "exposure".
3.2.1	41	4	7	Should note that no chronic toxicity testing was performed.
3.2.1	42	2	7	Consider deleting "out", and leaving the sentence to end after "dilute".

* PDF Page Number refers to the page number in the "June 2018 BPMD Aquatic BERA External Draft.pdf" document, not the number listed on the page of each report.

Section	PDF Page Number*	Paragraph Number	Line Number	Comment
3.2.1	43	2	2	"Insectivorous" and "invertivorous" seem to be used interchangeably throughout; suggest standardizing use of "invertivorous" based on AE3.
3.2.1	43	2	8	Do you mean decreased in the downstream direction? What does it mean to say risks decreased throughout the reach? Relative to what?
3.3	44	2	5	For clarity, suggest replacing "downstream from Cement Creek up to Bakers Bridge" with "from downstream of Cement Creek to Bakers Bridge".
3.3	44	2	7	Please clarify whether this is using dissolved or total metals concentrations.
3.3	46	3	1	Is this sentence meant to say "did not" alter? [Please note that this comment does not reflect our agreement with the statement.]
4.3	50	1	3	Suggest saying acid mine or acid rock drainage here, as you use the term acid rock drainage below.
6.3	64	2	5	Please clarify whether this is using dissolved or total metals concentrations.
9.1.3	90	6	8	Insert "to" or "from" in "exposure unknown".
9.8.1	110	2	1	Suggest saying "may never have", instead of "likely", and softening the certainty with which you are claiming longstanding natural impacts. Please see our overall comment on designation of naturally occurring populations of fish (comment # 5 in Attachment 1).
9.8.1	110	3	7	What about direction of potential bias associated with this uncertainty?
9.8.1	112	1	2	Suggest deleting this last sentence and instead adding a sentence about the direction of potential bias in risk estimate this uncertainty presents.
9.8.1	112	2	7	Please see suggested rewording in Executive Summary.
9.8.1	112	3	13	Instead of describing uncertainty as "small" even though sensitivity analyses were performed, suggest simply discussing the direction of any bias the uncertainty may introduce in the risk estimates.
9.8.1	112	4	14	Please see comment in Attachment 1 above related to characterizing uncertainty as "small".
9.8.1	113	1	12	Direction of potential bias?
9.8.2	114	3	12	Direction of potential bias? Fine to say could increase or decrease risk estimate.
Attachment 1	853	3	8	"Bonita Peak Monitoring District"; should standardize use of "Bonita Peak Mining District".
Attachment 1	853	4	7	"Bonita Peak Monitoring District"; should standardize use of "Bonita Peak Mining District".
Attachment 1	926	12	2	Misspelling, revise "power" to "pore".
Attachment 2	1964	-	-	The BERA Addendum is referred to as the BPMD BERA Addendum and the Upper Animas BERA Addendum interchangeably throughout. Revise for consistency.
Attachment 2	1984	2	2	Given the small sample size, some review of statistical power should be included.
Attachment 2	1986	2	5	The report states that for Step 1, "significant difference" is the criteria for exclusion. To clarify, it seems that this should state that the post-spill mean concentrations are not significantly "greater than" pre-spill concentrations.
Attachment 2	2005	-	-	CPW fish caging study: It is unclear whether there were any quantitative metrics of stress sampled, or if long-term survival was surveyed. Please provide a reference to this study's methodology.
Attachment 2	2008	2	1	The Upper Animas BERA and the BERA Addendum did not evaluate the potential for storm events to influence water quality. We suggest further consideration for how storm events may influence the BERA's risk characterization given data available related to increased concentrations of metals associated with storm events.
Attachment 2	2131-2134	-	-	Table 2.2, sampling locations that were not sampled should not be listed.

* PDF Page Number refers to the page number in the "June 2018 BPMD Aquatic BERA External Draft.pdf" document, not the number listed on the page of each report.

Agency Response #38: Specific and Editorial Comments listed in the above, NM ORNT/NN table were considered and respective text was revised. Note that Attachment 2 was removed from the final Aquatic BERA, so these revisions are no longer relevant.

Colorado Parks and Wildlife (CPW) Comments

CPW #1 General Comment: CPW does not have anything to add or change on your EA from comments and suggestions as well as responses made at the in-person presentation. We understand the approach, the role of the EA in the overall process and feel the EPA's process is thorough and adequate to inform decisions down the road.

Agency Response #39: No action items are associated with this comment.

Colorado Department of Public Health and Environment (CDPHE) Comments

CDPHE #1 Specific Point #1: Section 2.4.2.2. Why were none of the 6 amphibians[6] known or likely to occur in San Juan county selected? Wouldn't amphibians be considered as "species or groups most likely to experience exposure to the stressors?" Section 2.3 indicates that it may be possible that "boreal toads were not found in the area due to chemical and physical impacts of metals and acidity," which further supports the theory that amphibians would be highly likely to experience stress in the BPMD. The expatriation of animals due to inhabitable conditions caused by contaminants should not justify its exclusion from a risk assessment.

Agency Response #40: EPA agrees that amphibians are relevant aquatic receptors for the BPMD site and are now included in the Aquatic BERA. Please refer to the similar USFS comment #11 for a more detailed response regarding this addition.

CDPHE #2 Specific Point #2: Section 6.1. Why were the water, sediment, and biological data that have been collected by CDPHE, San Juan County, USGS, and San Juan Basin Public Health not been included? These data are publicly available[7]and could contribute to a more robust analysis of exposure point concentrations.

Agency Response #41: EPA confirmed that the provided data are not included in the Aquatic BERA dataset. The Aquatic BERA only relied on environmental chemistry data from and collected under EPA-approved work plans. This assures that data are of known quality and any conclusions made from it are defensible. These data are also easily

[6] Listed in Appendix 6.
[7] http://sjbpublichealth.org/wp-content/uploads/2018/08/Colorados-Long-Term-Monitoring-Plan-SW-and-Sediment-data-043018.pdf

accessed via EPA Scribe database tools. The CDPHE-provided dataset is a PDF table of analytical results for a handful of sampling locations (Station IDs) and was not associated with any work plan. None of the Station IDs in the PDF data table explicitly match the Aquatic BERA EU-specific sampling locations that were defined in the BERA Work Plan. The current Aquatic BERA sampling locations were carefully chosen by EPA and the BTAG to represent respective EUs. Inclusion of data from additional sampling locations would discount this selection process. Lastly the provided web address link was broken at the time the Aquatic BERA was revised. Therefore, these data do not seem to be publicly available at this time. EPA respectfully acknowledges the comment but will not incorporate the provided dataset into the Aquatic BERA for stated reasons. However, the CDPHE-provided dataset could be considered further in the RI/FS process if identified quality assurance/quality control issues can be resolved.

CDPHE #3 Specific Point #3: Section 6 and referenced environmental datasets. The BERA, at times, fails to use data collected via sufficiently sensitive methods. The laboratory practical quantitation limits (PQLs, also known as minimum levels)[8] fall above the state's requirements for PQLs[9]:

- Aluminum
- Beryllium
- Arsenic
- Manganese
- Selenium
- Silver
- Thallium
- Zinc

When the laboratory minimum level (or lab PQL) falls above the state PQL, and the data is reported as not-detected, the state's policy is that the method is not sufficiently sensitive. It should be noted that the state's policy aligns with EPA's 2014 sufficiently sensitive rule[10]. Using sufficiently sensitive methods would decrease uncertainty in the risk from contaminants reported as not-detected.

Agency Response #42: EPA acknowledges that PQLs are, for some samples and COPECs, not sufficiently sensitive to be detected above respective toxicity benchmarks. Analytical data were generated under EPA's Contract Laboratory Program using industry-standard levels of performance. Unfortunately, solid matrix interferences have potential to reduce PQLs below stated performance. Unique water quality characteristics, such as very low hardness levels, also create lower than expected toxicity benchmarks. While these issues represent considerable uncertainties for a small number of COPECs, such as chronic nickel toxicity in surface water, the vast majority of analytical data upon which the Aquatic BERA relied was generated with sufficiently low

[8] As reported in Appendix 8-10 tables and in EPA 2016d
[9] Water Quality Control Division, 2015. Practical quantitation limits. CW Policy 6, https://www.colorado.gov/pacific/sites/default/files/Policy%20CW-6%20%20PQL%20rev.pdf
[10] 40 CFR Part 136, amended August 2014

PQLs. Note that this issue was addressed in the Aquatic BERA section on uncertainties associated with elevated PQLs. Given this, no further action will be taken to address the comment.

CDPHE #4 Specific Point #4: Section 6.2. According to EPA [2000], the use of ½ the detection limit in place of a non-detect value is typically only appropriate when less than 15% of data falls below detection limits. Other means of handling censored data [Helsel, 2006] should be considered, especially when the censored data could influence the exposure point concentration. This is particularly concerning when CTEs [central tendency exposures] are calculated as arithmetic means, which could be artificially influenced by the substitute values.

Agency Response #43: As identified by the reviewer, the current Aquatic BERA uses half of the reported detection limit for censored data when identifying COPECs and calculating exposure scenarios. This is a common and acceptable approach when working with censored data (EPA, 2017b) and was prescribed in the BERA Work Plan (EPA, 2016a). EPA respectfully acknowledges the comment but will not revise the current analyses to account for alternative methods to handle censored data. EPA notes that COPEC selection process would not be affected by modifying the current approach since it did not rely on modeled data; such as reasonable maximum exposures (RME) and CTE values. Excluding the example provided in CDPHE comment #3 response, the majority of COPEC datasets were generated using adequately sensitive analytical methods and do not contain an excess of non-detect values. Therefore, any RME and CTE refinements would require a large data processing effort and not substantially change exposure estimates.

CDPHE #5 Specific Point #5: Section 6.8.2. This section lists sources of sediment toxicity benchmarks in order of preference. The rationale behind this preference should be included, particularly when multiple sources have differing benchmark values for the same contaminant.

Agency Response #44: The current Aquatic BERA obtained sediment ecological screening values (ESVs) from readily available and Agency acceptable literature sources. It should be noted that not all ESVs were available for all COPECs from a single source and that multiple and different ESVs might be available for individual COPECs from multiple sources. Therefore, EPA had to use multiple literature sources and prioritize sources to generate a robust set of sediment ESVs. MacDonald et al. (2000) was the most trusted and common source of all ESVs. MacDonald et al. (2000) is commonly cited as the most statistically sound and generally accepted source of sediment ESVs. This source is also more up-to-date than Oak Ridge National Laboratory ESVs (Jones et al., 1997). MacDonald et al. (2000) ESVs also encompass the most common and BPMD-specific COPECs. All other sources simply provide acceptable ESVs for COPECs not identified in MacDonald et al. (2000). Section 6.8.2 was revised to document the ESV source selection rationale.

CDPHE #6 Specific Point #6: Section 6.8.3. Again, please provide the rationale for preferentially selecting EPA and LANL TRVs, especially when values from Sample et al. (1996) are lower.

> *Agency Response #45: All but one wildlife TRV were obtained from EPA EcoSSL datasets; mercury TRV was obtained from Sample et al. (1996). Sample et al. (1996) mercury TRVs are used because this metal was not assessed by EPA when generating Eco-SSL derivation datasets. EcoSSL toxicity datasets were generated using EPA-accepted methods and are arguably the most defensible sources of acceptable toxicity studies currently available. Section 6.8.3 was revised to document TRV source selection rationale.*

CDPHE #7 Specific Point #7: Section 7.1. Please describe the hardness adjustment process when a contaminant was not detected (i.e., what hardness value was selected?).

> *Agency Response #46: Hardness is used to calculate surface and pore water ESVs when selecting COPECs for target metals when that metal's toxicity is modified with respect to hardness. Sample-specific ESVs are compared to their respective surface and pore water sample results (measured or half of ND) to select COPECs. Hardness is calculated from sample-specific, paired calcium and magnesium results which are detected in all water samples. Section 7.1 was revised to clarify this process.*

CDPHE #8 Specific Point #8: Section 8 (and associated appendices). Environmental datasets with small sample sizes are almost never normally-distributed, but more often skewed and/or left-censored. As such, nonparametric analyses are more appropriate. The reviewer is surprised by the large number of RME metal concentrations calculated using the student t-test method.

> *Agency Response #47: EPA followed the program-selected recommendation of the most appropriate 95UCL approach from the entire menu ProUCL 5.1 derivation methods. Note that ProUCL 5.1 warns users of unreliable 95UCLs; an analysis that considers dataset distribution and violation of underlying assumptions. When 95UCLs are flagged as being unreliable, the maximum concentration of a constituent among all measurements in an EU dataset is used to represent an RME value. ProUCL 5.1 selection of the student t-test method is supported by a goodness of fit test where data appear normal at a 5% significance level. This can occur for small datasets with acceptable distributions.*

CDPHE #9 Specific Point #9: Section 8.1 and 8.2. Please explain the sample size threshold and/or other criteria used to decide whether the RME/minimum hardness was calculated using ProUCL.

> *Agency Response #48: As stated in CDPHE comment #8 response, EPA followed the ProUCL 5.1 program-selected recommendation of the most appropriate 95UCL approach. Recommendations are based upon data size, data distribution, and skewness* and *simulation studies summarized in Singh et al. (2006). While more rigorous statistical methods to assess underlying assumptions may be available, EPA relied on ProUCL*

program recommendations. This allows for an efficient way to accomplish the extraordinary number of ProUCL runs associated with deriving EPCs for each EU and endpoint. Section 8.1 was revised to include more information on this subject.

CDPHE #10 Specific Point #10: Section 8.2. The use of a 95% UCL to derive a "reasonable minimum" hardness value assumes a normal distribution of the data that, as discussed above, is almost never found in environmental data. The uncertainty in the "reasonable minimum" hardness values derived using this method should be recognized.

Agency Response #49: As stated in Agency responses to CDPHE comments #8 and #9, EPA followed the ProUCL 5.1 program-selected recommendation when selecting 95UCLs. It should be noted that most of the surface water and all of the pore water reasonable minimum hardness values were represented by the minimum measured hardness values.

CDPHE #11 Editorial Comments List: Editorial comments were provided in a list and specific to Aquatic BERA substations.

● Page 72: Regulation No. 3 should be Regulation No. 31

● Page 1264: San Juan Country should be San Juan County

● Page 36: San Juan Country should be San Juan County

● Table 6.9: Footnote about shading should read BERA not SLERA.

● Figures 3.1-3.13, 3-27-3.28, 3.33-3.34, etc. The reviewer suggests broken y-axis to aid in readability of data.

● Appendix 6: Should be labeled as an appendix. Also, the footnoted web link is broken.

● Appendices 8 - 10. Please include definition of detection qualifiers in table footnotes (eg., J, JD, J+, J-, etc.)

● Appendices 8 and 9. For the following tables and contaminants, the screening value exceeds the maximum detected concentrations:

○ Table A8.2. Beryllium, mercury, molybdenum, vanadium ○ Table A8.20. Antimony, beryllium, lead

○ Table A8.21. Mercury, selenium

○ Table A9.9. Arsenic

○ Suggest a thorough review of all of these tables.

● Table A8.5: No chromium screening value is given even though a HQ value is provided.

Agency Response #50: All editorial comments have been addressed. Note that Attachment 2 was removed from the revised Aquatic BERA. Therefore, Attachment 2 editorial comments are not relevant. EPA notes that the comment regarding Appendices 8 and 9

screening values is correct but ignores that fact that detected concentrations may be lower than half of respective detection limits. Also note that lower screening values are selected when respective, sample-specific hardness values produce lower screening criteria and greater HQs than those associated with maximum detected concentrations.

Utah Department of Environmental Quality (UDEQ) Comments

UDEQ #1 General Comment – Cover Letter: We remain concerned with the limited scope of the risk assessment, specifically that the assessment does not consider the watershed downstream of Durango, Colorado. Clearly, the nature and extent of the impacts has not been completely characterized as evidenced by potential ecological risks identified at the most downstream locations assessed. Furthermore, the conclusion that the "Animas River - Durango Reach" is elevated for lead, manganese, zinc, and aluminum in sediment and surface water indicates that the extent of the potential ecological impacts downstream remain a concern. We recommend that the assessments be extended downstream until no risk to aquatic receptors is found. The report would also benefit from additional explanation as to why the current geographic extent was chosen.

Agency Response #51: The downriver extent of the current Aquatic BERA is about 50 river miles from the BPMD at Silverton, CO. EPA respectfully acknowledges this comment, but will not extend the risk assessment EUs beyond Purple Cliffs (EU-DR02) in Durango, CO for reasons discussed herein. First, the amount of environmental data available for the Animas River downriver from EU-DR02 is relatively sparse. Collection of additional environmental data, toxicity testing information, and aquatic community surveys needed to extend the assessment would take a considerable amount of time and resources to complete. Second, current risks are comparably much lower in EU-DR02 than are seen in the upper Durango reach (EU-DR01) and BPMD EUs. While low to moderate risks were identified for some measurement endpoints, respective contaminants may not be unique to BPMD sources. This represents a considerable uncertainty regarding the use of spatially distant risk information in supporting RI/FS activities. Lastly, the Animas River habitats and aquatic communities change from cold to warmer water downriver from Durango making Durango EU to BPMD EU comparisons even more difficult to justify.

UDEQ #2 General Comment – Cover Letter: Section 1.1 of the report describes in a single sentence how the risk assessment fits into the remedial investigation/feasibility study process. While not central to the purpose of the risk assessment, it would be beneficial for the reader to have a better understanding of the larger context of the report and specifically, how it will be used "to guide risk management decisions in selecting and implementing cleanup actions." We recommend adding information as to how the risk assessment fits in the larger remedial investigation/feasibility study process.

Agency Response #52: Additional text was added to Section 1.1 to address this comment.

UDEQ #3 General Comment – Cover Letter: Due to the large size of the report, it would be helpful to include clickable links for all sections, figures, and tables to make the document more navigable for the reader. The document should also be reviewed again for editorial errors. As an example, the words "previous" and "assessments" are misspelled in the table of contents and Figure ES-l does not appear to be included in the report or listed under "List of Figures." Furthermore, the reaches in Figure l-4 are mislabeled.

Agency Response #53: The Aquatic BERA PDF has embedded bookmarks that can be used to directly navigate to different sections; including figures and tables. These are found in the tool bar at the far left-hand site of the screen. All identified errors have been corrected.

UDEQ #4 Aquatic BERA Specific Comment #1: Section 4.4 Exposure Point Concentrations. What is the basis for using the arithmetic mean for the central tendency exposure? This approach is inconsistent with (USEPA, 2002) guidance for calculating the exposure point concentration and USEPA Region 8 precedence because the reasonable maximum exposure is based on the mean, albeit a potentially conservative estimate of the arithmetic mean.

Agency Response #54: The commenter did not provide the full citation for "USEPA, 2002" but it is assumed to be EPA's Office of Emergency and Remedial Response publication titled, "Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites." Respective guidance describes recommendations for deriving EPCs for non-normal nor -lognormal datasets; specifically, how data normality is tested and interpreted when using ProUCL software. EPA notes that this guidance was followed when deriving current Aquatic BERA EPCs by using ProUCL software. EPA also notes that the Aquatic BERA evaluates exposure using both arithmetic means (CTEs) and 95UCL or maximum (RME) values. This approach provides analysis of more-conservative RMEs and less-conservative CTEs in which the range of concentrations experienced by receptors can be assessed. EPA revised Section 4.4 text to clarify the current approach.

UDEQ #5 Aquatic BERA Specific Comment #2: p. 68, Section 6.6.1. BMI Tissue. "This BERA used co-located sediment and tissue results from the sediment and BMI tissue datasets to build regression models to estimate BMI tissue concentrations for these four EUs from the sediment analytical data. This analysis was done by pairing metals concentrations in sediments with tissue samples collected at the same location, date, and time, plotting results, and semi quantitatively selecting the best fitting or most conservative models. Microsoft Excel was used to build scatter plots for each metal with sediment concentrations as the independent variable and BMI tissue concentrations as the dependent variable. Linear, logarithmic, and power regression models were applied to each scatter plot using Microsoft Excel. The direction of each regression model's slope and R_2 value were inspected for each plot to assess the applicability of modeling BMI tissue from sediment. No attempt was made to test for assumptions or significance of slope terms. Of the three regression models, the one with the greatest R_2 was selected as the best fit regression

model. No minimum R_2 value threshold was considered. A site-specific model was not derived if all three regression slopes were negative."

This approach is technically unreliable and should be deleted. A lack of statistical significance or an evaluation of the variability accounted for in the regression analyses cannot support reliable conclusions.

> *Agency Response #55: EPA respectfully acknowledges the request to remove site-specific sediment-to-invertebrate tissue bioaccumulation factor modeling from the Aquatic BERA but has decided not to remove or revise the current analysis based on the comment. EPA aggress that the current approach is not statistically robust, but it does provide a reasonable, site-specific alternative to using generic literature-based bioaccumulation factors. It should be noted that site-specific factors are only derived for two of the ten bioaccumulative metals investigated; mercury and zinc. As seen in Aquatic BERA Appendix 6 figures, tissue residual estimates obtained from these two models are more conservative than readily available, literature-based models. Given that there are no low-effect TRV-based risks to any invertivore wildlife receptors from either of these COPECs, the requested revisions would not change risk characterization results.*

UDEQ #6 Upper Animas BERA Specific Comment #1: Please clarify why only acute and subchronic toxicity tests were used to characterize the potential effects. Specifically, why weren't chronic tests run to assess for longer term impacts?

> *Agency Response #56: Similar to what is done in the Aquatic BERA, the Upper Animas BERA investigates sediment exposure risks for BMIs and surface water exposure risks to sensitive trout species using subchronic and acute toxicity tests, respectively. Shorter duration testing methods were selected over chronic tests for the following reasons.*
>
> *First, toxicity testing is just one measurement endpoint in a lines-of-evidence approach used to evaluate risks to sediment dwelling invertebrates and fish. Endpoints such as BMI and fish surveys provide integrated exposure endpoints that incorporate chronic exposure regimes. The availability of field surveys outweighed the additional effort needed to conduct longer term tests. The level of additional effort is exemplified when one considers the amount of resources associated with conducting the number of tests needed to cover all EUs evaluated among both risk assessments. Longer duration tests require a substantial investment in testing equipment such as flow-through exposure systems that are difficult to set-up, maintain, and stock with more than a few separate tests. For surface water tests, the volume of water needed to run chronic tests is often space and cost prohibitive when using an off-site testing laboratory (EPA, 2002a). Use of the 10-day amphipod and 96-hr trout toxicity tests enabled the testing laboratory to simultaneously run many tests using the same general conditions and using a single batch of test organisms. This scenario produces the most comparable dataset in which individual EU-test results can be evaluated with respect to one another. Lastly, sediment tests provided both survival and sensitive growth/biomass endpoints; the same endpoints*

available with longer duration test methods. Test duration selection text was added to the Upper Animas BERA in respective Section 3.6 subsections to help address this comment.

UDEQ #7 Upper Animas BERA Specific Comment #2: Section 3.5.4. "Note that CrVI and MeHg are not expected to be present in surface water and sediment from the Animas River."

What are the bases for these conclusions? Given the source of a portion of the releases is from mine discharges that can be similar to groundwater with regards to redox potential and the pH, how was CrVI concluded to be absent? CrVI is more toxic and has a higher solubility in water than Cr3. Hg is likely inorganic when released from mining activities but under certain conditions can be methylated in the environment in for instance, sediment. The chronic Colorado water quality criteria for mercury is 0.01 µg/l. Were water samples analyzed with sufficiently sensitive analytical methods to support that mercury should not be a water COPEC? Further evaluation of Cr and Hg is necessary to support that Cr and Hg are not of ecological concern.

Agency Response #57: CDPHE (2017) provides a chronic surface water toxicity screening values for CrVI; 11µg/L (dissolved fraction). The greatest dissolved chromium concentration measured in Upper Animas BERA surface water was 2.3 µg/L and the greatest detection limit was 5.0 µg/L; see table in Appendix 1.g. Since these results account for all chromium species, there is little chance that CrVI would be measured in BPMD surface water above the 11µg/L screening value. There are no readily available CrVI sediment screening values.

Mercury was not routinely measured in BPMD surface water samples used in the Upper Animas BERA. However, there are some mercury analysis results in the Aquatic BERA and when analyzed the lowest detection limit was 0.0002 µg/L; see the EPA (2016b) Conceptual Monitoring Plan database. EPA (2015) provides a chronic surface water toxicity screening values for MeHg; 0.0028 µg/L (fraction not specified). The greatest measured total recoverable mercury concentrations were measured in the lower Durango reach (EU-DR02); maximum 0.02 µg/L, average 0.01 µg/L. MeHg is typically a small fraction of total mercury in surface waters. For example, the average percent of MeHg of total mercury measured by USGS (Scudder et al., 2009) among samples collected throughout the United States averaged 7.1%. When applied to the EU-DR02 maximum and average values, resultant estimated MeHg concentrations are 0.0014 µg/L and 0.0007 µg/L, respectively. These estimated MeHg concentrations are lower than the EPA (2015) screening value of 0.0028 µg/L. There are no readily available MeHg sediment screening values.

Although the above screening analyses of CrVI and MeHg carries a lot of assumptions, they do show that there is little risk to aquatic receptors associated with respective exposures. Nevertheless, Section 3.5.4 text was revised to specifically state that CrVI and MeHg might be present in surface water but not at concentrations above conservative screening levels.

UDEQ #8 Upper Animas BERA Specific Comment #3: The status of two locations as reference sites is confusing and potentially inconsistent. Section 2.6.1 Site Sediment Toxicity Test in the

2012 Sediment Toxicity Testing Report: "The two locations on the Animas River originally selected as references (i.e., A56 and A68) were determined to be impacted by mining activity and could therefore not be used for that purpose." However, the water samples from these two sites for the toxicity testing were concluded to be representative of reference conditions. The MMI evaluations also treat A56 and A58 as reference locations.

> *Agency Response #58: The Upper Animas BERA ES-1 and Section 1.1 specifically state that sampling locations A56 and A68 should not be considered to represent reference conditions but do represent regional "upstream" conditions. The sediment toxicity testing report used the term "reference" to describe these sampling locations but this was before test results and later BERA outcomes found that the two sites were impacted by upstream sources of metals.*
>
> *Note that current Upper Animas BERA MMI evaluations do reference and describe results from two actual reference sampling locations. As described in Upper Animas BERA Section 3.6.3, the sampling location on Elk Creek (A73EC) and another on Cascade Creek (A75CC) were considered reference locations and used to comparatively evaluate benthic invertebrate survey metrics for all Animas River sampling locations; A56 downstream to James Ranch, including CC49 in Cement Creek and M34 in Mineral Creek. EPA recognizes that respective survey metrics summaries in Section 3.6.3 are not clear and has revised text throughout to specify sampling locations when reference locations are cited. The rest of the Upper Animas BERA was reviewed to ensure that A56/A68 are consistently described as being representative of upstream conditions and actual, BMI survey reference sampling locations are consistently identified as A73EC/75CC.*

UDEQ #9 Upper Animas BERA Specific Comment #4: Appendix 7: Hardness-dependent water quality criteria appears to have been calculated when hardness exceeded 400 mg/L $CaCO_3$. Please verify that hardness corrections were capped at 400 mg/L $CaCO_3$ per USEPA and CDPHE requirements.

> *Agency Response #59: The Upper Animas BERA did calculate hardness-dependent water quality criteria using hardness values that exceeded 400 mg/L CaCO3. This infrequently occurred for Cement Creek surface and pore water when selecting COPECs and assessing risks for COPECs. All affected tables and text were revised to address this issue. Text was added to the Upper Animas BERA Section 3.3.1 that states hardness-specific benchmarks are not calculated for any hardness values above 400 mg of $CaCO_3$/L.*

UDEQ #10 Upper Animas BERA Specific Comment #5: Appendix 7: The equations in the table footnotes for the chronic surface water quality criteria for some of the metals, e.g., Cr and Cu, appear to be for total recoverable metals as opposed to a dissolved criteria. In addition, some of the exponents in the formulas deviate from USEPA national criteria documents. These should be verified to ensure that where they deviate, the deviations are consistent with CDPHE.

Agency Response #60: EPA reviewed all of the Upper Animas BERA Appendix 7 chronic surface water quality criteria and confirmed all are consistent with CDPHE (2013) Regulation 31 Table Value Standards. CDPHE (2013) was the primary source of all Upper Animas BERA hardness-specific benchmark equations. Noe that these may differ from EPA aquatic life criteria which, are in fact, recommendations for states to adopt.

UDEQ #11 BERA Addendum Specific Comment #1: Section 5.4 Conclusions. p.32., "The lack of an acute toxic response by the caged juvenile rainbow trout exposed to the full brunt of the GKM spill spike is particularly striking. The lack of a significant response by the benthic invertebrate community shortly after the passage of the GKM spill is also telling. Finally, the lack of measurable effects in natural fish populations exposed to the post-spill surface water quality for over one month also suggests that the post-spill metal levels do not represent a major ecotoxicological concern."

"The conclusion, therefore, is that the GKM spill resulted in higher post-spill exposures for several metals but that the effects on benthic invertebrates and fish were negligible."

The conclusion is overstated and not supported by the available data. First, the general lack of appropriate methods for evaluating chronic effects from acute exposures should be acknowledged. The text should also be revised to conclude "...acute effects on benthic invertebrates and fish were not detected."

The caged fish were an acute evaluation and acute effects were not observed but these observations provide no measure of the presence or absence of chronic effects from the acute exposure. The other measures would also only detect acute and frank effects. Observational, i.e., fields, studies often have reduced power to detect effects and with the Bonita Peak confounders of existing exposures, the power is likely even lower. The existing instream fish populations are selected to be relatively tolerant of metals because of the ongoing exposures to the same contaminants elevated by the GKM release.

Similar limitations apply to the macroinvertebrate observations. As noted for the benthic macroinvertebrates in Section 5.1, "It is worthwhile to note that the metal-sensitive families of benthic macroinvertebrates (i.e., Heptageniidae, Ephemerellidae and Taeniopterygidae) were absent both in 2014 and in 2015, suggesting that the benthic macroinvertebrate community was already stressed prior to the GKM spill. In addition, at location A68, which was not impacted by the spill, MSI biologists observed similar increases in abundance and total richness metrics, and a decrease in the EPT taxa richness in samples collected 24- to 48-hours and 1-week after the GKM spill. This observation suggested that other influences not connected to the August 5, 2015 GKM spill event may have affected the benthic invertebrate community in the Animas River."

The evidence of an already stressed macroinvertebrate community and paucity of macroinvertebrates sensitive to metals severely weakens the reliability of this measure of effect. In addition, some other confounder affected the macroinvertebrates based on the results at location A68 further decreasing the sensitivity.

Agency Response #61: The BERA Addendum and supporting text was completely removed from the current Aquatic BERA. Therefore, this comment is no longer relevant. The BERA Addendum was effectively replaced by summaries of the EPA (2017a; 2018a) fate and transport and biological data reports. The EPA (2018a) biological data report provides a more robust analysis and description of GKM release impacts to aquatic receptors.

Mountain Studies Institute (MSI) Comments

MSI #1 General Comment #1: You may consider re-calculating the Colorado Multi-Metric Index (MMI) scores using the recently recalibrated version of MMI. The following is an example comparing MMI scores using the 2010 version vs. the 2017 version. In this example, some benthic samples shifted from being impaired to not being impaired when the revised MMI version was used.

Table 1. MMI scores and attainment using the 2010 and 2017 versions of MMI.

ID	Stream Name	Site Name	MMI Scores					
			2010 Version			2017 Version		
			2014	2015	2016	2014	2015	2016
Animas River								
AaElk	Animas River	Above Elk Creek	30.7	40.7	-	37.9	42.4	43.0
AaCas	Animas River	Above Cascade Creek	52	47.1	-	47.8	55.8	63.8
ABB	Animas River	Baker's Bridge	51.8	60.2	-	52.2	61.4	58.2
AJR	Animas River	James Ranch	61.2	46.7	-	55.8	52.6	63.5
A32nd	Animas River	32nd Street	30.8	20	-	47.4	41.8	48.3
AaLC	Animas River	Above Lightner Creek	48.5	47.3	-	57.3	46.1	46.0
APC	Animas River	Purple Cliffs	46.4	50.7	-	45.0	53.4	45.7
Reference Sites								
ELKaA	Elk Creek	Above Animas River	65.2	49.5	-	78.4	59.2	71.9
CASaA	Cascade Creek	Above Animas River	68.9	90.7	-	64.7	80.8	76.4

Note: Gold highlight indicates sites that are impaired according to MMI scores. For 2016 samples, we only calculated scores using the 2017 version of MMI. These scores are derived from samples collected in the fall. We did not assess attainment of spring samples as they were collected outside of the approved MMI sampling period.

Agency Response #62: MMI scores were recalculated using the 2017 recalibrated version of the MMI tool for all locations summarized in the Aquatic BERA. This includes locations investigated in the Upper Animas BERA. Text was added to the Aquatic BERA Section 6.5.1 describe this action and indicate that recalibrated scores may not match those reported in respective, cited supporting studies.

MSI #2 General Comment #2: The document states "The 32nd Street Bridge and Oxbow Park survey reaches did not contain riffle habitat…" It is accurate that the Oxbow Park survey site was solely depositional habitat and did not contain riffles. However, the benthic samples collected at 32nd Street Bridge were downstream of the bridge exclusively in riffle habitat.

> *Agency Response #63: Section 9.1.4 text was revised to account for additional details provided by the commenter.*

MSI #3 General Comment #3: To further understand the risk to aquatic life from aluminum exposure in the Durango reach of the Animas River, it would be helpful to further examine aluminum levels in context of EPA's "2017 Draft Aquatic Life Ambient Water Quality Criteria for Aluminum" (which requires knowing dissolved organic carbon) as well as New Mexico's aluminum standard for aquatic life (which requires knowing the more biologically available concentration of total aluminum that passes through a 10 um filter).

> *Agency Response #64: EPA respectfully acknowledges the comment but has decided not to update the Aquatic BERA to account for draft EPA or New Mexico aluminum aquatic life criteria. First, the draft EPA criteria were only finalized on December 21, 2018 (EPA, 2018b) are have not been adopted by CDPHE; the primary source of surface and pore water ESVs used in the Upper Animas and Aquatic BERAs. It should also be noted that these criteria are modified with respect to dissolved organic carbon (DOC) and that parameter was only measured for a small number of surface water and no pore water samples. Given this, the final EPA aluminum criteria could not be calculated for all EUs evaluated for surface water risks and any DOC assumptions would represent an added uncertainty with unknown bias. Lastly, with regards to evaluation against New Mexico's water quality criteria, there are very few surface water samples that have been filtered to 10 µm and all were collected in the Durango Reach. Therefore, the New Mexico criteria could not be used to investigate water column receptor risks for the vast majority of EUs evaluated in the Upper Animas and Aquatic BERAs.*

Sunnyside Gold Corporation (SGC) Comments

SGC #1 Overarching Comment #1: The BPMD BERA and its attachments have several deficiencies that need to be addressed in order for the document to meet its intended goal. As stated on page 10 (Executive Summary) and again on page 116 (Summary and Conclusions), that goal is as follows: " ... this risk assessment was intended to guide future risk management decisions when selecting and implementing cleanup actions." The BERA identifies several uncertainties associated with the risk characterization, some of which are significant enough to suggest that the BERA is not finished and thus cannot serve as a basis for making any defensible remedial management decisions.

> *Agency Response #65: EPA acknowledges this comment, but no specific, identifiable action items are associated with this comment.*

SGC #2 Overarching Comment #2: EPA acknowledges considerable uncertainty for several aspects of the BERA. While some uncertainty in ecological risk assessments is unavoidable, EPA guidance (1998)[11] recommends an iterative approach to reduce uncertainty and EPA ecological risk management policy is explicit about using site-specific data. Building on EPA's uncertainty characterization, SGC has identified several areas within EPA's BERA that should be addressed before risk management actions can be identified. A revised BERA should focus on the following aspects that are critically important to risk conclusions and risk management decisions:

• Natural and anthropogenic background conditions: An understanding of the contribution of background sources of chemical stressors and upstream conditions will be necessary to, at a minimum, evaluate risk management actions. The information will also be helpful in prioritizing sources for risk management. Absent this understanding, the risk characterization misrepresents actual risks.

• Spatial and temporal data gaps: For many exposure units (EUs), EPA made risk conclusions based on one or very few data points. Better understanding of concentrations and exposure is necessary for making effective risk management decisions. For example, Colorado water quality criteria for some metals vary from month to month; thus, one surface water sample in any given month is not adequate to evaluate compliance. In addition, abundant data are available for the Animas River adjacent to the Mayflower impoundments that were not acknowledged or considered in the BERA. This data would contribute significantly to understanding potential ecological risks in this EU.

• Representativeness of data: In addition to spatial/temporal gaps, the sources of some samples may not represent the ecologically important exposure points. For example, EPA collected sediment samples in some reaches from near-shore depositional areas that do not represent the environments actually in the river to which receptors are exposed.

• Exposure assumptions: In some cases, site-specific chemical data or knowledge of receptor biology has not been used to refine risk estimates. The bioavailability of lead and the diet of the southwestern willow flycatcher are good examples. The forms of lead that are present at the site are known and can be used to refine the estimates of bioavailability and exposure to receptors, which are almost certainly far below the levels assumed by EPA in the BERA. Exposure to lead in ingested sediment is the largest source of risk for the American dipper, which is used as a surrogate for the flycatcher. However, the flycatcher and dipper have very different feeding habits. The dipper feeds mainly in the stream on aquatic insects and has the potential to ingest contaminated sediments. In fact, the BERA concludes that sediments are the greatest estimated source of risk to the dipper. By contrast, the flycatcher feeds mainly on aerial and terrestrial insects and has little chance of contacting contaminated sediments or soils. As a result, use of the dipper as a surrogate, and the lack of consideration of the actual bioavailability of lead at the site, substantially overestimates potential risks to the flycatcher.

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[11] U.S. Environmental Protection Agency. 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-9S/002F. (April)

These and other sources of uncertainty must be addressed in the BERA to support the risk management phase of the project. If they are not addressed in the BERA, it will be necessary to complete the analyses in the risk management phase.

Agency Response #66: Regarding characterization of background conditions, EPA respectfully acknowledges the comment but does not agree that the risk assessment is uninformative without characterizing contribution of background sources of chemical stressors and upstream conditions. The current Aquatic BERA assessed risks that would be currently experienced in each EU. This information is useful in determining potential risks and comparing risk outcomes among river reaches. It is also the same approach taken by Besser et al., (2007) and SGC (Formation Environmental, 2018) in respective, Animas River ecological risk assessments and it is the approach that was prescribed in the Aquatic BERA work plan (EPA, 2016). As stated in previous comments regarding characterization of contributions of background conditions, EPA added a background risk characterization Section 9.8 and text throughout the Aquatic BERA to describe background conditions and how background contributions will be assessed on a site-specific basis later in the RI/FS process. As stated in the added text, the requested contribution assessment approach is not in-line with standard EPA guidance, complicated by spatial variability and uncharacterized nature of background conditions, and is best accomplished using a site-by-site analysis.

Regarding spatial and temporal data gaps, EPA respectfully acknowledges comment, but the Aquatic BERA is not evaluating site-specific standards compliance, but rather aquatic ecological risk during high flow and low flow periods. As far as spatial data gaps, the locations that have been factored into the Aquatic BERA were agreed to after consultation with the BTAG; a process that is reflected in the BERA Work Plan. Data from additional locations (and other times of year) is available and will be evaluated further in the RI/FS process.

Regarding representativeness of sediment data, EPA respectfully acknowledges the comment but disagrees that aquatic receptors would not be exposed to fine-grained sediments. It is common practice and recommended that bed sediment sampling focus on obtaining samples of fine-grained surficial sediments from depositional areas (USGS, 1995; Ohio EPA, 2001). In acceptable quantities, fine-grained sediment provides important habitat in stream ecosystems (Apitz, 2011). They can also be a sink for metals. It is also reasonable to assume that subaerial sediments collected from near-shore areas would be available to wildlife receptors and under water, potentially exposing sediment dwelling invertebrates during high flows.

Regarding exposure assumptions associated with selection of the American dipper receptor species and bioavailability, EPA respectfully acknowledges the comments but has decided not to revise the Aquatic BERA in response to them. EPA recognizes that the bioavailability of lead in sediment to avian invertivores is likely less than the 100% that is currently assumed. This point was specifically discussed in the current Aquatic BERA Uncertainty Analysis Section 9.8.2. To make this point clearer, the uncertainty text was

revised to add more detail on potential wildlife risk estimate biases associated with bioavailability assumptions.

The selection of the American dipper as aquatic avian receptor and surrogate to southwestern flycatcher was prescribed in the BERA Work Plan (EPA, 2016). The BERA Work Plan was drafted so that interested parties could have input in how the Aquatic BERA would be conducted while limiting the revision of associated analyses. Nevertheless, a new wildlife uncertainty analysis bullet describing life history differences between American dipper and southwestern willow flycatcher and associated biases on risk estimates was added to Section 9.8.2. EPA also notes that the same 100% bioavailability assumption and the use of the American dipper as a surrogate for flycatcher were included in the SGC BERA for the Animas River reach above Silverton near the Mayflower Mill (Formation Environmental, 2018).

SGC #3 General Comment #1: The BERA clearly states that evaluation of incremental risk due to natural or anthropogenic background is outside the scope of the document and that the BERA did not attempt to define background conditions. This approach is arbitrary, capricious, and contrary to EPA guidance (2002)[12]. In addition, failure to analyze background results in a risk characterization that misrepresents actual risks (EPA, 1998)[13], and without an understanding of the contribution of background to risk and concentrations it is not possible to evaluate remedial alternatives.

EPA guidance is explicit about addressing natural background in the risk assessment. In the context of CERCLA, EPA (2000) defines "background" as constituents or locations that are not influenced by the releases from a site. Further, "background" is typically described as anthropogenic and/or naturally occurring. Anthropogenic background includes natural and human-made substances present in the environment as a result of human activities (not specifically related to the CERCLA release in question). Naturally occurring background includes substances present in the environment in forms that have not been influenced by human activity. EPA (2002) further clarifies the role of "background" in ecological risk assessments:

Specifically, the COPCs [chemicals of potential concern] with high background concentrations should be discussed in the risk characterization, and if data are available, the contribution of background to site concentrations should be distinguished. COPCs that have both release-related and background related sources should be included in the risk assessment. When concentrations

[12] See USEPA. 2002. Role of Background in the CERCLA Cleanup Program. OSWER 9285.6-07P: US Environmental Protection Agency (USEPA). 1998 Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F. (April)

[13] E.g., the BERA's assertion that "it appeared highly likely that BPMD activities have substantially increased exposure, and hence risk, to metals by aquatic receptors to levels beyond those that would have occurred without mining" is utter speculation, particularly when the BERA affirmatively chose not to analyze natural background, and thus no attribution to various sources (natural and mining) is possible based on the BERA. Similarly, the BERA's assertion that "[t]he greatest risks to aquatic community receptors occurred in reaches that were directly downgradient from mine features and highly mineralized watersheds" is vague and incapable of guiding risk management decisions. Is it the mine features or the naturally highly mineralized watersheds that are the sources?

of naturally occurring elements at a site exceed risk-based screening levels, that information should be discussed qualitatively in the risk characterization. To summarize:

• The COPCs retained in the quantitative risk assessment should include those hazardous substances, pollutants, and contaminants with concentrations that exceed risk-based screening levels.

• The Risk Characterization should include a discussion of elevated background concentrations of COPCs and their contribution to site risks.

• Naturally occurring elements that are not CERCLA hazardous substances, pollutants, and contaminants, but exceed risk-based screening levels should be discussed in the risk characterization.

Background information is "important to the public," and is also "important to risk managers because the CERCLA program, generally, does not clean up to concentrations below natural or anthropogenic background levels" EPA (2002).

Similarly, in EPA's Guidelines for Ecological Risk Assessment, all sources must be identified, and "[m]any stressors have natural counterparts or multiple sources, so it may be necessary to characterize these as well." "[A]II sources of a stressor" must be considered, even if "[r]elative source attribution can be accomplished as a separate step."[14] EPA cannot ignore the considerable impact of natural background within the BPMD or relative source attribution simply because it is inconvenient.[15]

In the BPMD, understanding the contributions of both anthropogenic and naturally occurring background conditions is essential to making informed and effective risk management decisions. Mast et al. (2007)[16] confirms that metals released from weathering of altered rock from unmined areas are significant in some stream reaches and must be taken into account when water quality standards and remediation goals are established for the Animas River watershed. In fact, even the BERA notes that "[i]t is important to note that levels of naturally occurring metals in some locations suggested that portions of the site likely never supported significant aquatic communities (Besser et al., 2007)," and that "[m]ainstem Mineral Creek and upper Animas River watershed reaches likely never supported viable aquatic life communities before mining activities started in the 19th century" (Church et al., 2007). Differentiating between the impact from significant mining-related features and the effects of natural sources of metals and/or acidic waters is a critical component of a CERCLA Remedial Investigation and deserves considerable thought relevant to the selection of sample locations and how the resulting chemical data will be

[14] U.S. Environmental Protection Agency. 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-9S/002F. (April)

[15] "It is important to investigate possible reasons for any disagreement rather than ignore inconvenient evidence." US Environmental Protection Agency (USEPA). 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F. (April)

[16] Mast, M.A., P.L. Verplanck, W.G. Wright, and D.J. Bove. 2007. Characterization of Background Water Quality, Chapter E7 in Church, S.E., von Guerard, Paul, and Finger, S.E., eds., 2007, Integrated investigations of environmental effects of historical mining in the Animas River watershed, San Juan County, Colorado: U.S. Geological Survey Professional Paper 1651, 1,096 p. plus CD-ROM. [In two volumes.]

used in the ecological risk assessment process. Background conditions within the BPMD must be evaluated quantitatively for the risk characterization so they can be considered in the risk management and decision-making process, consistent with EPA policy (EPA 2002). Furthermore, the "major uncertainty" related to not addressing background and related incremental risks must be fully vetted in the document.

"[H]igh background concentrations of hazardous substances, pollutants, and contaminants found at a site is a factor that should be considered in risk assessment and risk management." EPA (2002) (emphasis added). Moreover, the failure to consider natural background, as the BERA recognizes, is "a major uncertainty," and "[s]ince these habitats have always been naturally impaired, risks identified in this BERA may not reflect negatively on current conditions."

> *Agency Response #67: EPA agrees that the reviewed Aquatic BERA draft would be improved with addition of information on background conditions. As such, EPA has added a Background Conditions Section 9.8 to the current Aquatic BERA's risk characterization section. The background conditions section summarizes information provided in Church et al. (1999) and Mast et al. (2007). As reported in Mast et al. (2007), the large size of the assessment area, myriad of mine features within it, and complex underlying geology, complicate quantification of background conditions. Given these attributes, thorough characterization of background versus mining risks is highly uncertain and spatially variable; therefore, best accomplished on a site-by-site basis. As described in Section 9.8, EPA is planning on conducting quantitative analysis of background conditions on a site-by-site basis, at later stages of the RI/FS process, using environmental data collected on a finer geographic scale than the EU reaches evaluated in the Aquatic BERA. That said, the Aquatic BERA evaluates risks for six reference EUs; some of which were selected by Mast et al. (2007) when conducting a background water quality characterization study for the BPMD watershed. These reference EUs are located throughout the BPMD study area. Risk information from reference EUs can be used to comparatively evaluate non-reference EU risks since risk measurement endpoints are similar among evaluated BPMD river reaches. A new Reference and background Section 1.5 was added to the Aquatic BERA that describes the utility of reference EUs in characterizing background risks in respective areas. EPA notes that the current "total" risk approach follows applicable agency risk assessment guidance (EPA, 2002b; 2018c). EPA (2002b) specifically states that both release- and background-related sources should be carried through the entire risk assessment and that risks associated with naturally occurring sources should be discussed qualitatively in the risk characterization.*

SGC #4 General Comment #2: SGC supports the use of multiple lines of evidence in the risk assessment process. However, where results for lines of evidence contradict each other, the BERA should provide further interpretation or identify the uncertainty as a data gap. Lines of evidence and their contribution to the characterization of risk could be prioritized. The BERA developed assessment and measurement endpoints to aid in characterizing risks and identified the lines of evidence for each assessment and measurement endpoint. Results were compiled for the lines of evidence in Table ES-1 and Table 10-1. However, in many cases, the lines of

evidence are conflicting to varying degrees. Where these conflicts arise, which lines of evidence should be considered as more critical or biologically relevant?

For example, when sediment toxicity test data indicate one result, but comparison of chemical concentrations to pore water or sediment toxicity reference values (TRVs) suggests a different result, which does the BERA use as the priority line of evidence? Guidelines suggest that empirical site data (such as toxicity test data) are a premium and should be considered more heavily than comparison of site concentrations with non-site-specific thresholds for effects[17]. Some discussion of the priorities or importance of the lines of evidence relative to their contribution for risk characterization and risk management should be included in the BERA.

> *Agency Response #68: EPA respectfully acknowledges the recommendation but will not to prioritize risk endpoints or lines of evidence. This decision is predicated on the concept that each measurement endpoint has a unique set of strengths and weaknesses. When assessed without prejudice, endpoints can be objectively evaluated with respect inherent strengths, weaknesses, and associated biases. Furthermore, it is the responsibility of risk managers to consider all endpoint attributes when making remedial action decisions based on information provided in risk assessments. The risk assessment attempts to accomplish this by objectively reporting risk results and qualifying respective uncertainties and associated biases. Text was added to Aquatic BERA Section ES.2 and Section 5.4 to describe why endpoints are not prioritized.*

SGC #5 General Comment #3: More scientifically defensible aquatic TRVs should be used for some ecological chemicals of potential concern (ECOPCs) in the BERA. For some ECOPCs, risks are characterized based on outdated thresholds for effects or are based on adopted thresholds for effects (state or national criteria) that do not necessarily reflect the species assemblage present in the Animas River and its tributaries. More realistic but still conservative assessments of risk could be achieved using more up-to-date TRVs. Two examples in the BERA are cadmium and aluminum.

Colorado's cadmium Table Value Standard (TVS) is based on Colorado's 2005 adoption of a cadmium criterion based on its internal review of the scientific literature available at that time. In 2016, EPA issued a revised national cadmium criterion based on the same principle of adopting criteria that reflect the current science. At a hardness of 50 mg/L CaCO3, the Colorado TVS chronic criterion (0.252 ug/L) is nearly two times lower than the 2016 cadmium criteria (0.426 ug/L). Both of these are substantially lower than the brown trout and rainbow trout chronic values EPA derived in the BERA (0.99 and 1.3 ug/L, respectively)[18]. Many new studies on the toxic effects of cadmium have allowed for a revised criterion that considers the new data integrated with the old data. Collectively, these values represent a wide range of potential cadmium thresholds that depend in large part on the species included in their derivation.

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[17] Environmental Protection Agency (EPA). 1999. Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites. Letter from S. Luftig, Office of Emergency and Remedial Response. (October 7)

[18] EPA 2016 identified a life cycle chronic test for brook trout reproduction conducted at a hardness of 44 mg/L from Benoit et al. 1976 that resulted in a brook trout EC20 of 1.224 ug/L.

Utilization of a more up-to-date cadmium TRV in the BERA would result in more realistic estimates of ecological risks due to cadmium where it is considered to be a risk driver.

Colorado's aluminum TVS is based in large part on the work conducted for the Arid West Water Quality Research Project (2006), which concluded that aluminum effects are hardness based, much like several other metals. Colorado adopted the revised values from this work, except when the pH falls below 6.9; then the TVS reverts to the 1988 chronic criterion of 87 ug/L. Since then, Gensemer in Parametrix (2009)[19] and EPA (2017)[20] have significantly revised this earlier work on the effects of aluminum to aquatic life. The current science indicates that aluminum is less toxic to aquatic life than previously thought due to the modifying factors of pH, dissolved organic carbon (DOC), and hardness. The EPA 2017 proposed chronic aluminum criteria at a DOC of 0.5 mg/L and hardness of 50 mg/L CaCQ3 for pH 6.5 is 160 ug/L whereas at pH 7 it is 350 ug/L. In contrast, the Colorado TVS at 50 ug/L hardness and a pH of 6.5 is 87 ug/L and at pH 7 is 189 ug/L. These values are nearly two times lower than the EPA 2017 proposed chronic aluminum criteria. In the case of aluminum, the science has been continually evolving to better understand its toxic mechanisms and factors that modify its toxicity. Similar to cadmium, utilization of a more up-to-date aluminum TRV in the BERA would result in more realistic estimates of ecological risks due to aluminum where it is considered to be a risk driver.

> *Agency Response #69: EPA respectfully acknowledges the recommendation but will not revise aquatic receptor risk estimates using updated cadmium or aluminum water quality criteria. All Aquatic BERA surface water receptor risks that are assessed using ESVs based on current CDPHE table value standards. The EPA revised cadmium criteria have not been adopted by CDPHE at the time the Aquatic BERA surface and pore water risk analyses were conducted. The latest January 31, 2018 CDPHE basic standards Regulation 31 cadmium table value standards did not adopt the revised EPA, recommended aquatic life criteria and remain the same as those used in the current Upper Animas and Aquatic BERA.*
>
> *EPA also respectfully points out that EPA recommended criteria are meant to be protective of all aquatic species (fish, invertebrates, and amphibians) that are included in respective toxicity datasets in which they were derived. Trout species chronic values presented in the Aquatic BERA are based on respective trout species toxicity datasets and not a combination of all species. As such, the commenter's comparison of cadmium criteria to trout species chronic values presented in the Aquatic BERA is not substantive. Trout species-specific chronic value risk information is included to provide a more realistic evaluation of risks for an important COPEC using site-relevant fish species.*
>
> *Regarding the updated aluminum aquatic life criteria, EPA respectfully acknowledges the comment but will not up update the current Aquatic BERA. First, the draft EPA criteria were only finalized on December 21, 2018 (EPA, 2018b) and have not been*

[19] Parametrix. 2009. Updated Freshwater Aquatic Life Criteria for Aluminum (Exhibit 2 of Direct Testimony of Robert W. Gensemer. 2009. Prepared for Los Alamos National Laboratory. 25 pp.
[20] EPA. 2017. Draft Aquatic Life Ambient Water Quality Criteria for Aluminum 2017. Office of Water, EPA-822-P-17-001

adopted by CDPHE; the primary source of surface water quality criteria used in the Upper Animas and Aquatic BERAs. As noted, these criteria are modified with respect to dissolved organic carbon (DOC) and that parameter was only measured for a small number of surface water and no pore water samples. Given this, the final EPA aluminum criteria cannot be calculated for the all EUs evaluated for surface and pore water risks and any DOC assumptions would represent additional uncertainty with unknown bias.

EPA added an uncertainty bullet to the Aquatic BERA Section 9.8.1 that identifies respective biases associated with adoption of CDPHE cadmium and aluminum standards verses recently finalized EPA recommended aquatic life standards.

SGC #6 General Comment #4: More defensible terrestrial TRVs should be used for some ECOPCs in the BERA. As noted in Section 6.8.3, a significant change in the effect-based TRVs for birds and mammals was made between the BPMD BERA Workplan (BERA Workplan) and the 2015 Draft of the Upper Animas River BERA (2015 Draft BERA) and the BERA/Attachment 1. The change was based on adopting the LANL Eco risk Database (ECO RISK v 3.3) as the source for TRVs. However, the 2018 BERA is not consistent with the Los Alamos National Laboratories (LANL) 2017 version (v4.4), which adopts lowest observed adverse effects level (LOAEL) values for development of preliminary remediation goals (PRGs), which are a good indicator of acceptable risk.

The revised set of LOAEL TRVs was taken from the 2016 version of the (LANL Ecorisk Database (ECO RISIK 3.3). The revised LOAEL TRVs are derived either via the application of an uncertainty factor equal to 10 times the no observed adverse effects level (NOAEL) TRV or as the paired LOAEL TRV from the study used as the basis for the NOAEL TRV from EPA's Ecological Soil Screening Level guidance[21]. The application of a generic uncertainty factor is an uncertain approach for deriving a LOAEL TRV. Likewise, use of TRVs from the study with the lowest values is highly conservative and is contrary to EPA Risk Characterization guidance (EPA, 2000). The highly conservative approach taken in the BERA is useful for identifying CO PCs that clearly pose no risk to wildlife receptors but has little utility in describing the potential for risk to receptor populations when the predicted exposure exceeds the highly conservative TRVs.

The true threshold for toxicity is species specific and likely lies at an exposure rate greater than the conservative NOAEL TRV. Thus, the selection of a single effect TRV without consideration of the available database of effects TRVs can result in an overestimation of risk. For example, the arbitrary change of the LOAEL TRV for lead from the value used in the 2015 Draft BERA to the lead TRV used in the BERA/Attachment 1 results in a large change in the conclusions. The 2015 Draft BERA states (highlighting added for emphasis):

> "Animas River above mainstem Cement Creek: A potential for minimal risk to wildlife receptors was identified for Zn /American dipper) and Pb (belted kingfisher). The American dipper was also used as a surrogate species to perform a conservative

[21] US Environmental Protection Agency (USEPA). 2000. Science Policy Council Handbook: Risk Characterization. EPA 100-B-00-002. Office of Science Policy, Office of Research and Development. (December).

assessment of risk to the southwestern willow flycatcher, a federally and state listed bird species. **The evidence did not suggest that this species was at substantial risk from foraging in the Animas River above mainstem Cement Creek between sampling location A60 and A68**" (emphasis added).

Attachment 1, which is a revision to the 2015 Draft BERA states:

> "Animas River above mainstem Cement Creek A potential for high-level risk to American dipper from Ph exposure was identified in this reach. The American dipper was used as a surrogate species to perform an assessment of risk to the southwestern willow flycatcher, a federally and state-listed bird species. Evaluation of the surrogate species suggests that the flycatcher may be at risk from foraging in the Animas River above mainstem Cement Creek between sampling location A60 and A68 (emphasis added). This conclusion was based on a single line of evidence (food chain exposure modeling) and conservative exposure and effects assumptions. Low-level Ph risks were also identified in the three other wildlife receptors; namely the belted kingfisher, mallard, and muskrat. Of these receptors, the kingfisher was determined to be most at risk in this reach with a CTE effect HQ of 4.2. Low-level Cu risks were also identified for American dipper with CTE HQs ranging from 1. 7 to 1.9."

Based on SGC's review of Attachment 1, no changes were made to the assessment of wildlife risks between the two versions of the assessment other than the decision to retroactively change the LOAEL TRV for lead following the completion of the BERA Work Plan, yet the conclusions between the documents are significantly different. The geometric mean LOAEL TRVs published in the BPMD BERA Work Plan for all CO PCs should be critically reviewed for their utility in predicting risks rather than providing single-study LOAEL TRVs without consideration of their ability to predict risks to the assessment endpoints in the BERA and Attachment 1.

> *Agency Response #70: EPA respectfully acknowledges the recommendation but will not revise wildlife TRVs currently used in the Upper Animas and Aquatic BERAs. The existing set of wildlife TRVs reflect EPA Region 8 current position on TRV selection methods and utilization for BPMD wildlife risk analyses. EPA recently revisited the wildlife TRV selection process when developing the terrestrial risk assessment work plan for the BPMD. Respective TRVs were selected in cooperation with U.S. Fish and Wildlife staff. As stated by the commenter, EPA revised the 2016 Upper Animas BERA draft using the revised set of wildlife TRVs. This was done to harmonize all wildlife risk assessment methods conducted for the BPMD. More information is provided in a new Aquatic BERA Section 9.8.1 uncertainty bullet that provides justification for the revision and specifically identifies uncertainties and biases associated with the use of the revised lead TRV.*

SGC #7 General Comment #5: The BERA and Attachment 1 recognize and discuss the uncertainties associated with the risk assessments. Two particularly concerning uncertainties are identified: (1) EUs represented by limited spatial data, and (2) limited temporal data to derive exposure estimates for a given location. The BERA indicates the following with respect to limited spatial data, "this scenario represents an unknown hut potentially significant uncertainty

especially in large heterogeneous EUs such as Cunningham Creek (EU-08) and South Fork Mineral Creek (EU-05)." Temporal limitations of the data are also important. The BERA states that "assessing risks based on small datasets reduces the level of confidence assessing risks and the amount of inference that can he applied to the affected EUs." Small pore water data sets were identified for a number of EUs and there are some EUs where surface water and sediment data are also limited. Fish tissue and benthic macroinvertebrate (BMI) data used for assessment of risks to aquatic receptors were limited throughout the EUs in both the BPMD BERA and Attachment 1. In many cases, central tendency exposure (CTE) and reasonable maximum exposure (RME) risks were assessed using either a single sample or via bioaccumulation model estimates.

Limited hardness data comprises another area of uncertainty. BERA Tables 8.1 and 8.2 show the hardness data used to derive the hardness-based criteria for some metals. For many of these EUs there are no data for the pre-runoff period, and very limited data during runoff. Since hardness is known to vary, more extensive hardness data are needed for an accurate derivation of criteria. Where these types of issues arise, the BERA should identify them as data gaps that are important to site decisions and require more investigation.

> *Agency Response #71: Regarding uncertainties associated with limited spatial and temporal data, EPA respectfully points out that multiple risk measurement endpoints were evaluated to assess aquatic receptor risks. Each of these endpoints has their own inherent strengths and weaknesses. Uncertainty sections text attempts to describe weaknesses and respective biases. If these uncertainties are too concerning for a given endpoint, EPA suggests that alternate, more robust endpoints be considered. EPA also notes that the Aquatic BERA was written as prescribed in the EPA (2016a) BERA Work Plan. All EUs and respective, representative sampling locations were defined in the BERA Work Plan. It is beyond the scope of the current Aquatic BERA to add or adjust EU reach boundaries beyond what was agreed upon and already conducted.*
>
> *Regarding lack of hardness data, EPA agrees that the Aquatic BERA should identify and discuss associated data gaps with limited hardness data. As such a new uncertainty bullet was added to the Aquatic BERA Section 9.8.1. Added uncertainties text identifies current data gaps, recommends approaches to reduce or mitigate uncertainty, and recommends that additional hardness data be collected for affected EUs when deemed necessary for future risk management decisions.*

SGC #8 General Comment #6: Section 2.3 of the BERA and Section 2.2.2 of Attachment 1 discuss the potential presence of the southwestern willow flycatcher in the riparian areas of the site(s) and use of the American dipper as a surrogate species for assessing risk to the flycatcher. The use of surrogate species that have more readily available exposure parameters available for risk assessment is common and generally appropriate in baseline risk assessments. Both birds are insectivorous and inhabit riparian areas, but the differences in habits, especially diet, limit the utility of the dipper as a surrogate. The American dipper feeds heavily on aquatic benthic macroinvertebrates within the stream and is assumed to be exposed to contaminants in incidentally ingested sediments, and sediment in the guts of invertebrates. By contrast, the

flycatcher feeds primarily on flying invertebrates, including those of both aquatic and terrestrial origin, and to a lesser extent, invertebrates found on vegetation and the ground. Because of its feeding behavior, the flycatcher's potential ingestion of sediment is likely to be negligible. Aerial feeding birds would rarely, if ever, directly contact sediment and the ingestion of flying invertebrates would virtually eliminate ingestion of sediments in the gut of prey.

This is an important consideration since lead exposure is the largest source of estimated risk to the American dipper and by extension the southwestern willow flycatcher in both the BERA and Attachment 1. As shown in Table 1 below, the exposure via the sediment ingestion pathway for the American dipper ranges between 27% and 99% of the total exposure with a geometric mean equal to 74% of the total exposure. This indicates that if the sediment ingestion by the flycatcher is negligible, exposure is heavily over-estimated.

In addition, review of the range and habitat requirements for the flycatcher suggest little chance that they would occur at the site. First, the study area is at the extreme northern edge of the southwestern willow flycatcher range, and the flycatcher has not been observed at the site or in the area. Durst et al. (2008)[22] indicated that the majority (>90%) of southwestern willow flycatcher breeding territories are at elevations from sea level to 1,600 meters (5,250 ft); with relatively few sites known above 2,000 meters (6,500 ft). The elevation at Silverton, CO is 2,840 meters (9,300 ft).

Given the unlikely presence of the flycatcher at the site, and the uncertainty about exposure due to low lead bioavailability (See General Comment 7) and low exposure to sediments, risk to the southwest willow flycatcher is likely grossly overestimated in the assessments presented in the BERA and in Attachment 1.

[22] Durst, S.L, M.K. Sogge, S.D. Stump, H.A. Walker, B. E. Kus, and S.J. Sferra. 2008. USGS Southwestern Willow Flycatcher Breeding Site and Territory Summary. 2007. Open- File Report 2008-1303.

Table 1 - Fraction of Total Exposure for the American Dipper Receptor Due to Ingestion of Sediment

EU	Total Exposure (mg/kg BW/day)	Sediment Ingestion Exposure (mg/kg BW/day)	Percentage of Total
EU-1	18.1	4.85	27%
EU-2	8.24	6.79	82%
EU-3	18.7	13.7	73%
EU-4	62.5	33.1	53%
EU-5	2.15	1.87	87%
EU-6	2.85	1.76	62%
EU-7	95.8	25.4	27%
EU-8	12.7	11.2	88%
EU-9	38	34.1	90%
EU-10	35.4	33.6	95%
EU-11	5.64	5.58	99%
EU-12	18.2	12.2	67%
EU-13	14.8	13.5	91%
EU-14	23.5	23	98%
EU-15	49.3	40.8	83%
Animas above Cement	43.1	37.7	87%
A73	17.3	15.8	91%
A75D	8.48	7.97	94%
Bakers Bridge	8.72	8.17	94%
		Geometric Mean	***74%***
		Minimum	***27%***
		Maximum	***99%***

<u>Agency Response #72</u>: EPA respectfully acknowledges the comment but has decided not to revise the Aquatic BERA in response to the comment. EPA recognizes that American dipper risks may be biased high with respect to those that might occur with the endangered southwestern willow flycatcher for stated reasons. The conservative nature of risk methods and results obtained using the American dipper are justifiable given the listing status of flycatcher. It is common practice to build a level of conservatism into risk assessments for threatened and endangered species; as prescribed in the BERA Work Plan and done in the current Aquatic BERA. EPA respectively points out that the SGC Animas River Mayflower Mill BERA also used the American dipper as a surrogate for flycatcher. Regardless, a new uncertainty bullet was added to the current Aquatic BERA

Uncertainty Analysis Section 9.8.2 to describe potential biases associated with using the American dipper as a surrogate to flycatcher.

SGC #9 General Comment #7: Both the BERA and Attachment 1 consider the direct incidental ingestion of metals in sediments as a complete and significant exposure pathway. As shown in General Comment 6, the incidental ingestion of sediments is in many cases the primary driver of the calculated total exposure for wildlife receptors. However, the BERA uses unnecessarily conservative estimates of metal bioavailability, especially for lead, leading to significant overestimates of exposure and risk.

It is widely accepted that the bioavailability of metals, especially lead, from ingested soils and sediments is considerably lower than 100 percent (See General Comment 7). For example, Ruby et al. (1999)[23] observed relative bioavailability of lead to rats in mine waste soils ranging from 9-41% and Drexler and Brattin (2007)[24] observed approximately 1% relative bioavailability of lead (as galena) in soils fed to swine. For birds, Beyer et al. (2016)[25] observed the relative bioavailability of lead from soils to birds at five mining and smelting sites in the US ranged from 33% to 66% of lead acetate as used in the derivation of the lead TRV. Beyer at al. (2016) recommends a 50% relative bioavailability from soils as a reasonable default value but notes that it could be much lower if less soluble forms, such as galena, are present in large percentages. The forms of lead most likely found in sediments within the study area are galena, the native mineralized form, and lead-sulfate and lead oxides that are formed from weathering of galena and other minerals. All of these forms have much lower potential lead bioavailability than was assumed in the BERA.

Despite the clear and readily available data regarding bioavailability, it is assumed in both the BERA and Attachment 1 that all metals detected in sediments are equal in bioavailability to the forms used in deriving the TRVs used in the assessment. While this approach is appropriate for selection of COPCs in a highly conservative screening assessment, it must be considered in a BERA when drawing conclusions of risk to wildlife receptors.

This significant uncertainty is neither discussed nor acknowledged in either the BERA or Attachment 1 despite exposure and risk estimations that are at times made up of > 90% of exposure from the incidental soil ingestion pathway.

The relative bioavailability of COPCs from sediments, particularly lead, should be considered in the BERA and Attachment 1 and adjusted accordingly. In addition, a detailed discussion of the effects of relative bioavailability from sediments should be included in the uncertainty section and considered in the risk conclusions.

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[23] Ruby M.V., R. Schoof, W. Brattin, M. Goldade, G. Post, M. Harnois, D.E. Mosby, S.W. Casteel, W. Berti, and M. Carpenter. 1999. Advances in evaluating the oral bioavailability of inorganics in soil for use in human health risk assessment. fnv Sci Tech 33:3697-3705.

[24] Drexler J.W., W.J. Brattin. 2007. An in vitro procedure for estimation of lead relative bioavailability: With validation. Hum Ecol Risk Assess 13:383-401.

[25] Beyer W. N., N. T. Basta, R. L. Chaney, P. F. P. Henry, D. E. Mosby, 8. A. Rattner, K. G. Scheckel, D. T. Sprague, and J. S. Weber. 2016. Bioaccessibility Tests Accurately Estimate Bioavailability of Lead to Quail. Env Tax And Chem 35: 2311-2319.

Agency Response #73: EPA respectfully acknowledges the comment but has decided not to revise the Aquatic BERA exposure estimates with respect to metals bioavailability. The current 100% bioavailability assumption is conservative and likely overestimates risks to wildlife receptors. However, the bioavailability of lead is not well known and uncharacterized for respective wildlife species and BPMD exposure media. Therefore, EPA has decided to take a conservative approach in estimating BPMD wildlife exposure risks to reduce the chance of overlooking any risks that could occur from exposure to BPMD contamination sources. Regardless, EPA added a bullet to the current wildlife uncertainty Section 9.8.2 which describes factors that could contribute to reduced bioavailability and biases associated with assuming 100% bioavailability.

SGC #10 General Comment #8: EPA's 2018 BERA, which includes the 2018 revision to the (2015) Upper Animas BERA (Attachment 1), should be integrated into a single, cohesive BERA. There is lack of continuity in the document due to the lack of integration of the earlier aquatic BERA. As it is currently presented, the BERA includes multiple redundancies between the BERA and Attachment 1, which makes for an excessively and unnecessarily long document. Integrating Attachment 1 into the main document would result in a much more cohesive BERA. Having the results of Attachment 1 compiled into the final tables of the main document would provide a clear risk characterization from the headwaters area to downstream waters that could more easily be understood.

Agency Response #74: EPA agrees that the Aquatic BERA would benefit from an integration of Upper Animas BERA results so that risk managers can efficiently evaluate risks for the entire BPMD study area. As such, the current Aquatic BERA summarizes Upper Animas BERA EU risks in summary tables and text. Although assessment methods are very similar between the two BERAs, there are slight differences that limit direct comparison of results. The newly added, Aquatic BERA Section 6.9 identifies these differences and actions taken to homogenize results between the two BERAs. Results from these actions are summarized in the Aquatic BERA risk characterization summary text and tables and in a newly added Attachment 3.

SGC #11 General Comment #9: Data from SGC's Mayflower reach BERA[26] must be included and considered.[27] SGC's BERA was conducted on a much finer spatial scale than EPA's assessment of the Animas River upstream of Cement Creek. Some results of the Mayflower BERA agree with EPA's characterization of the reach, but others do not. One specific example relates to sediment toxicity data. The Mayflower BERA found no sediment toxicity at any of the

[26] Draft Aquatic Biota Baseline Ecological Risk Assessment Mayflower Tailings Impoundments Area (Formation, Jan.
2018) (provided to EPA Jan. 16, 2018).

[27] As provided in EPA guidance, "[t]he interface among risk assessors, risk managers, and interested parties during planning at the beginning and communication of risk at the end of the risk assessment is critical to ensure that the results of the assessment can be used to support a management decision." The risk assessment process must "ensure that all key participants are appropriately involved." Interested parties "may provide important information to risk assessors," and 11[t]his knowledge should be considered when assessing available information
during problem formulation." US Environmental Protection Agency (USEPA). 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F. (April)

seven locations assessed in 2016 (biomass and survival) and only significant effects on survival at A56, which is at the upstream end of the reach. EPA's BERA examined sediment toxicity at A56 in 2012, 2014, and 2016 and found significant effects on survival and biomass; at A60 in 2014 and found significant effect only on biomass; and at A68 in 2012 and 2014 and found significant effects on survival and biomass in 2012, but only biomass in 2014. A discussion of these types of findings in the EPA's BERA may yield a conclusion that sediment toxicity in the Animas River is apparent and likely consistent upstream of the Mayflower impoundments and intermittent to low within the reach and downstream to the Cement Creek confluence. The BERA should discuss the differences in sampling methods and sampling locations and the related effects on the observed results. For example, EPA's sediment samples were collected along the stream margins whereas SGC's sediment samples were collected as integrated composites from across the stream width. Consideration and discussion of the risk characterization from SGC's BERA and from Attachment 1 for the same reach would provide a large amount of additional information that would be beneficial for future risk management decisions.

> *Agency Response #75: EPA respectfully acknowledges the request but has decided not to revise the Aquatic BERA to include information from the Mayflower BERA. The Mayflower BERA was not drafted according to an agency accepted work plan nor did it consider stakeholder or BTAG member involvement. EPA has reviewed and provided comments to SCG regarding the Mayflower BERA but has not seen a final draft at this time. Moreover, this addition is not needed because the current Upper Animas BERA assesses risks for the same Animas River reach evaluated in the Mayflower BERA.*

SGC #12 General Comment #10: EPA should reevaluate the need for a risk assessment. As recognized in EPA guidance, "[i]n some cases, a risk assessment may add little value to the decision process because management alternatives may be available that completely circumvent the need for risk assessment."[28] That is the situation here. Metals, whether sourced naturally or anthropogenically, are an understood source of risk to receptors within the BPMD. The solution to metals reduction and improving Animas River water quality is apparent. Operating the EPA Gladstone Water Treatment Plant at full capacity is practicable, cost-effective, and would result in demonstrable water quality improvement.[29] CERCLA prefers remedial actions involving treatment over those not involving treatment.[30] The National Contingency Plan contemplates treatment as the preferred option: "EPA expects to use treatment to address the principal threats posed by a site, whenever practicable."[31] No amount of study will change the efficacy, practicability, and cost-effectiveness of this solution, nor will further risk analysis change what is

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[28] US Environmental Protection Agency (USEPA). 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F. (April)

[29] See e.g. Pioneer Technical Services1 Inc., Technical and Engineering Considerations Summary Treatment Options for Mining-Influenced Water Upper Cement Creek, Bonita Peak Area (Feb. 2018); Pioneer Technical Services, Inc., Bonita Peak Mining District Superfund Site, CERCLA-08-2018-0005, Unilateral Administrative Order for Remedial Investigation (April 2018); SGC's Comments on EPA's Proposed Plan for Interim Remedial Actions (Plan) at the so called Bonita Peak Mining District (Aug. l5, 2018).

[30] 42 U.S.C. 9621(b)(1).

[31] 40 C.F.R. § 300.430(a)(1)(iii)(A).

already known. More than sufficient information exists to identify, evaluate, and implement a remedial action,[32] and further risk assessment is unnecessary and wasteful of resources.

> *Agency Response #76: EPA respectfully does not concur with the opinion that the current BPMD BERAs are not needed. EPA is following standard CERCLA, RI/FS guidance that specifies drafting risk assessments. It is the risk manager's responsibility to assess the efficacy of respective BERA methods and risk outcomes in directing subsequent remedial actions. No specific, identifiable action items are associated with this comment.*

SGC #13 Specific Comment #1: Page 24: "Toxicity testing generally agreed with [hazard quotient] HQ-based risk estimates and showed that sediment and surface water collected in the most metals-contaminated EUs corresponded with low amphipod and juvenile trout survival in laboratory test exposures."

Comment: This broad statement is contradicted by the information in Tables 9.4 and 9.5 and by statements later in the document. The BERA states on page 90 that "bulk sediment toxicity might be a poor predictor of amphipod toxicity since total metals concentrations do not reflect what would be bioavailable to amphipods and that sediment pore water may be a better predictor of metal bioavailability." Later, on page 93, the BERA states "Sediment toxicity test results did not provide a consistent risk characterization picture. For some EUs, HQs derived for sediments used in tests identified high BM/risks but test performance was on par with tests using less-contaminated sediments. Substantial variability was also observed in test performance for locations where multiple tests were conducted."

These statements, as well as the data presented in Tables 9.4 and 9.5, present a different picture for sediments that indicates cases where a lack of agreement between sediment toxicity test results and sediment chemistry using generic sediment TRVs to derive HQs occurs. When pH was low, toxicity tests always showed significant toxicity. However, there are many instances where toxicity data and sediment chemistry data do not agree. EU-08 sample A48 shows significant effects on survival and biomass, with the highest HQ being for lead at 2.67 and pH was 6.74. At the James Ranch EU-DR0l, significant effects were observed for both survival and biomass. pH was above neutral and again the highest HQ was for lead at 2.3. At EU-DR02 (Purple Cliffs) again significant effects on survival and biomass were observed, but the highest HQ was 0.37 for iron.

However, there are cases when both the sediment effect thresholds and pore water comparisons do not agree with the toxicity test results. For example, in EU-01 (M34), test results indicate only 9 percent survival and significant effects on biomass, but both sediment thresholds and pore water data suggest relatively low HQs. Thus, there is (no agreement between the field test results and corresponding comparisons of site data to TRVs.

For surface water, zinc concentrations exceed acute toxicity criteria for multiple locations, including EU-04, 10, 14 and 16. But surface waters in these EUs were not generally toxic to

[32] See There is More Than Sufficient Knowledge to Tackle Bonita Peak Today and Improve Water Quality in the Animas River (and supporting documentation) (Feb. 2018).

rainbow trout in acute toxicity tests. The discrepancy between the site-specific testing and comparison of ambient concentrations to generic benchmarks should be more fully vetted in the BERA.

The BERA should separate the statements about surface water and sediments to more clearly characterize what has occurred. Moreover, there needs to be a clear understanding of what is driving toxicity when it is clear that the metals being assessed may not be the drivers. In other words, the single test approach may not be adequate and additional testing may be warranted. SGC further suggests that the BERA assess the accuracy of the generic sediment effect thresholds and/or pore water thresholds to predict toxicity (e.g., type I and type II error rates). Given the number of toxicity tests performed for the BERA and Attachment 1, there are plenty of data to make this assessment. By doing so, such an assessment should help to quantify the uncertainty with using these benchmarks or sediments and may likely point toward using the sediment toxicity testing as the primary line of evidence since the toxicity testing is assessing cumulative effects of the metals mixture. The BERA may also consider the use of Probable Effects Concentrations (PEC)-quotients as another method to integrate the metal mixture data and assess its accuracy for predicting toxicity. Understanding if these benchmarks are adequate predictors of toxicity will become important in developing remedial decisions and clean up goals.

> *Agency Response #77: EPA respectfully acknowledges the comment and suggestions and has revised relevant text and uncertainties associated with sediment toxicity testing results. EPA has performed an in-depth analysis of both surface water and sediment toxicity test performance results with respect to overlying water, sediment pore water, and bulk sediment chemistry results. Other than low pH and exposure to metals at concentrations above respective toxicity benchmarks, no clear picture as to what was specifically driving toxicity was observed. It is likely that multiple factors are driving observed toxicity and that these factors are not the same for each EU evaluated. EPA suggests that the reviewer consult the original toxicity testing data reports for more insights on interpreting test results. EPA does not agree that thorough identification of risk drivers or toxicity thresholds should be included in the Aquatic BERA. These actions are best taken and documented in subsequent RI/FS reports on an as-needed basis for smaller geographical areas or on a site-by-site basis. As described in previous comment responses, risk endpoints are evaluated using information obtained from multiple independent measurement endpoints. All endpoints have their own, unique strengths, weakness, and biases that need to be considered during the risk management phase of the RI/FS process. Sediment and surface water toxicity tests provide just one measurement endpoint used to investigate risks to BMIs and fish, respectively.*

SGC #14 Specific Comment #2: Page 12: Use of terms “hardness-adjusted”, “hardness-dependent”, “hardness-based”, “hardness-normalized”, “hardness-sensitive.”

Comment: There are numerous terms related to hardness that are used throughout the BERA and its attachments. Based on SGC’s understanding of how the information was presented in the BERA, there appears to be three primary differences in how hardness was used for deriving

criteria and comparing ambient measured data to the criteria. For some comparisons of surface water and pore water, hardness-dependent criteria were derived based on the sample specific measured hardness values (i.e., hardness derived from calcium and magnesium measured in the same sample as the metals concentrations). This approach appears to have been used primarily for screening. For effects characterization, two specific hardness values came from the sample specific data including a reasonable minimum hardness and an average hardness, which appears to be equivalent to the term hardness-adjusted. For comparison to the trout-specific criteria for cadmium and zinc, hardness was normalized to 50 mg/L to derive the specific test endpoints for trout. Ambient hardness data were normalized to 50 mg/L using a chronic hardness multiplier. On page 16, the BERA states that " ....hydroperiod-specific hardness-normalized water ESVs for those metals. Whose toxicity vary depending on surface water hardness." Based on information presented elsewhere in the BERA, this implies that the hardness values were "normalized" to 50 mg/I hardness, but the data and graphics do not suggest that to be the case, except for the comparisons of the trout specific criteria to ambient concentrations of cadmium, lead, and zinc. collected for comparison. SGC suggests that the BERA be revised to use more consistent terminology regarding hardness criteria.

> *Agency Response #78: EPA addressed this comment by revising Aquatic BERA so that text associated with each of the three primary differences in which hardness is used are clear and consistent.*

SGC #15 Specific Comment #3: Page 12: "All of these data were obtained using EPA-approved sampling and analysis plans and quality assurance/project plans {SAP/QAPPs)."

Comment: SGC commented on this language in the 2016 Work Plan, noting that samples collected for chemistry and toxicity testing were focused on fine-grained sediments from depositional areas. Such sediments are rare in this portion of the Animas River due to the high energy flows resulting in large substrate dominance. In the July 2018 BTAG meeting, it was verified that sediments for chemistry and toxicity testing were collected from stream margins and depositional areas. Such an approach does not necessarily include instream sediments where BM ls dwell, but rather includes fringe environments that may not be inundated all year.

> *Agency Response #79: EPA respectfully acknowledges the comment but disagrees that aquatic receptors would not be exposed to fine-grained sediments. It is common practice and recommended that bed sediment sampling focus on obtaining samples of fine-grained surficial sediments from depositional areas (USGS, 1995; Ohio EPA, 2001). In acceptable quantities, fine-grained sediment provides important habitat in stream ecosystems (Apitz, 2011). Fine-grained sediment can also be a sink for metals. It is also reasonable to assume that subaerial sediments collected from near-shore areas would be available to wildlife receptors and under water, potentially exposing sediment dwelling invertebrates during high flows.*

SGC #16 Specific Comment #4: Page 20: "Many of the EUs evaluated in this BERA were represented by environmental chemistry data collected at a single monitoring location. While many of these locations were situated towards the downstream end of each EU, sampling results

may not reflect the EU as a whole and could fail to identify variability in risks associated with contamination hot spots within on EU." "The exposure estimates for surface water, pore water, sediment, and dietary items were derived from relatively small datasets for select EUs. Small EU-specific datasets were particularly pervasive in pore water exposure assessments. For EUs with small datasets (three to five data points), a UCL-based RME could not always be derived and maximum values were used instead. The RME and CTE exposure estimates were the same for the EU datasets that contained only one observation. Assessing risks based on limited datasets reduced the level of inference that can [be] applied to the affected EUs."

Comment: These two statements summarize the low spatial and temporal extent of sampling and the likely uncertainty associated with properly characterizing risk and suggest that, for some EUs, the BERA may not be sufficient for making decisions on remedial actions.

> *Agency Response #80: EPA acknowledges the comment, but no specific, identifiable action items are associated with this comment.*

SGC #17 Specific Comment #5: Page 20: "The risk characterization did not identify COPECs or assess aquatic community-level risks to BMIs and fish from exposure to aluminum, antimony, barium, beryllium, cobalt, iron, molybdenum, and vanadium in pore water for the two Durango EUs because pore water samples were not analyzed for TRM. Therefore, it is unknown if exposure to these metals posed any risks to the aquatic communities in these two EUs. However, other lines of evidence suggested that the pore water in the Durango EUs might not be significantly impacted by metals."

Comment: While total recoverable metals (TRM) metals were not analyzed, the dissolved metal concentrations could be assessed in a semi-quantitative evaluation since the dissolved fraction is a significant portion of the TRM. Alternatively, data from upgradient Animas River sites where both TRM and dissolved metals were assessed could be used to develop translator ratios as multipliers to estimate the TRM.

> *Agency Response #81: EPA respectfully acknowledges the recommendations but will not use dissolved metal (DM) concentrations to assess Durango EU pore water risks or model total recoverable metal (TRM) concentrations from DM results. First, the level of uncertainty associated with these approaches is so large that it negates any benefits of performing them. For example, the Durango Reach is far removed from the BPMD and is subject to a myriad of non BPMD-related chemical and physical impacts. Second, there are other risk endpoints that are used to characterize benthic risks for the Durango Reach. With addition of the partially incomplete pore water endpoint, these additional risk endpoints are sufficient in characterizing risk to benthic organisms for the Durango Reach.*

SGC #18 Specific Comment #6: Page 21: "All of the sediment toxicity tests lasted for 10 days, which was not long enough to represent the longer-term chronic exposures expected to be experienced by the BMIs in the field. Also, the two toxicity endpoints evaluated in the tests (i.e., survival and biomass) did not assess reproductive effects, which can be quite sensitive. However, for this BERA, the uncertainties associated with relatively short exposures and lack of

reproductive endpoints were considered to be small because significant toxicity responses were observed in all but eight of the field-collected sediment samples used in the toxicity tests."

Comment: It should be noted that the bulk of the data used to generate the sediment no-effect and effect thresholds are based on the 10-day H. azteca and chironomid tests. Such tests have traditionally been considered chronic. Thus, the same uncertainty applies to the use of those thresholds for comparing bulk sediment chemistry to sediment thresholds. We agree that more emphasis should be placed on the toxicity test data because it does integrate exposure and effects, regardless of the exposure duration.

> *Agency Response #82: EPA acknowledges the comment, but no specific, identifiable action items are associated with this comment.*

SGC #19 Specific Comment #7: Pages 32-33: Paragraph addressing SGC.

Comment: The paragraph addressing SGC contains numerous inaccuracies and misstatements. Standard Metals operated the Sunnyside Mine and Mayflower Mill prior to SGC's operation. The two companies, however, are entirely unrelated and there should be no suggestion that SGC is a corporate successor to Standard Metals. SGC has conducted extensive reclamation and remediation work at certain sites within the BPMD, and its reclamation and remediation work did not cease after years but continues to today. SGC has spent approximately $30 million on reclamation and remediation work, much of it on properties SGC never owned or operated. SGC did not install eleven bulkheads within the Sunnyside Mine. As part of the work under the Consent Decree, SGC constructed twelve bulkheads at various sites within the BPMD, including those at the American Tunnel and Terry Tunnel. Certain of these bulkheads served to isolate the Interior Workings of the Sunnyside Mine and contain any mine-impacted water.[33] In addition to the bulkheads, any mine-impacted water contained in the Interior Workings of the Sunnyside Mine was treated with several hundred tons of lime. Moreover, there is absolutely no basis for the statement, nor is the statement even understandable, that the bulkheads (whichever those may be) "may have increased elevation and pressure of water trapped in the connected mine workings." It is not specified which bulkheads are purportedly at issue, no basis is provided for the speculative assertion that any "elevation" or "pressure" was increased, and any ostensibly "connected" workings are not demonstrated. In fact, EPA has recognized that certain mines are not known to be connected to the Sunnyside Mine by workings, including the Gold King and Red & Bonita Mines. Please correct these inaccuracies and misstatements in the revised BERA.

> *Agency Response #83: Section 2.1 text was revised to correct identified inaccuracies identified in the comment. Text regarding bulkhead hydrology was deleted.*

SGC #20 Specific Comment #8: Page 36: "SECTION 3 PREVO/US BMPD RISK ASSESSMNETS"

Comment: Please correct the two typographical errors in this heading.

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[33] See The Engineered Concrete Bulkheads Installed by SGC (Feb. 2018) (attached as Appendix E-3 to SGC Statement of Position and Written Comments (April 11, 2018)).

Agency Response #84: Section heading typographical errors were corrected. Additionally, all headings were reviewed for spelling errors and corrected when found.

SGC #21 Specific Comment #9: Page 45: "After considering the above lines of evidence, EPA determined that the GKM **spill did alter** the Animas River aquatic communities from conditions that occurred prior to the spill" (emphasis added).

Comment: Based on SGC's review of Attachment 2, EPA's opinion appears to be that the Gold King Mine (GKM) spill did NOT alter the Animas River aquatic communities from conditions that occurred prior to the spill. This sentence should be so corrected in the revised BERA.

Agency Response #85: The identified sentence, now on page 51, was corrected to say that "the GKM release did not alter the Animas River aquatic communities".

SGC #22 Specific Comment #10: Page 72: "Most of the acute and chronic WQC/WQS ESVs were calculated according to ambient total water hardness." "Hardness was calculated using dissolved calcium and magnesium concentrations in each DM sample and the Standard Method 2340B equation:"

Comment: These conflicting statements need to be addressed. Total hardness should be used to derive hardness dependent criteria. SGC assumes that the term "dissolved" in this sentence means calcium and magnesium concentrations from filtered water samples. The convention for hardness based metals criteria is to use unfiltered calcium and magnesium to derive hardness via calculation.

Agency Response #86: All hardness values used in the Aquatic BERA were based on dissolved calcium and magnesium. This is in-line with the chemical-physical processes that calcium and magnesium ions interact with dissolved metal ions and aquatic receptors sites (i.e. fish gills). Text on page 72 was corrected to address conflicting statements.

SGC #23 Specific Comment #11: Page 74: "For example, the TRVs presented in the BERA work plan EPA (2016c) were based on the geometric means of all growth and reproductive endpoint LOAELs from all studies selected in metal specific EcoSSL reports. This methodology may generate low-effect TRVs that are not protective of all bird and mammal species for important bioaccumulative metals such as lead."

Comment: The LOAEL TRV for lead effects on birds was changed from 44.6 mg/kg BW/day in the BERA Workplan and in the 2015 Draft BERA to 3.28 mg/kg BW/day in the Review Draft BPMD BERA and Attachment 1, representing an over thirteen-fold change in the TRV. The 44.6 mg/kg BW/day TRV was cited as from a risk assessment completed by Tetra Tech and further clarified in Section 6.8.3 of the External Review Draft as representative of the geometric mean of the growth and reproduction TRVs from the EcoSSL database. The revised 3.28 mg/kg BW/day TRV is representative of the paired TRV from the single study result from which the screening-

level NOAEL TRV was derived (Edens and Garlich 1983[34]). This single study result was selected from 43 total study results from 28 referenced studies of effects to avian growth and/or reproduction that were critically reviewed and identified by EPA as being of sufficient quality for use in derivation of the EcoSSL TRV for lead.

Of the 43 study results, four LOAEL TRVs were equal to or less than the LOAEL TRVs identified in the BERA Work Plan and used in the Draft BERA. Of those four, three study results were from the same reference (Edens and Garlich 1983) and one was from a second study by Meluzzi et al. (1996)[35]. The Edens and Garlich study showed a statistically significant reduction in egg laying for chickens and Japanese quail when provided with the low oral doses of lead in the form of Lead(II) acetate. The Meluzzi et al. (1996) study observed a decrease in egg weight for chickens where Lead(II) oxide was added to their food.

The dose rates from these two studies (as calculated in the EcoSSL document) represent, by far, the lowest dose rates observed in the database as having an effect on bird reproduction due to lead exposure and represent the most conservative approach to assessing risk. The risk assessed is conservative for several reasons. First, the form of lead utilized in both tests is expected to be much more highly bioavailable to the birds compared to the lead forms found in the exposure media at the site. Second, using comparisons of egg laying rates in bird species specifically bred to increase egg laying rates to levels never encountered in wild bird species is highly uncertain.

Aside from the results from those two studies, the LOAEL TRVs for growth and reproductive endpoints are less than the geometric mean LOAEL TRV presented in the BERA Work Plan in 24 of 26 tests for growth and reproduction endpoints in the EcoSSL database. As noted in the LANL ECORISK database, it is likely that many TRV datasets in the EcoSSL database have such wide ranges of LOAEL TRVs due to varying degree of relative bioavailability among soluble lead salts used in laboratory testing compared to forms of metals to which wildlife are exposed in the ecosystem. Because of this variability in the TRVs, geometric mean approaches to TRVs are better estimators of potential effects than single studies. This is particularly true in the lead example presented here where aside from the two highly conservative studies used to derive the TRVs, lead LOAEL TRVs in 92% of all other tests are less than the geometric mean LOAEL TRV, published in the BERA Work Plan. In the case of lead and based on the review of the available data, the geometric mean LOAEL TRV would be a better and more useful predictor of potential effects to birds than the most conservative TRV available that was used in the revised assessments.

> *Agency Response #87: Please refer to Agency Response #70 for EPA's response to this comment.*

[34] Edens F. W. and J. D. Garlich. 1983. Lead-induced Egg Production Decrease in Leghorn and Japanese Quail Hens. Poult Sci 62(9): 1757-1763.

[35] Meluzzi, A., F. Simoncini, F. Sirri1 L. Vandi, and G. Giordani. 1996. Feeding Hens Diets Supplemented with Heavy Metals (Chromium, Nickel and Lead). Archiv Fuer Gefluege/kunde 60(3): 119-125.

SGC #24 Specific Comment #12: Attachment 1, Page 79: "Finally, the risk characterization does not quantify "incremental risk" by subtracting reference risk from site risk. Hence, the risks summarized in this section for each EU represent "total" risk."

BERA, Page 85: "A critical point to keep in mind is that the risks for each receptor group provided in this BERA represent "total risk" and not "incremental risk." Total risk includes any contribution from COPECs at an EU present at background concentrations, whereas incremental risk represents the total risk minus the background risk."

Comment: The BERA interchanges the terminology for background and reference site risks. SGC suggests the terms natural and anthropogenic background be used throughout, deleting the term reference sites.

> *Agency Response #88: EPA agrees and all "incremental risk" terminology has been removed from the current Aquatic BERA. A new Reference and Background Section 1.5 was also added to the current Aquatic BERA to clarify how reference EUs can be used to evaluate potential background conditions.*

SGC #25 Specific Comment #13: Page 96: "In order to display all trout thresholds on a single figure for each metal, metal concentrations and respective thresholds were normalized to a standard water hardness of 50 mg/L as described in Appendix 5.a Normalizing dissolved metals concentrations to a standard surface water hardness of 50 mg/Lin EPA (2018c); Attachment 1 of this BERA."

Comment: This statement and its related text on page 96 discusses the derivation of acute toxicity thresholds for trout species and normalizing the hardness to compare those thresholds to ambient concentrations. However, the information presented (Appendix 5a) of Attachment 1 relates to "normalizing" hardness based on chronic hardness multipliers derived from chronic criteria. Page 2191 of the BERA .pdf file shows the chronic hardness multiplier regressions again for chronic criteria. How are these chronic hardness multipliers appropriately applied to normalize data compared to acute trout thresholds?

> *Agency Response #89: The Aquatic BERA uses methodology described in Appendix 5.a (Normalizing dissolved metals concentrations to a standard surface water hardness of 50 mg/L) to normalize metal concentrations and acute toxicity thresholds for all trout species so that all trout thresholds could be plotted in the same figure for a given metal. As pointed out in the comment, Appendix 5.a provided methods for normalizing values to chronic criteria; specifically, CDPHE (2013) table value standards for cadmium, copper, and zinc. The Aquatic BERA uses the same Appendix 5.a methodology, but normalization is based on the acute toxicity thresholds for each trout species and metal obtained from the Upper Animas BERA Appendix 5, Table 1 (Parameters for species-specific metal toxicity equations). The Aquatic BERA Section 9.2.1 text was revised to provide additional details on how Appendix 5.a methodology and species-specific acute thresholds were used to make respective figures. This addition should clarify confusion on how metal concentrations and respective thresholds were normalized to a standard water hardness of 50 mg/L.*

SGC #26 Specific Comment #14: Page 112, 2d bullet: Uncertainty Analysis

"Hence, for six or more months the embryo-larval stages of trout are fully exposed to metals in pore water (note: the surface water benchmarks are derived from toxicity tests on hatched fish, not eggs). This BERA used the pore water HQs to assess the risk to the benthic invertebrate community. This particular assessment was not performed for the sac fry. However, the risk from pore water exposure to trout sac fry would have been identical to BM ls because both aquatic community-level receptor groups are evaluated using the same set of surface water screening benchmarks. Hence, the risk from pore water exposure to trout sac fry was indirectly evaluated and is known (see Tables 9.2 and 9.3)."

Comment: SGC agrees that the surface water quality criteria are intended to be protective of most species and life stages. These criteria are inherently conservative to achieve that goal. However, the uncertainty analysis suggests that pore water exposure point concentrations, surface water screening levels, and resulting HQs calculated for BMIs reflect a similar risk level to larval trout. The text suggests that pore water measured in the study represents the environment in which sac fry reside. This simply is not correct. Trout spawning nests (redds) are formed in surficial gravels, when present, and are constructed to have sufficient flow of surface water within the redd. They are constructed to have a specific range of water velocities at the head and tail out of the redd, and depth. Once hatched, sac fry inhabit the interstitial spaces of the surface gravels in the redds. The water in the surface gravels is primarily surface water, and flow rates are such that residence time of water in the gravels is short. This is a substantially different environment than the specific locations and sediment depths from which EPA sampled in-situ pore water. Pore water measurements in general, and certainly for the locations sampled in the BERA, are not likely to be representative of exposures to larval fish or BMIs. Many of the pore water measurements appear to have been obtained from sediment rich in highly mineralized materials such as mine waste or naturally mineralized rock. Pore water data collected for this BERA more likely represent tightly compacted materials and depths that do not represent the habitat where most BMI are found and certainly not where sac fry would be found.

> *Agency Response #90: EPA agrees with the comment and removed the identified uncertainty bullet from the current Aquatic BERA.*

SGC #27 Specific Comment #15: Page 113 through 114: Uncertainty for Wildlife Receptors

Comment: The information provided in the 1st and 5th bullets appears to be contradictory. In the 1st bullet, the availability of site-specific sediment to invertebrate and fish models 'greatly reduced this uncertainty' as related to estimating exposure via the food ingestion pathway where prey items were unavailable. The 5th bullet indicates that when prey bioaccumulation is considered uncertainties are increased due to expected large over-estimation of prey tissue concentrations, particularly where sediment concentrations are elevated. The 5th bullet is expected to be the more accurate description of uncertainty and should replace the contradictory information in the 1st bullet.

In the 2nd bullet, the characterization of the representativeness of using both a CTE and RME exposure scenario for a single sample is under-stated. It is unknown what the exposure

concentrations of tissue would be should adequate data have been collected from each exposure unit. The effect of using a single sample to represent exposure could be large and is certainly not minor as indicated in the bullet.

In the 3rd bullet, the discussion focuses on the use of area use factors equal to one and indicates that its use is not unrealistic due to the home range of the receptors. While that may be true for individual animals, the assessment endpoints discussed in Section 5 are based on the maintenance of receptor populations, which would likely encompass multiple EUs. This uncertainty should be discussed in the bullet.

In the 4th bullet, a discussion of metals bioavailability from ingested sediments should be included as discussed in General Comment 7.

> *Agency Response #91: The above Section 9.8.2 uncertainties bullet points were revised to make a clear distinction and reduce contradiction between topics. Additional details were also added to respective, identified uncertainties.*

SGC #28 Specific Comment #16: Page 116 - Summary and Conclusions

The BERA indicates that "Information presented in this risk assessment was intended to guide future risk management decisions when selecting and implementing cleanup actions."

Comment: The BERA identifies uncertainties associated with temporal and spatial sampling frequency that appear to be significant data gaps that could affect interpretation of risks and decision making. The BERA also identifies the "major uncertainty" related to not addressing background, which has resulted in an arbitrary and capricious BERA not in compliance with EPA guidance, and a BERA that results in a risk characterization that misrepresents actual risks and that fails to provide any meaningful guidance in evaluating remedial alternatives.

> *Agency Response #92: EPA acknowledges the comment, but no specific, identifiable action items are associated with this comment.*

SGC #29 Specific Comment #17: BERA Appendices - lack of supporting data

Comment: While the BERA includes summary tables, it does not provide the supporting data (2015 BMI study, toxicity testing data and reports, water quality data, sediment quality data, nor fishery data). The list of samples used for water quality is provided. The fishery data associated with the Gold King Mine (GKM) addendum is not available nor summarized. In some cases, that supporting data is necessary for the reader to examine concentrations, when and where they occurred, etc.

> *Agency Response #93: As described in the Aquatic BERA methods section, all analytical data are available upon request. The full Aquatic BERA with three complete attachments is a very large document. As such, the decision was made to not include all of the data or supporting survey and toxicity testing data reports. EPA notes that all of the cited data reports are either publicly available with web addresses provided with respective citations in Aquatic BERA References Section 11 or available upon request. Please also*

note, that the GKM Addendum is no longer included or referenced in the current Aquatic BERA.

SGC #30 Specific Comment #18: BPMD BERA Attachment 1

Comment: In Sections 5.4 through 5.7 of Attachment 1, the Upper Animas BERA, wildlife risks were characterized using the geometric mean of the NOAEL and LOAEL HQs for both the CTE and RME exposure scenarios. In Sections 9.3 through 9.7 of the BERA, wildlife risks were characterized using separate calculations of the NOAEL and LOAEL HQs for the CTE and RME exposure scenarios. Use of the geometric mean of the NOAEL and LOAEL HQs adds little to the risk characterization, particularly in cases such as lead where the TRV are from a single study and are similar values. The assessment in Attachment 1 should be modified to match the BERA by eliminating the reliance on the geometric mean HQs.

Agency Response #94: EPA respectfully notes that all individual LOAEL- and NOAEL-based risk analyses and respective HQs are provided in the Upper Animas BERA supporting Section 5 series tables. Geometric means are only mentioned in the Upper Animas BERA text for brevity and in Figure 5.13 plots.

SGC #31 Specific Comment #19: GKM Attachment 2

Comment: The statistical data comparisons (spatially, temporally) may not be appropriate and may result in skewed conclusions. Comparisons of a relatively few data points collected over several years at a site to those collected daily over a 2-month time frame heavily weights the post-spill data and produces statistical comparisons of highly variable pre-spill data to low variability post-spill data.

Agency Response #95: The BERA Addendum and supporting text was completely removed from the current Aquatic BERA. Therefore, this comment is no longer relevant.

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Attachment 3

Additional and Revised Upper Animas Baseline Ecological Risk Assessment (BERA) Analysis Tables to Support Assimilating Results with the Aquatic BERA Risk Characterization Summaries

Table A-1 Upper Animas Baseline Ecological Risk Assessment (BERA) Sediment-Based Central Tendency Exposure (CTE) Hazard Quotient (HQ) Risk Estimates for Iron (Fe).

Exposure Unit	Sampling Locations	Maximum [Fe][1] (mg/kg)	Average [Fe][2] (mg/kg)	COPEC?[3]	CTE HQ[4]
Cement Creek	CC48, CC49	143000	143000	Yes	3.58
Animas R. above Cement Cr. to Arrastra Cr.	A60, A61, A64, A65, A66, A68	45300	29075	Yes	0.73
Animas R. between Cement Cr. and Mineral Cr.	A69A, A70B	NA	NA	No	NA
Animas R. 300 ft. below Mineral Cr.	A71B	NA	NA	No	NA
Animas R. 3,500 feet below Mineral Cr.	A72	74600	55360	Yes	1.38
Animas R. at Elk Cr. confluence	A73, A73B	109000	60871	Yes	1.52
Animas R. at Cascade Cr. confluence	A75B, A75D	84500	42486	Yes	1.06
Animas R. at Bakers Bridge	Bakers Bridge	68400	46475	Yes	1.16

COPEC = Contaminant of Potential Ecological Concern

1 Maximum Fe concentrations in sediments from exposure unit sampling locations reported in Upper Animas BERA Appendix 2.1 through 2.5 tables

2 Average Fe concentrations in sediments from exposure unit sampling locations reported in Upper Animas BERA Appendix 2.1 through 2.5 tables

3 Fe considered a COPEC when the maximum concentration was greater than the no-effect sediment ecological screening value (20,000 mg/kg)

4 CTE HQ calculated by dividing the average concentration of Fe by the low-effect sediment ecological screening value (40,000 mg/kg)

Table A-2 Upper Animas Baseline Ecological Risk Assessment (BERA) Sediment-Based Central Tendency Exposure (CTE) Hazard Quotient (HQ) Risk Estimates for Manganese (Mn).

Exposure Unit	Sampling Locations	Maximum [Mn][1] (mg/kg)	Average [Mn][2] (mg/kg)	COPEC?[3]	CTE HQ[4]
Cement Creek	CC48, CC49	478	478	Yes	0.43
Animas R. above Cement Cr. to Arrastra Cr.	A60, A61, A64, A65, A66, A68	22300	10617	Yes	9.65
Animas R. between Cement Cr. and Mineral Cr.	A69A, A70B	NA	NA	No	NA
Animas R. 300 ft. below Mineral Cr.	A71B	NA	NA	No	NA
Animas R. 3,500 feet below Mineral Cr.	A72	3400	2100	Yes	1.91
Animas R. at Elk Cr. confluence	A73, A73B	7120	3827	Yes	3.48
Animas R. at Cascade Cr. confluence	A75B, A75D	6900	3660	Yes	3.33
Animas R. at Bakers Bridge	Bakers Bridge	13100	7425	Yes	6.75

COPEC = Contaminant of Potential Ecological Concern

1 Maximum Mn concentrations in sediments from exposure unit sampling locations reported in Upper Animas BERA Appendix 2.1 through 2.5 tables

2 Average Mn concentrations in sediments from exposure unit sampling locations reported in Upper Animas BERA Appendix 2.1 through 2.5 tables

3 Mn considered a COPEC when the maximum concentration was greater than the no-effect sediment ecological screening value (460 mg/kg)

4 CTE HQ calculated by dividing the average concentration of Mn by the low-effect sediment ecological screening value (1,100 mg/kg)

Table A-3 Upper Animas Baseline Ecological Risk Assessment (BERA) Revised Colorado Department of Public Health and Environment (CDPHE, 2017)[1] Benthic Macroinvertebrate (BMI) Multi-Metric Index (MMI) Scores.				
Exposure Unit	**Sampling Location**	**BMI Survey Date**	**Revised MMI Score**	**Reference Code**
Cement Creek				
	CC49	9/25/2014	6.3	2
Animas River above Cement Creek to Arrastra Creek confluence				
	A60	9/25/2014	50.5	2
	A60	9/23/2015	29.5	2
	A68	9/25/2014	33.0	2
	A68	9/23/2015	28.6	2
Animas River 3,500 feet below Mineral Creek confluence				
	A72	9/25/2014	19.7	2
	A72	9/23/2015	27.1	2
Animas River at Elk Creek confluence				
	A73	10/16/2014	37.9	3
	A73	10/15/2015	42.4	3
	A73	10/20/2016	43.0	3
Animas River at Cascade Creek confluence				
	A75D	10/16/2014	47.8	3
	A75D	10/15/2015	55.8	3
	A75D	10/19/2016	63.8	3
Animas River at Bakers Bridge				
	Bakers Bridge	9/26/2014	52.2	3
	Bakers Bridge	9/21/2015	61.4	3
	Bakers Bridge	9/27/2016	58.2	3

1 Colorado Department of Public Health and the Environment. 2017. Regulation No. 31 - The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31), effective 3/1/2017

2 MSI. 2016. Animas River 2015 Benthic Macroinvertebrate (BMI) Report Gold King Mine Release Monitoring. June, Updated using 2017 recalibrated MMI model

3 MSI. 2017. Animas River 2017 Benthic Macroinvertebrate Assessment. December, Updated using 2017 recalibrated MMI model

Table A-4 Upper Animas Baseline Ecological Risk Assessment (BERA) Revised Surface Water pH Central Tendency Exposure (CTE) Values for Each Exposure Unit and Hydrologic Period.

Exposure Unit	Sampling Locations	Pre-Runoff CTE	Runoff CTE	Post-Runoff CTE	Minimum[1] CTE	Relative Risk Category[2]
Cement Creek	CC48, CC49	3.56	4.63	3.54	3.54	high risk
Animas R. above Cement Cr. to Arrastra Cr.	A60, A61, A64, A65, A66, A68	6.87	7.31	6.93	6.87	acceptable risk
Animas R. between Cement Cr. and Mineral Cr.	A69A, A70B	--	--	5.72	5.72	low risk
Animas R. 300 ft. below Mineral Cr.	A71B	--	--	6.10	6.10	low risk
Animas R. 3,500 feet below Mineral Cr.	A72	5.23	6.63	6.34	5.23	moderate risk
Animas R. at Elk Cr. confluence	A73, A73B	--	7.23	6.83	6.83	acceptable risk
Animas R. at Cascade Cr. confluence	A75B, A75D	--	7.40	7.00	7.00	acceptable risk
Animas R. at Bakers Bridge	Bakers Bridge	--	7.63	7.35	7.35	acceptable risk

"--" = No pH measurements available for identified sampling locations and runoff periods

1 Minimum CTE among the three hydrologic periods for each exposure unit

2 Relative risk category corresponds to the minimum CTE pH value for each exposure unit; Risk categories defined according to the following classification definitions:

<u>Relative risk categorization definitions*:</u>

Acceptable risk = pH >6.5

Low risk = pH <6.5 but >5.5

Moderate risk =pH <5.5 but >4.4

High risk = pH <4.4

* Relative risk terminology was only used to qualitatively highlight differences in risk and should not be interpreted beyond this intended use.

Table A-5 Upper Animas Baseline Ecological Risk Assessment (BERA) Revised Surface Water Total Recoverable Aluminum (Al) Central Tendency Exposure (CTE) Hazard Quotients (HQs) for Each Exposure Units and Hydrologic Period															
Exposure Unit	**Al CTE Values (µg/L)**			**Low Hardness Values (mg/L)[1]**			**Al Hardness-Dep. Criteria (µg/L)[2]**			**Al Hardness-Dependent HQs[3]**			**Al Default Criteria HQs[4]**		
	Pre-Runoff	**Runoff**	**Post-Runoff**	**Pre-Runoff**	**Runoff**	**Post-Runoff**	**Pre-Runoff**	**Runoff**	**Post-Runoff**	**Pre-Runoff**	**Runoff**	**Post-Runoff**	**Pre-Runoff**	**Runoff**	**Post-Runoff**
Cement Creek	7318	2389	6360	334	91.0	343	2544	429	2644	2.88	5.57	2.41	84.1	27.5	73.1
Animas R. above Cement Cr. to Arrastra Cr.	305	480	138	148	63.9	112	835	264	573	0.37	1.82	0.24	3.51	5.52	1.59
Animas R. between Cement Cr. and Mineral Cr.	--	--	2490	--	--	295	--	--	2148	--	--	1.16	--	--	28.6
Animas R. 300 ft. below Mineral Cr.	--	--	2780	--	--	263	--	--	1836	--	--	1.51	--	--	32.0
Animas R. 3,500 feet below Mineral Cr.	3455	1359	1777	192	56.5	158	1193	223	910	2.90	6.09	1.95	39.7	15.6	20.4
Animas R. at Elk Cr. confluence	1620	909	1486	182	37.0	83.0	1109	125	378	1.46	7.26	3.93	18.6	10.4	17.1
Animas R. at Cascade Cr. confluence	1260	1345	929	133	57.8	85.0	722	230	391	1.75	5.84	2.38	14.5	15.5	10.7
Animas R. at Bakers Bridge	843	1022	316.5	--	60.2	--	--	244	--	--	4.19	--	9.69	11.7	3.64

Exposure Unit	**Min. pH Measurment[5]**	**Criteria Type[6]**	**Maximum CTE HQ[7]**	**Relative Risk Category[8]**
Cement Creek	3.24	Default	84.1	High risk
Animas R. above Cement Cr. to Arrastra Cr.	6.26	Default	5.52	Moderate risk
Animas R. between Cement Cr. and Mineral Cr.	5.54	Default	28.6	High risk
Animas R. 300 ft. below Mineral Cr.	6.10	Default	32.0	High risk
Animas R. 3,500 feet below Mineral Cr.	5.04	Default	39.7	High risk
Animas R. at Elk Cr. confluence	6.54	Default	18.6	High risk
Animas R. at Cascade Cr. confluence	6.89	Default	15.5	High risk
Animas R. at Bakers Bridge	7.20	Hard.-Dep.	4.19	Low risk

1 Low hardness values represent the average difference or lowest hardness value for each exposure unit and hydroperiod; see Aquatic BERA Section 8.2 text for details on how average difference hardness is derived.
2 Al hardness-dependent chronic water quality criteria calculated using the Colorado Department of Public Health and Environment (CDPHE, 2017c) equation (e^(1.3695[In(hardness)]-0.1158) and respective low hardness values.
3 Al hardness-dependent HQs calculated by dividing the Al CTE concentration for each exposure unit and runoff period by the respective hardness-dependent chronic water quality criteria
4 Al default criteria HQs calculated by dividing the Al CTE concentration for each exposure unit and runoff period by the default chronic water quality criteria for Al (87 µg/L)
5 Minimum pH measurement for each exposure unit
6 Criteria type corresponds to the CDPHE (2017) chronic criteria application procedure that states the hardness-dependent equation will apply when pH is above 7.0 and the default criteria (87 µg/L) will apply when pH is less than 7.0
7 Maximum HQ corresponds to the greatest CTE-based HQ value among the three hydroperiods for each exposure unit; HQs are dependent on which criteria type was applied according to footnote #6
8 Relative risk category corresponds to the maximum HQ value for each exposure unit; Risk categories defined according to the following classification definitions:

<u>Relative risk categorization definitions*:</u>
Acceptable risk = Maximum HQ <1.0
Low risk = Maximum HQ >1.0 but <5.0
Moderate risk = Maximum HQ >5.0 but <10.0
High risk = Maximum HQ >10.0
* Note that it is understood that risk does not increase in a linear fashion with increasing HQs. As such, relative risk terminology was only used to qualitatively highlight differences in risk and should not be interpreted beyond this intended

Table A-6 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for American Dipper Foraging in the Cement Creek Exposure Unit.

COPECs	CTE[1] Exposure Point		EDD[3]					CTE Scenario HQs			
			Diet		Sediment	Water	Total EDD[d]				
	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (mg/kg dw)[2]	$Dose_{invert}$ [a]	$Dose_{sed}$ [b]	$Dose_{water}$ [c]		No-Effect TRV	Low-Effect TRV	No-Effect HQ[4]	Low-Effect HQ[5]
Arsenic	40.6	0.003	8.33	1.81E+00	8.82E-01	4.76E-04	2.69E+00	2.24	22.4	**1.20**	0.12
Cadmium	0.60	0.005	0.37	8.08E-02	1.29E-02	7.21E-04	9.44E-02	1.47	14.7	0.06	0.01
Chromium	4.62	0.002	2.83	6.15E-01	1.00E-01	3.73E-04	7.16E-01	2.66	26.6	0.27	0.03
Copper	55.6	0.113	45.8	9.96E+00	1.21E+00	1.72E-02	1.12E+01	4.05	12.1	**2.76**	0.92
Lead	282	0.018	12.2	2.64E+00	6.13E+00	2.75E-03	8.77E+00	1.63	3.26	**5.38**	**2.69**
Mercury	0.06	--	0.20	4.43E-02	1.30E-03	--	4.56E-02	0.45	0.9	0.10	0.05
Nickel	2.85	0.011	0.75	1.63E-01	6.19E-02	1.66E-03	2.27E-01	6.71	67.1	0.03	<1.00
Selenium	0.75	0.001	0.75	1.62E-01	1.62E-02	1.26E-04	1.79E-01	0.29	0.579	0.62	0.31
Silver	2.00	0.001	0.36	7.82E-02	4.35E-02	7.96E-05	1.22E-01	2.02	20.2	0.06	0.01
Zinc	195	1.912	65.6	1.43E+01	4.24E+00	2.91E-01	1.88E+01	66.1	661	0.28	0.03

-- = values not available
COPECs - Chemicals of Potential Ecological Concern; all bioaccumulative metals
CTE - Central Tendency Exposure
EDD - Estimated Daily Dose
dw - Dry Weight
TRV = Toxicity Reference Values for avian receptors; From the Aquatic BERA, Table 6.8
1 The CTE values represents the mean concentration.
2 Invertebrate tissue concentrations were derived using Aquatic BERA sediment-to-benthic macroinvertebrate regression models and uptake factors (Table 6.3) and CTE sediment concentrations
3 Al EDD units in milligrams per kilogram of body weight per day
4 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
5 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

a $Dose_{invert} = IR_{invert} \text{ X } C_{invert} \text{ X AUF}$

b $Dose_{sed} = IR_{sediment} \text{ X } EPC_{sediment} \text{ X AUF}$

c $Dose_{water} = IR_{water} \text{ X } C_{water} \text{ X AUF}$

d Total EDD = $Dose_{invert} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.2173
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.152
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.02173

Table A-7 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for Mallard Foraging in the Cement Creek Exposure Unit.

COPECs	CTE[1] Exposure Point Concentrations		EDD[4]										CTE Scenario HQs			
			Diet							Sediment	Water	Total EDD[e]				
	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert Tissue Concentration (dw)[2]	DF_{Invert}	Plant BSAFs	Plant Concentration ($C_{plant, dw}$)[3]	DF_{plant}	$Dose_{invert}$ [a]	Dose $_{plant}$ [b]	Dose $_{sed}$ [c]	$Dose_{water}$ [d]		No-Effect TRV	Low-Effect TRV	No-Effect HQ[5]	Low-Effect HQ[6]
Arsenic	40.6	0.003	8.33	0.50	Equation	1.10	0.50	2.16E-01	2.86E-02	4.22E-02	1.75E-04	2.87E-01	2.24	22.4	0.13	0.01
Cadmium	0.60	0.005	0.37	0.50	Equation	0.47	0.50	9.65E-03	1.21E-02	6.19E-04	2.66E-04	2.27E-02	1.47	14.7	0.02	<1.00
Chromium	4.62	0.002	2.83	0.50	0.04	0.19	0.50	7.34E-02	4.92E-03	4.80E-03	1.38E-04	8.33E-02	2.66	26.6	0.03	<1.00
Copper	55.6	0.113	45.8	0.50	Equation	9.5	0.50	1.19E+00	2.47E-01	5.78E-02	6.34E-03	1.50E+00	4.05	12.1	0.37	0.12
Lead	282	0.018	12.2	0.50	Equation	6.3	0.50	3.16E-01	1.63E-01	2.93E-01	1.01E-03	7.73E-01	1.63	3.26	0.47	0.24
Mercury	0.06	--	0.20	0.50	Equation	0.08	0.50	5.29E-03	2.07E-03	6.24E-05	--	7.42E-03	0.45	0.9	0.02	0.01
Nickel	2.85	0.011	0.75	0.50	Equation	0.24	0.50	1.95E-02	6.14E-03	2.96E-03	6.13E-04	2.92E-02	6.71	67.1	<1.00	<1.00
Selenium	0.75	0.001	0.75	0.50	Equation	0.37	0.50	1.94E-02	9.55E-03	7.77E-04	4.65E-05	2.98E-02	0.29	0.579	0.10	0.05
Silver	2.00	0.001	0.36	0.50	0.014	0.03	0.50	9.34E-03	7.27E-04	2.08E-03	2.93E-05	1.22E-02	2.02	20.2	0.01	<1.00
Zinc	195	1.912	65.6	0.50	Equation	90	0.50	1.70E+00	2.34E+00	2.03E-01	1.07E-01	4.35E+00	66.1	661	0.07	0.01

-- = values not available
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
CTE - Central Tendency Exposure
DF - Dose Fraction
dw - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
TRV = Toxicity Reference Values for avian receptors; From the Aquatic BERA, Table 6.8
1 The CTE values represents the mean concentration.
2 Invertebrate tissue concentrations were derived using Aquatic BERA sediment-to-benthic macroinvertebrate regression models and uptake factors (Table 6.3) and CTE sediment concentrations
3 Plant tissue concentrations were derived using Aquatic BERA sediment-to-plant regression models and uptake factors (Table 6.5) and CTE sediment concentrations
4 Al EDD units in milligrams per kilogram of body weight per day
5 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
6 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

a $Dose_{invert} = IR_{diet}$ X C_{invert} X DF_{invert} X AUF
b $Dose_{plant} = IR_{diet}$ X C_{plant} X DF_{plant} X AUF
Where $C_{plant} = (EPC_{sediment}$ X plant BSAF) or the result of the BSAF regression equation
c $Dose_{sed} = IR_{sediment}$ X $EPC_{sediment}$ X AUF
d $Dose_{water} = IR_{water}$ X C_{water} X AUF
e Total EDD = $Dose_{invert}$ + $Dose_{plant}$+ $Dose_{sed}$+$Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Table A-8 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for Belted Kingfisher Foraging in the Cement Creek Exposure Unit.

COPECs	CTE[1] Exposure Point Concentration		EDD[3]						CTE Scenario HQs			
			Diet			Sediment	Water					
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)[2]	$Dose_{fish}$[a]	$Dose_{sediment}$[b]	$Dose_{water}$[c]	Total EDD[d]	No-Effect TRV	Low-Effect TRV	No-Effect HQ[4]	Low-Effect HQ[5]
Arsenic	40.6	0.003	0.126	5.12	4.45E-01	7.06E-02	3.48E-04	5.15E-01	2.24	22.4	0.23	0.02
Cadmium	0.60	0.005	Equation	0.38	3.29E-02	1.03E-03	5.27E-04	3.44E-02	1.47	14.7	0.02	<1.00
Chromium	4.62	0.002	0.038	0.18	1.53E-02	8.03E-03	2.73E-04	2.36E-02	2.66	26.6	0.01	<1.00
Copper	55.6	0.113	Equation	5.8	5.06E-01	9.66E-02	1.26E-02	6.15E-01	4.05	12.1	0.15	0.05
Lead	282	0.018	0.070	19.7	1.72E+00	4.90E-01	2.01E-03	2.21E+00	1.63	3.26	**1.35**	0.68
Mercury	0.06	--	3.25	0.195	1.69E-02	1.04E-04	--	1.70E-02	0.45	0.9	0.04	0.02
Nickel	2.85	0.011	1.00	2.85	2.48E-01	4.95E-03	1.22E-03	2.54E-01	6.71	67.1	0.04	<1.00
Selenium	0.75	0.001	Equation	2.108	1.83E-01	1.30E-03	9.21E-05	1.85E-01	0.29	0.579	0.64	0.32
Silver	2.00	0.001	1.00	2.00	1.74E-01	3.48E-03	5.82E-05	1.77E-01	2.02	20.2	0.09	0.01
Zinc	195	1.912	Equation	62.5	5.43E+00	3.39E-01	2.12E-01	5.98E+00	66.1	661	0.09	0.01

-- = values not available
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
CTE - Central Tendency Exposure
dw - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
TRV = Toxicity Reference Values for avian receptors; From the Aquatic BERA, Table 6.8
1 The CTE values represents the mean concentration.
2 Fish tissue concentrations were derived using Aquatic BERA sediment-to-fish regression models and uptake factors (Table 6.4) and CTE sediment concentrations
3 Al EDD units in milligrams per kilogram of body weight per day
4 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
5 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

a $Dose_{fish} = IR_{diet} \text{ X } C_{fish} \text{ X AUF}$

Where $C_{fish} = EPC_{sediment} \text{ X BSAF}$

b $Dose_{sediment} = IR_{sediment} \text{ X } EPC_{sediment} \text{ X AUF}$

c $Dose_{water} = IR_{water} \text{ X } C_{water} \text{ X AUF}$

d Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0869
IR_{water} (L/kg BW-day)	0.111
IR_{sed} (kg/kg BW-day, dw)	0.001738

Table A-9 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for Muskrat Foraging in the Cement Creek Exposure Unit.

COPECs	CTE[1] Exposure Point		EDD[3]						CTE Scenario HQs			
			Diet			Sediment	Water					
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant, dw}$)[2]	$Dose_{plant}$[a]	$Dose_{sed}$[b]	$Dose_{water}$[c]	Total EDD[d]	No-Effect TRV	Low-Effect TRV	No-Effect HQ[4]	Low-Effect HQ[5]
Arsenic	40.6	0.003	Equation	1.10	9.24E-02	3.41E-01	3.05E-04	4.33E-01	1.04	1.66	0.42	0.26
Cadmium	0.60	0.005	Equation	0.47	3.93E-02	4.99E-03	4.63E-04	4.47E-02	0.77	7.70	0.06	0.01
Chromium	4.62	0.002	0.04	0.19	1.59E-02	3.88E-02	2.39E-04	5.49E-02	2.40	24.0	0.02	<1.00
Copper	55.6	0.113	Equation	9.51	7.98E-01	4.66E-01	1.10E-02	1.28E+00	5.60	9.34	0.23	0.14
Lead	282	0.018	Equation	6.28	5.27E-01	2.37E+00	1.76E-03	2.89E+00	4.70	8.90	0.62	0.33
Mercury (inorganic)	0.06	--	Equation	0.08	6.71E-03	5.03E-04	--	7.21E-03	1.00	14.1	0.01	<1.00
Nickel	2.85	0.011	Equation	0.24	1.99E-02	2.39E-02	1.07E-03	4.48E-02	1.70	3.40	0.03	0.01
Selenium	0.75	0.001	Equation	0.37	3.09E-02	6.27E-03	8.09E-05	3.72E-02	0.14	0.21	0.27	0.17
Silver	2.00	0.001	0.014	0.03	2.35E-03	1.68E-02	5.11E-05	1.92E-02	6.02	60.2	<1.00	<1.00
Zinc	195	1.912	Equation	90.2	7.56E+00	1.64E+00	1.86E-01	9.39E+00	75.4	754	0.12	0.01

-- = values not available
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
dw - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
TRV = Toxicity Reference Values for mammalian receptors; From the Aquatic BERA, Table 6.9
1 The CTE values represents the mean concentration.
2 Plant tissue concentrations were derived using Aquatic BERA sediment-to-plant regression models and uptake factors (Table 6.5) and CTE sediment concentrations
3 Al EDD units in milligrams per kilogram of body weight per day
4 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
5 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

1 $Dose_{plant} = IR_{diet} \text{ X } C_{plant} \text{ X AUF}$
Where $C_{plant} = (EPC_{sediment} \text{ X BSAF})$ or the result of the BSAF regression equation
2 $Dose_{sed} = IR_{sediment} \text{ X } EPC_{sediment} \text{ X AUF}$
3 $Dose_{water} = IR_{water} \text{ X } C_{water} \text{ X AUF}$
4 Total EDD = $Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

Table A-10 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for Raccon Foraging in the Cement Creek Exposure Unit.

COPECs	CTE[1] Exposure Point Concentration		EDD[3]						CTE Scenario HQs			
			Diet			Sediment	Water	Total EDD[d]				
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)[2]	$Dose_{fish}$ [a]	$Dose_{sediment}$ [b]	$Dose_{water}$ [c]		No-Effect TRV	Low-Effect TRV	No-Effect HQ[4]	Low-Effect HQ[5]
Arsenic	40.6	0.003	0.126	5.12	1.84E-01	1.39E-01	2.60E-04	3.23E-01	1.04	1.66	0.31	0.19
Cadmium	0.60	0.005	Equation	0.38	1.36E-02	2.03E-03	3.94E-04	1.60E-02	0.77	7.70	0.02	<1.00
Chromium	4.62	0.002	0.038	0.18	6.32E-03	1.58E-02	2.04E-04	2.23E-02	2.40	24.0	0.01	<1.00
Copper	55.6	0.113	Equation	5.8	2.10E-01	1.90E-01	9.40E-03	4.09E-01	5.60	9.34	0.07	0.04
Lead	282	0.018	0.07	19.7	7.11E-01	9.63E-01	1.50E-03	1.67E+00	4.70	8.90	0.36	0.19
Mercury (inorganic)	0.06	--	3.25	0.195	7.02E-03	2.05E-04	--	7.22E-03	1.00	14.1	0.01	<1.00
Nickel	2.85	0.011	1.00	2.85	1.03E-01	9.73E-03	9.10E-04	1.13E-01	1.70	3.40	0.07	0.03
Selenium	0.75	0.001	Equation	2.108	7.59E-02	2.55E-03	6.90E-05	7.85E-02	0.14	0.21	0.56	0.37
Silver	2.00	0.001	1.00	2.00	7.20E-02	6.83E-03	4.35E-05	7.89E-02	6.02	60.2	0.01	<1.00
Zinc	195	1.912	Equation	62.5	2.25E+00	6.66E-01	1.59E-01	3.07E+00	75.4	754	0.04	<1.00

-- = values not available
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
CTE - Central Tendency Exposure
dw - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
TRV = Toxicity Reference Values for mammalian receptors; From the Aquatic BERA, Table 6.9
1 The CTE values represents the mean concentration.
2 Fish tissue concentrations were derived using Aquatic BERA sediment-to-fish regression models and uptake factors (Table 6.4) and CTE sediment concentrations
3 Al EDD units in milligrams per kilogram of body weight per day
4 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
5 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

a $Dose_{fish} = IR_{diet} \times C_{fish} \times AUF$

Where $C_{fish} = EPC_{sediment} \times BSAF$

b $Dose_{sediment} = IR_{sediment} \times EPC_{sediment} \times AUF$

c $Dose_{water} = IR_{water} \times C_{water} \times AUF$

d Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.036
IR_{water} (L/kg BW-day)	0.0831
IR_{sed} (kg/kg BW-day, dw)	0.003414

Table A-11 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for Raccoon Foraging in the Animas River above Cement Creek to Arrastra Creek. This exposure unit is represented by five sampling locations; A60, A61, A64, A65, A66, and A68.

COPECs	CTE[1] Exposure Point Concentration		EDD[3]						CTE Scenario HQs			
			Diet			Sediment	Water	Total EDD[d]				
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)[2]	$Dose_{fish}$ [a]	$Dose_{sediment}$ [b]	$Dose_{water}$ [c]		No-Effect TRV	Low-Effect TRV	No-Effect HQ[4]	Low-Effect HQ[5]
Arsenic	27.4	--	0.126	3.45	1.24E-01	9.35E-02	--	2.18E-01	1.04	1.66	0.21	0.13
Cadmium	11.1	0.0014	Equation	0.99	3.57E-02	3.79E-02	1.16E-04	7.37E-02	0.77	7.7	0.10	0.01
Chromium	4.70	--	0.038	0.18	6.43E-03	1.60E-02	--	2.25E-02	2.4	24	0.01	<1.00
Copper	339	0.0155	Equation	14.3	5.13E-01	1.16E+00	1.29E-03	1.67E+00	5.6	9.34	0.30	0.18
Lead	1508	0.0116	0.070	105.6	3.80E+00	5.15E+00	9.64E-04	8.95E+00	4.7	8.9	**1.90**	**1.01**
Mercury	0.07	--	3.25	0.228	8.19E-03	2.39E-04	--	8.43E-03	1.00	14.1	0.01	0.00
Nickel	8.20	--	1.00	8.20	2.95E-01	2.80E-02	--	3.23E-01	1.70	3.4	0.19	0.10
Selenium	1.50	--	Equation	3.457	1.24E-01	5.12E-03	--	1.30E-01	0.14	0.214	0.93	0.61
Silver	5.50	--	1.00	5.50	1.98E-01	1.88E-02	--	2.17E-01	6.02	60.2	0.04	<1.00
Zinc	3172	0.432	Equation	311.1	1.12E+01	1.08E+01	3.59E-02	2.21E+01	75.4	754	0.29	0.03

-- = values not available
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
dw - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
TRV = Toxicity Reference Values for mammalian receptors; From the Aquatic BERA, Table 6.9
1 The CTE values represents the mean concentration of measured values.
2 Fish tissue concentrations were derived using Aquatic BERA sediment-to-fish regression models and uptake factors (Table 6.4) and CTE sediment concentrations
3 EDD units in milligrams per kilogram of body weight per day
4 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
5 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

a $Dose_{fish} = IR_{diet} \times C_{fish} \times AUF$

Where $C_{fish} = EPC_{sediment} \times BSAF$

b $Dose_{sediment} = IR_{sediment} \times EPC_{sediment} \times AUF$

c $Dose_{water} = IR_{water} \times C_{water} \times AUF$

d Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.036
IR_{water} (L/kg BW-day)	0.0831
IR_{sed} (kg/kg BW-day, dw)	0.003414

Table A-12 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for Raccoon Foraging in the Animas River 3,500 feet below Mineral Creek. This exposure unit is represented by one sampling location; A72

COPECs	CTE[1] Exposure Point Concentration		EDD[3]						CTE Scenario HQs			
			Diet			Sediment	Water	Total EDD[d]				
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)[2]	$Dose_{fish}$[a]	$Dose_{sediment}$[b]	$Dose_{water}$[c]		No-Effect TRV	Low-Effect TRV	No-Effect HQ[4]	Low-Effect HQ[5]
Arsenic	33.4	0.005	0.126	4.21	1.52E-01	1.14E-01	4.16E-04	2.66E-01	1.04	1.66	0.26	0.16
Cadmium	2.10	0.0016	Equation	0.57	2.06E-02	7.17E-03	1.33E-04	2.79E-02	0.77	7.7	0.04	<1.00
Chromium	4.60	--	0.038	0.17	6.29E-03	1.57E-02	--	2.20E-02	2.4	24	0.01	<1.00
Copper	137	0.0274	Equation	9.1	3.28E-01	4.68E-01	2.28E-03	7.98E-01	5.6	9.34	0.14	0.09
Lead	478	0.0128	0.070	33.5	1.20E+00	1.63E+00	1.06E-03	2.84E+00	4.7	8.9	0.60	0.32
Mercury (inorganic)	0.06	--	3.25	0.195	7.02E-03	2.05E-04	--	7.22E-03	1.00	14.1	0.01	<1.00
Nickel	5.10	0.005	1.00	5.10	1.84E-01	1.74E-02	4.16E-04	2.01E-01	1.70	3.4	0.12	0.06
Selenium	1.50	--	Equation	3.457	1.24E-01	5.12E-03	--	1.30E-01	0.14	0.214	0.93	0.61
Silver	1.90	--	1.00	1.90	6.84E-02	6.49E-03	--	7.49E-02	6.02	60.2	0.01	<1.00
Zinc	651	0.600	Equation	125.0	4.50E+00	2.22E+00	4.99E-02	6.77E+00	75.4	754	0.09	0.01

-- = values not available
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
dw - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
TRV = Toxicity Reference Values for mammalian receptors; From the Aquatic BERA, Table 6.9
1 The CTE values represents the mean concentration of measured values.
2 Fish tissue concentrations were derived using Aquatic BERA sediment-to-fish regression models and uptake factors (Table 6.4) and CTE sediment concentrations
3 EDD units in milligrams per kilogram of body weight per day
4 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
5 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

a $Dose_{fish} = IR_{diet} \times C_{fish} \times AUF$

Where $C_{fish} = EPC_{sediment} \times BSAF$

b $Dose_{sediment} = IR_{sediment} \times EPC_{sediment} \times AUF$

c $Dose_{water} = IR_{water} \times C_{water} \times AUF$

d Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.036
IR_{water} (L/kg BW-day)	0.0831
IR_{sed} (kg/kg BW-day, dw)	0.003414

Table A-13 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for Raccoon Foraging in the Animas River at Elk Creek Confluence. This exposure unit is represented by one sampling location; A73

COPECs	CTE[1] Exposure Point Concentration		EDD[3]						CTE Scenario HQs			
			Diet			Sediment	Water	Total EDD[d]				
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)[2]	$Dose_{fish}$ [a]	$Dose_{sediment}$ [b]	$Dose_{water}$ [c]		No-Effect TRV	Low-Effect TRV	No-Effect HQ[4]	Low-Effect HQ[5]
Arsenic	27.9	--	0.126	3.52	1.27E-01	9.53E-02	--	2.22E-01	1.04	1.66	0.21	0.13
Cadmium	4.00	0.0015	Equation	0.71	2.55E-02	1.37E-02	1.25E-04	3.93E-02	0.77	7.70	0.05	0.01
Chromium	4.00	--	0.038	0.15	5.47E-03	1.37E-02	--	1.91E-02	2.40	24.0	0.01	<1.00
Copper	199	0.0178	Equation	10.9	3.94E-01	6.79E-01	1.48E-03	1.07E+00	5.60	9.34	0.19	0.12
Lead	513	0.0111	0.070	35.9	1.29E+00	1.75E+00	9.22E-04	3.05E+00	4.70	8.90	0.65	0.34
Mercury (inorganic)	0.04	--	3.25	0.130	4.68E-03	1.37E-04	--	4.82E-03	1.00	14.1	<1.00	<1.00
Nickel	6.40	0.0038	1.00	6.40	2.30E-01	2.18E-02	3.16E-04	2.53E-01	1.70	3.40	0.15	0.07
Selenium	1.10	--	Equation	2.740	9.87E-02	3.76E-03	--	1.02E-01	0.14	0.21	0.73	0.48
Silver	1.90	--	1.00	1.90	6.84E-02	6.49E-03	--	7.49E-02	6.02	60.2	0.01	<1.00
Zinc	1049	0.521	Equation	164.6	5.92E+00	3.58E+00	4.33E-02	9.55E+00	75.4	754	0.13	0.01

-- = values not available
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
dw - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
TRV = Toxicity Reference Values for mammalian receptors; From the Aquatic BERA, Table 6.9
1 The CTE values represents the mean concentration of measured values.
2 Fish tissue concentrations were derived using Aquatic BERA sediment-to-fish regression models and uptake factors (Table 6.4) and CTE sediment concentrations
3 EDD units in milligrams per kilogram of body weight per day
4 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
5 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

a $Dose_{fish} = IR_{diet} \text{ X } C_{fish} \text{ X AUF}$

Where $C_{fish} = EPC_{sediment} \text{ X BSAF}$

b $Dose_{sediment} = IR_{sediment} \text{ X } EPC_{sediment} \text{ X AUF}$

c $Dose_{water} = IR_{water} \text{ X } C_{water} \text{ X AUF}$

d Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.036
IR_{water} (L/kg BW-day)	0.0831
IR_{sed} (kg/kg BW-day, dw)	0.003414

Table A-14 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for Raccoon Foraging in the Animas River at Elk Creek Confluence. This exposure unit is represented by one sampling location; A73B

COPECs	CTE[1] Exposure Point Concentration		EDD[3]						CTE Scenario HQs			
			Diet			Sediment	Water	Total EDD[d]				
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)[2]	$Dose_{fish}$[a]	$Dose_{sediment}$[b]	$Dose_{water}$[c]		No-Effect TRV	Low-Effect TRV	No-Effect HQ[4]	Low-Effect HQ[5]
Arsenic	29.9	--	0.126	3.77	1.36E-01	1.02E-01	--	2.38E-01	1.04	1.66	0.23	0.14
Cadmium	3.50	0.0010	Equation	0.68	2.44E-02	1.19E-02	8.31E-05	3.64E-02	0.77	7.70	0.05	<1.00
Chromium	4.50	0.0058	0.038	0.17	6.16E-03	1.54E-02	4.82E-04	2.20E-02	2.40	24.0	0.01	<1.00
Copper	177	0.0094	Equation	10.3	3.72E-01	6.04E-01	7.81E-04	9.77E-01	5.60	9.34	0.17	0.10
Lead	534	0.0055	0.070	37.4	1.35E+00	1.82E+00	4.57E-04	3.17E+00	4.70	8.90	0.67	0.36
Mercury (inorganic)	0.07	--	3.25	0.228	8.19E-03	2.39E-04	--	8.43E-03	1.00	14.1	0.01	<1.00
Nickel	10.0	0.0029	1.00	10.00	3.60E-01	3.41E-02	2.41E-04	3.94E-01	1.70	3.40	0.23	0.12
Selenium	2.90	--	Equation	5.965	2.15E-01	9.90E-03	--	2.25E-01	0.14	0.21	1.60	**1.05**
Silver	2.00	--	1.00	2.00	7.20E-02	6.83E-03	--	7.88E-02	6.02	60.2	0.01	<1.00
Zinc	1114	0.265	Equation	170.4	6.13E+00	3.80E+00	2.20E-02	9.96E+00	75.4	754	0.13	0.01

-- = values not available
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
dw - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
TRV = Toxicity Reference Values for mammalian receptors; From the Aquatic BERA, Table 6.9
1 The CTE values represents the mean concentration of measured values.
2 Fish tissue concentrations were derived using Aquatic BERA sediment-to-fish regression models and uptake factors (Table 6.4) and CTE sediment concentrations
3 EDD units in milligrams per kilogram of body weight per day
4 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
5 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

a $Dose_{fish} = IR_{diet} \times C_{fish} \times AUF$

Where $C_{fish} = EPC_{sediment} \times BSAF$

b $Dose_{sediment} = IR_{sediment} \times EPC_{sediment} \times AUF$

c $Dose_{water} = IR_{water} \times C_{water} \times AUF$

d Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.036
IR_{water} (L/kg BW-day)	0.0831
IR_{sed} (kg/kg BW-day, dw)	0.003414

Table A-15 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for Raccoon Foraging in the Animas River at Cascade Creek Confluence. This exposure unit is represented by one sampling location; A75D

COPECs	CTE[1] Exposure Point Concentration		EDD[3]						CTE Scenario HQs			
			Diet			Sediment	Water					
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)[2]	$Dose_{fish}$[a]	$Dose_{sediment}$[b]	$Dose_{water}$[c]	Total EDD[d]	No-Effect TRV	Low-Effect TRV	No-Effect HQ[4]	Low-Effect HQ[5]
Arsenic	19.4	--	0.126	2.44	8.80E-02	6.62E-02	--	1.54E-01	1.04	1.66	0.15	0.09
Cadmium	4.80	0.0010	Equation	0.75	2.71E-02	1.64E-02	8.31E-05	4.36E-02	0.77	7.70	0.06	0.01
Chromium	4.20	--	0.038	0.16	5.75E-03	1.43E-02	--	2.01E-02	2.40	24.0	0.01	<1.00
Copper	147	0.0138	Equation	9.4	3.39E-01	5.02E-01	1.15E-03	8.42E-01	5.60	9.34	0.15	0.09
Lead	300	0.0112	0.070	21.0	7.56E-01	1.02E+00	9.31E-04	1.78E+00	4.70	8.90	0.38	0.20
Mercury (inorganic)	0.04	--	3.25	0.130	4.68E-03	1.37E-04	--	4.82E-03	1.00	14.1	<1.00	<1.00
Nickel	9.40	--	1.00	9.40	3.38E-01	3.21E-02	--	3.70E-01	1.70	3.40	0.22	0.11
Selenium	1.20	--	Equation	2.920	1.05E-01	4.10E-03	--	1.09E-01	0.14	0.21	0.78	0.51
Silver	1.10	--	1.00	1.10	3.96E-02	3.76E-03	--	4.34E-02	6.02	60.2	0.01	<1.00
Zinc	1738	0.361	Equation	220.1	7.92E+00	5.93E+00	3.00E-02	1.39E+01	75.4	754	0.18	0.02

-- = values not available
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
dw - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
TRV = Toxicity Reference Values for mammalian receptors; From the Aquatic BERA, Table 6.9
1 The CTE values represents the mean concentration of measured values.
2 Fish tissue concentrations were derived using Aquatic BERA sediment-to-fish regression models and uptake factors (Table 6.4) and CTE sediment concentrations
3 EDD units in milligrams per kilogram of body weight per day
4 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
5 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

a $Dose_{fish} = IR_{diet} \text{ X } C_{fish} \text{ X AUF}$

Where $C_{fish} = EPC_{sediment} \text{ X BSAF}$

b $Dose_{sediment} = IR_{sediment} \text{ X } EPC_{sediment} \text{ X AUF}$

c $Dose_{water} = IR_{water} \text{ X } C_{water} \text{ X AUF}$

d Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.036
IR_{water} (L/kg BW-day)	0.0831
IR_{sed} (kg/kg BW-day, dw)	0.003414

Table A-16 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for Raccoon Foraging in the Animas River at Cascade Creek Confluence. This exposure unit is represented by one sampling location; A75B

COPECs	CTE[1] Exposure Point Concentration		EDD[3]						CTE Scenario HQs			
			Diet			Sediment	Water					
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)[2]	$Dose_{fish}$[a]	$Dose_{sediment}$[b]	$Dose_{water}$[c]	Total EDD[d]	No-Effect TRV	Low-Effect TRV	No-Effect HQ[4]	Low-Effect HQ[5]
Arsenic	19.9	--	0.126	2.51	9.03E-02	6.79E-02	--	1.58E-01	1.04	1.66	0.15	0.10
Cadmium	5.00	0.0009	Equation	0.76	2.74E-02	1.71E-02	7.48E-05	4.46E-02	0.77	7.70	0.06	0.01
Chromium	5.20	--	0.038	0.20	7.11E-03	1.78E-02	--	2.49E-02	2.40	24.0	0.01	<1.00
Copper	188	0.0122	Equation	10.6	3.83E-01	6.42E-01	1.01E-03	1.03E+00	5.60	9.34	0.18	0.11
Lead	296	0.0121	0.070	20.7	7.46E-01	1.01E+00	1.01E-03	1.76E+00	4.70	8.90	0.37	0.20
Mercury (inorganic)	0.07	--	3.25	0.228	8.19E-03	2.39E-04	--	8.43E-03	1.00	14.1	0.01	<1.00
Nickel	9.70	--	1.00	9.70	3.49E-01	3.31E-02	--	3.82E-01	1.70	3.40	0.22	0.11
Selenium	1.90	--	Equation	4.174	1.50E-01	6.49E-03	--	1.57E-01	0.14	0.21	**1.12**	0.73
Silver	1.40	--	1.00	1.40	5.04E-02	4.78E-03	--	5.52E-02	6.02	60.2	0.01	<1.00
Zinc	2190	0.302	Equation	251.4	9.05E+00	7.48E+00	2.51E-02	1.66E+01	75.4	754	0.22	0.02

-- = values not available
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
dw - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
TRV = Toxicity Reference Values for mammalian receptors; From the Aquatic BERA, Table 6.9
1 The CTE values represents the mean concentration of measured values.
2 Fish tissue concentrations were derived using Aquatic BERA sediment-to-fish regression models and uptake factors (Table 6.4) and CTE sediment concentrations
3 EDD units in milligrams per kilogram of body weight per day
4 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
5 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

a $Dose_{fish} = IR_{diet} \times C_{fish} \times AUF$

Where $C_{fish} = EPC_{sediment} \times BSAF$

b $Dose_{sediment} = IR_{sediment} \times EPC_{sediment} \times AUF$

c $Dose_{water} = IR_{water} \times C_{water} \times AUF$

d Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
IR_{diet} (kg/kg BW-day, dw)	0.036
IR_{water} (L/kg BW-day)	0.0831
IR_{sed} (kg/kg BW-day, dw)	0.003414

Table A-17 Upper Animas Baseline Ecological Risk Assessment (BERA) Central Tendency Exposure- (CTE) Based Exposure Estimates and Hazard Quotients (HQs) for Raccoon Foraging in the Animas River at Bakers Bridge. This exposure unit is represented by one sampling location; Bakers Bridge

COPECs	CTE[1] Exposure Point Concentration		EDD[3]						CTE Scenario HQs			
			Diet			Sediment	Water	Total EDD[d]				
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentration ($C_{fish, dw}$)[2]	$Dose_{fish}$[a]	$Dose_{sediment}$[b]	$Dose_{water}$[c]		No-Effect TRV	Low-Effect TRV	No-Effect HQ[4]	Low-Effect HQ[5]
Arsenic	21.9	--	0.126	2.76	9.93E-02	7.48E-02	--	1.74E-01	1.04	1.66	0.17	0.10
Cadmium	10.1	0.0007	Equation	0.96	3.46E-02	3.45E-02	5.82E-05	6.91E-02	0.77	7.70	0.09	0.01
Chromium	5.40	--	0.038	0.21	7.39E-03	1.84E-02	--	2.58E-02	2.40	24.0	0.01	<1.00
Copper	191	0.0095	Equation	10.7	3.86E-01	6.52E-01	7.89E-04	1.04E+00	5.60	9.34	0.19	0.11
Lead	300	0.0078	0.070	21.0	7.56E-01	1.02E+00	6.48E-04	1.78E+00	4.70	8.90	0.38	0.20
Mercury (inorganic)	0.04	--	3.25	0.130	4.68E-03	1.37E-04	--	4.82E-03	1.00	14.1	<1.00	<1.00
Nickel	18.3	--	1.00	18.30	6.59E-01	6.25E-02	--	7.21E-01	1.70	3.40	0.42	0.21
Selenium	2.10	--	Equation	4.532	1.63E-01	7.17E-03	--	1.70E-01	0.14	0.21	**1.22**	0.80
Silver	1.30	--	1.00	1.30	4.68E-02	4.44E-03	--	5.12E-02	6.02	60.2	0.01	<1.00
Zinc	4620	0.216	Equation	386.4	1.39E+01	1.58E+01	1.79E-02	2.97E+01	75.4	754	0.39	0.04

-- = values not available
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
dw - Dry Weight
BSAF - Biota-Sediment Accumulation Factor or regression equation
TRV = Toxicity Reference Values for mammalian receptors; From the Aquatic BERA, Table 6.9
1 The CTE values represents the mean concentration of measured values.
2 Fish tissue concentrations were derived using Aquatic BERA sediment-to-fish regression models and uptake factors (Table 6.4) and CTE sediment concentrations
3 EDD units in milligrams per kilogram of body weight per day
4 No-effect HQ calculated by dividing the total EDD by the no-effect TRV; HQs above 1.0 in bold text
5 Low-effect HQ calculated by dividing the total EDD by the low-effect TRV; HQs above 1.0 in bold text

Equations

a $Dose_{fish} = IR_{diet} \text{ X } C_{fish} \text{ X AUF}$

Where $C_{fish} = EPC_{sediment} \text{ X BSAF}$

b $Dose_{sediment} = IR_{sediment} \text{ X } EPC_{sediment} \text{ X AUF}$

c $Dose_{water} = IR_{water} \text{ X } C_{water} \text{ X AUF}$

d Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.036
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.0831
$\mathbf{IR_{sed}}$ (kg/kg BW-day, dw)	0.003414