SEMS-RM DOCID # 100034911

RECORD OF DECISION

IRON KING MINE – HUMBOLDT SMELTER SUPERFUND SITE

DEWEY-HUMBOLDT, YAVAPAI COUNTY, ARIZONA
EPA ID: AZ0000309013

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 9
SUPERFUND AND EMERGENCY MANAGEMENT DIVISION
SAN FRANCISCO, CALIFORNIA

RECORD OF DECISION

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ACRONYMS AND ABBREVIATIONS

A&Ww	Aquatic and Wildlife (Warm Water)
AAC	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
ALM	Adult Lead Methodology
AOC	Area of Concern
APSI	Area of Potential Site Impact
ARAR	Applicable or Relevant and Appropriate Requirement
ARD	Acid Rock Drainage
ARS	Arizona Revised Statutes
BaPe	Benzo(a)pyrene Equivalents
BLM	Bureau of Land Management
BTV	Background Threshold Value
CCC	Criterion Continuous Concentration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R.	Code of Federal Regulations
COC	Chemical of Concern
COEC	Chemical of Ecological Concern
COI	Chemical of Interest
COPC	Chemical of Potential Concern
CrVI	Hexavalent Chromium
CSM	Conceptual Site Model
CWA	Clean Water Act
CY	Cubic Yard
ELCR	Excess Lifetime Cancer Risk
EPA	U.S. Environmental Protection Agency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESI	Expanded Site Investigation
FEMA	Federal Emergency Management Act
FS	Feasibility Study
FYR	Five-Year Review
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IEUBK	Integrated Exposure Uptake Biokinetic
LOAEL	Lowest Observed Adverse Effect Level
MCL	Maximum Contaminant Level
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
µg/dL	Micrograms per Deciliter
µg/L	Micrograms per Liter
NA	Not Applicable
NAI	North American Industries

NC	Not Calculated
NCP	National Oil and Hazardous Substances Contingency Plan
NHPA	National Historic Preservation Act
NPL	National Priorities List
NRWQC	National Recommended Water Quality Criteria
O&M	Operation and Maintenance
PA/SI	Preliminary Assessment/Site Inspection
RAFLU	Reasonably Anticipated Future Land Use
RAO	Remedial Action Objective
RBA	Relative Predicted Bioavailability
RCRA	Resource Conservation and Recovery Act
RDA	Recommended Dietary Allowance
RI	Remedial Investigation
ROD	Record of Decision
RSL	Regional Screening Level
SARA	Superfund Amendments and Reauthorization Act
SWDA	Solid Waste Disposal Act
TBC	To Be Considered
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxicity Equivalent
UCL	Upper Concentration Limit
U.S.C.	United States Code
UTL	Upper Threshold Level

PART 1: DECLARATION

1.0 SITE NAME AND LOCATION

Iron King Mine – Humboldt Smelter Superfund Site
Dewey-Humboldt, Yavapai County, Arizona
Superfund Identification Number AZ0000309013

2.0 STATEMENT OF BASIS AND PURPOSE

This decision document presents the U.S. Environmental Protection Agency's (EPA) selected remedy for the Iron King Mine – Humboldt Smelter Superfund site (the Site) in Yavapai County, Arizona, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) as set forth in 42 United States Code (U.S.C.) §§ 9601-9675 and, to the extent practicable, the National Oil and Hazardous Substances Contingency Plan (NCP), 40 Code of Federal Regulations (C.F.R.) Part 300. This decision is based on the Administrative Record file for the Site.

EPA is the lead agency for site activities. The Arizona Department of Environmental Quality (ADEQ) is the support agency. ADEQ provided input during the remedial investigation (RI) and feasibility study (FS) and the remedy selection process. The State of Arizona concurs with the selected remedy presented in this Record of Decision (ROD).

3.0 ASSESSMENT OF SITE

The response actions selected in this ROD are necessary to protect public health or welfare, or the environment from actual or threated releases of hazardous substances into the environment.

4.0 DESCRIPTION OF SELECTED REMEDY

The response actions selected in this ROD are intended to address threats to human health and the environment posed by site contamination and will be the final response actions for soils in residential areas, mine and smelter waste and contaminated soils in non-residential areas and surface water in the Agua Fria River and the Chaparral Gulch on and downstream of the smelter property. This ROD also selects an interim response action for groundwater at the Site. A final response action for groundwater, if necessary, will be selected after the response actions for soils, mine and smelter wastes, and surface water have been implemented and groundwater impacts have been re-evaluated.

The response actions selected in this ROD address the Site as follows:

Non-Residential Areas

The ROD addresses final response actions for the mine and smelter properties, mine wastes, contaminated drainages, tailings (wastes left over from ore concentrating operations in which economically valuable concentrated ore is separated from the remaining earthen materials in raw ore), dross, slag and waste rock, and contaminated soils in the areas not presently being used for residential purposes or for potential future residential development.

Residential Areas

Removal actions implemented between 2006 and 2017 addressed some residential areas with surface soil contamination. However, in this ROD, EPA is selecting cleanup levels for soil that are more conservative than the cleanup levels used in the previous removal actions. Therefore, the response actions selected in this ROD will address additional residential cleanup.

The ROD addresses final response actions for soil contamination within areas where the current use or reasonable anticipated future land use is residential. This includes existing residential areas as well as areas north and south of the mine tailings pile that may be used for residential purposes in the future.

Surface Water

The ROD addresses final response actions for surface water in the Agua Fria River and the Chaparral Gulch on and downstream of the smelter property.

Groundwater

The ROD addresses an interim response action for groundwater at the Site that will be protective of human health and the environment in the short term. Final groundwater remedial actions will be addressed in a later remedy selection, as necessary, after re-evaluation of groundwater following implementation of the response actions for soils, mine and smelter wastes, and surface water. The interim response action for groundwater will be consistent with the final action selected for the Site.

Selected Remedy

The major components of the selected remedy include:

- Reconfiguration of waste at the mine tailings pile on the former mine property as a waste repository.
- Construction of a second waste repository at the former smelter property.
- Excavation and removal of all waste and contaminated materials from areas at and surrounding the mine west of Highway 69 for disposal in the repository at the mine tailings pile.
- Excavation and removal of all waste and contaminated materials from east of Highway 69, including from the smelter and the Chaparral Gulch, for disposal in the repository at the former smelter property.

- Excavation and removal of soil exceeding cleanup levels from existing residential yards with disposal of the contaminated soil in one of the two on-site repositories.
- Treatment of dross at the smelter property prior to disposal in one of the two on-site repositories.
- Grading and capping of the repositories with permanent engineered covers.
- Localized capping or placement of soil covers in areas near the former mineworks area west of the mine tailings pile and in open land north and south of the mine tailings pile.
- Backfilling and regrading of excavated areas with imported clean fill and topsoil to promote vegetative growth and control erosion.
- Implementation of engineering controls (e.g., fencing) and institutional controls to restrict land and groundwater use.
- Long-term maintenance and monitoring of both on-site repositories, localized capped areas and other remedial components.
- Long-term groundwater monitoring.
- Surface water monitoring in the Agua Fria River.

The following institutional controls shall be implemented:

- Land use shall be restricted, physical controls applied, and excavation prohibited on the mine tailings pile repository, the smelter repository and the immediate areas around the repositories needed for their protection and maintenance.
- Zoning and/or land use restrictions shall be applied to prevent development of capped and covered areas, which could damage the caps. Development, construction, filling, grading, excavating, drilling, mining, or vehicle parking/transport shall be prohibited on, and in surrounding functional areas near, repository covers.
- Zoning and/or land use restrictions shall be applied to prevent exposures in open areas north and south of the mine tailings pile repository if waste or contaminated soil above cleanup levels is left in place.
- The installation of drinking water wells shall be prohibited at the mine tailings pile repository, at the former smelter property and near and below the Chaparral Gulch, where shallow groundwater contamination has been identified.
- Land use restrictions and physical controls shall be implemented on the remaining stabilized monolithic slag to prohibit construction and prevent persons from falling off the slag or into crevasses.
- In residential areas and areas for which the reasonably anticipated future land use (RAFLU) is residential, landowners with warning barriers installed on their parcel after cleanup will receive instructions from EPA on how to handle a warning barrier if exposed. Also, the town government will receive instructions and a map of all parcels with a warning barrier for land management.

The mine tailings pile, other mine and smelter wastes, and soil contaminated with high concentrations of chemicals of concern (COCs) are considered principal threat wastes at the Site. The selected remedy will address principal threat waste at the Site with removal and containment in two on-site repositories, thereby reducing the volume of principal threat waste and eliminating its mobility. In addition, dross waste at the smelter property will be excavated and treated before disposal in one of the two on-site repositories.

5.0 STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The selected remedy does not satisfy the statutory preference for treatment as a principal element of the remedy because the extraordinary volume of the wastes at the Site makes the implementation of treatment technologies impracticable. EPA therefore expects to use engineering controls instead of treatment for this waste (40 C.F.R. § 300.430(a)(1)(iii)(B)). Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that permit unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

6.0 DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for the Site.

1	COCs and their respective concentrations	Section 5.5.1
2	Baseline risk represented by the COCs	Sections 7.1 and 7.2
3	Cleanup levels established for the COCs and the basis for these levels	Section 8.1
4	How source materials constituting principal threats are addressed	Section 11.0
5	Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD	Section 6.0
6	Potential land and groundwater use that will be available at the Site as a result of the selected remedy	Section 12.4
7	Estimated capital, annual operation and maintenance (O&M) and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected	Section 12.3
8	Key factor(s) that led to selecting the remedy	Section 12.1

7.0 AUTHORIZING SIGNATURE

MICHAEL MONTGOMERY

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Date: 2023.10.20 14:28:24 -07'00'

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Michael Montgomery, Director
Superfund and Emergency Management Division
U.S. Environmental Protection Agency, Region 9

Date

PART 2: DECISION SUMMARY

1.0 SITE NAME, LOCATION, AND BRIEF DESCRIPTION

The Iron King Mine – Humboldt Smelter Superfund site (the Site) is in the town of Dewey-Humboldt (pop. 4,455) in Yavapai County, Arizona. It is situated on Arizona State Highway 69 about 80 miles north of Phoenix, Arizona, and 80 miles south of Flagstaff, Arizona (Figure 1). The town lies in a broad segment of the Agua Fria River valley southeast of the city of Prescott Valley and east of the city of Prescott. There is a legacy of mining and smelting in this area. The Site's Superfund identification number is AZ0000309013.

The Site encompasses locations with contamination from two historical industrial operations: the former Iron King Mine and the former Humboldt Smelter. The former Iron King Mine property is immediately west of Highway 69. The former Humboldt Smelter property is about a half-mile east of Highway 69. Historical operations at the facilities left behind millions of tons of mine and smelter wastes, including mine tailings, mixed alluvium and tailings, dross, smelter slag and contaminated soils. These wastes have contaminated soils and surface water drainages at and near the former mine and smelter properties and soils in residential areas of Dewey-Humboldt. Shallow groundwater is also affected below the primary waste areas. Figure 2 shows the major areas of concern at the Site.

Both the former mine and smelter properties are located on the Chaparral Gulch, a major drainage that passes into Dewey-Humboldt from the west. The Chaparral Gulch drains from tributaries in the mountains west of the Site and empties into the Agua Fria River on the east side of the Site. The gulch is ephemeral; the Agua Fria River flows all year.

The U.S. Environmental Protection Agency (EPA) is the lead agency for response under the Comprehensive Response, Compensation, and Liability Act (CERCLA), as amended. The Arizona Department of Environmental Quality (ADEQ) is the support agency. Site remediation will be conducted and funded by EPA.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 HISTORY OF SITE ACTIVITIES

The Iron King Mine and Humboldt Smelter were independent operations. Table 2-1 and Table 2-2-2 in the *Remedial Investigation Report, Iron King Mine – Humboldt Smelter Superfund Site, Dewey-Humboldt, Yavapai County, Arizona* (CH2M HILL, Inc., 2016) (RI) and the *Feasibility Study, Iron King Mine / Humboldt Smelter Superfund Site* (Tetra Tech, 2022) (FS) present a timeline of operations for the mine and smelter properties. A summary of the historical site activities for the mine and smelter, as well as the Chaparral Gulch, is below.

2.1.1 The Mine

Except for a period of shutdown from 1915 to 1922, the Iron King Mine was an active mine in the Big Bug Mining District from the late 1890s to 1968. Shattuck Denn Mining Corporation operated the mine from 1942 to 1968, during which time the mine reached its peak production. The Iron King Mine produced gold, silver, zinc, copper, and lead ores. It was one of the largest silver and zinc mines in Arizona.

The mine included miles of underground shafts extending to depths greater than 3,000 feet. During operation, waste rock overburden removed from the shafts was stockpiled on the western portion of the mine property. Ores were milled and concentrated in on-site processing facilities to produce ore concentrates and tailings. Tailings are the wastes left over from such operations in which economically valuable ores are separated from the remaining earthen materials in the mined ore.

Photo 1: The Iron King Mine, 1903-1905.

Tailings were discharged to a series of diked tailings ponds, which eventually joined together as the amount of tailings waste increased. The pond later dried, leaving what is now known as the mine tailings pile.[1] The pile contains 4.3 million cubic yards of mining tailings up to 100 feet high with high levels of arsenic and lead.

Photo 2: Aerial view of the Iron King Mine, 1955.

During operation, outfalls in the tailings ponds allowed the continuous transport of tailings from the mine into stormwater drainages and eventually into the Chaparral Gulch. In March 1964, a portion of the east face of the mine tailings pile collapsed, leading to a large release of tailings. These tailings flowed off the property and under Highway 69, into the Chaparral Gulch, eastward to the tailings floodplain, and eventually to the dam in the lower reach of the gulch.

In the late 1970s and early 1980s, a company acquired and sold tailings at the mine property as a fertilizer called Ironite. This continued until sales were halted due to high levels of arsenic in the product.

Currently, a fertilizer and soil supplement plant is located on the former mine property, adjacent to and north of the mine tailings pile. This plant is currently idle.

[1] The mine tailings pile was previously referred to as the main tailings pile, or MTP, in the RI and FS. This ROD refers to this feature as the mine tailings pile.

2.1.2 The Smelter

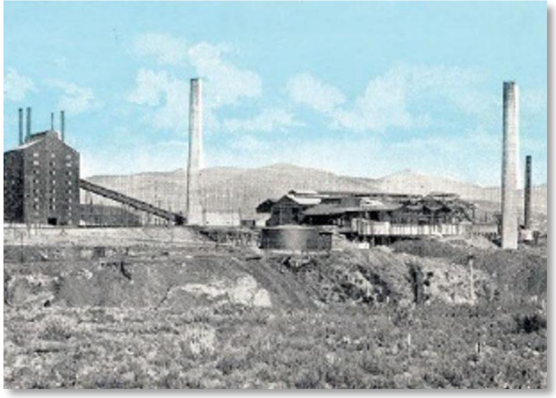


Photo 3: Humboldt Smelter, 1918.

Smelters melt ore concentrates and purify them to make pure metals for sale. As early as 1878, operations on the Humboldt Smelter property began at a small facility on the Agua Fria River at the southeast corner of the property. The Agua Fria Mill was located at the confluence of the Chaparral Gulch and the Agua Fria River. It stopped operating before 1900.

In the early 1900s after the end of the Agua Fria Mill's operations, successively larger smelting facilities operated at the property. From 1899 to 1903, the Val Verde Smelter smelted copper and lead at a larger facility on the hillside above the river, north of the Agua Fria Mill, that has come to be known as the smelter plateau. In 1906, a larger copper and lead smelter was built on the northern portion of the smelter plateau, and it was rebuilt and expanded until 1914. These larger facilities post-1906 are traditionally referred to as the Humboldt Smelter.

In addition to smelting, operations at the Humboldt Smelter included the grinding and concentrating of ores from local mines. This produced waste mine tailings that were disposed in a diked, bowl-shaped depression on the west portion of the smelter property. After 1923, production was sporadic, and the Humboldt Smelter closed around 1937.

Between 1942 and 1945, a private company reprocessed some existing tailings and imported new ores for processing. The operation created new tailings that were disposed in the depression. Sometime before 1940, the tailings dike holding back the tailings in the depression broke open, allowing tailings to flow into the tailings floodplain in the Chaparral Gulch.

In the late 1950s, zinc and aluminum dross, a waste material consisting mostly of flue dust and smelter skimmings, was imported from several die-casting plants for reprocessing. By 1962, a company started to process the dross in an attempt to recover metals but went out of business. Currently, many dross piles and an open field covered with dross remain on the surface of the former Humboldt Smelter main operations area on the smelter plateau.

All of the structures associated with the Agua Fria Mill and Val Verde smelter, almost all of the buildings associated with Humboldt Smelter, and the rail lines leading into and through the smelter were demolished and removed by 1937. ADEQ took down remaining structures – the smokestack and the attached brick converter flue located on the plateau – in 2022. A mostly-collapsed, small assay/laboratory building and a former fuel oil tank remain.

2.1.3 The Chaparral Gulch

Waste mine tailings from the mine washed into the Chaparral Gulch from the west and migrated down the gulch toward the smelter. Farther downstream, these tailings mixed with tailings from the blowout of the berm holding back tailings at the smelter. The mixed tailings flowed into a large floodplain. A 25-foot-high concrete dam currently holds back wet tailings at the downstream end of the floodplain. It is unknown who built the dam and when, or its original purpose. Some water drains through and under the dam downstream toward the Agua Fria River. Today, tailings mixed with alluvium carried from the mountains remain in the gulch.

2.2 History of Investigations and Cleanup Actions

Formal concerns related to the accumulated contamination at the former mine and smelter properties resulted from EPA and ADEQ involvement in the various air quality, stormwater, landfill operation and wastewater treatment permits held by facility operators. Complaints were documented and permit compliance violations reported. Table 3-1 in the RI includes a summary of the early regulatory history related to the various permits held at the facilities.

2.2.1 Preliminary Assessments

Starting in 2002, EPA, ADEQ and other parties conducted preliminary investigations at the former Iron King Mine and Humboldt Smelter properties to assess site conditions.

- 2002: ADEQ completed the Preliminary Assessment/Site Inspection (PA/SI) of the former Iron King Mine property.
- 2004: ADEQ completed the PA/SI of the former Humboldt Smelter property.
- 2005: EPA completed a Removal Assessment to assess a small number of residential properties along the Chaparral Gulch near the Iron King Mine property.
- 2006: ADEQ prepared an Expanded Site Investigation (ESI) of the former Iron King Mine and Humboldt Smelter properties at the request of EPA.
- 2008: A property owner (Ironite Products Company) conducted sampling at the Iron King Mine property under the ADEQ Voluntary Remediation Program.

Table 3-2 in the RI includes a summary of the findings from the preliminary assessments. Based on the findings of these investigations, EPA proposed the Site for listing on the Superfund program's National Priorities List (NPL) in March 2008 and formally listed the Site on the NPL in September 2008.

2.2.2 Removal Actions and Previous Residential Cleanup

EPA, ADEQ and other parties have performed various removal actions at the Site and affected residential areas, beginning in 2006.

- 2006/2007: Under EPA's oversight, a property owner/operator (Ironite Products Company) performed a removal action at seven residential and municipal properties near the former Iron King Mine property. It included removal of surface soil with concentrations of arsenic and lead exceeding site-specific action levels set by EPA. At that time, investigation of the Site had just begun and the distribution of contamination throughout the Site, residential extent of contamination, extensive soils background information, air, water and groundwater status, and many other elements that came to be investigated during the RI and FS phases were unknown. Cleanup levels used in the

2006/2007 removal action were preliminary and not based on the extensive knowledge of risk, site-specific bioavailability, toxicity and exposure values, background information, and related factors as they are known today.

- 2011: EPA applied a chemical tackifier to the dross at the smelter to prevent aerial dust dispersion.
- Also in 2011, EPA performed a surface soil removal action at 12 residential properties situated along the former rail line leading into the former smelter property. EPA also removed a small tailings pile in a non-residential area near the former mine. These tailings were disposed of on the mine tailings pile.
- 2017: EPA performed another surface soil removal action at 31 residential properties.
- 2019: EPA applied a cover material called "Posi-Shell" on top of the dross at the smelter plateau to prevent dross from blowing into the air. It was intended to be temporary pending a permanent response action. EPA also added more fencing and warning signage to the smelter property.
- 2020: EPA worked with the owner of the former mine property to upgrade and add fencing at the former mine property. In addition, EPA added 20 more warning signs at or near the former mine property. Signs were also added along the Chaparral Gulch and at the smelter property.
- 2022: ADEQ, in coordination with EPA, dismantled what remained of a partially-collapsed smelter smoke stack and converter flue building at the smelter property. ADEQ greatly expanded and reinforced the previous Posi-Shell cover over the waste dross that EPA had placed in its 2019 removal action. ADEQ also covered the debris remaining from dismantling the stack with gunite and added more fencing to the smelter property.

Photo 4: ADEQ dismantling the smelter smoke stack, 2022.

As noted above, three separate removal actions have taken place at residential properties.[2] Most of the yards included in the removal actions were within about a half-mile of the smelter property. Cleanup levels varied from 23 milligrams per kilogram (mg/kg) to 144 mg/kg for arsenic and from 400 mg/kg to 513 mg/kg for lead. While the cleanup levels themselves shifted over time, the net result was that all properties for which EPA received property access were cleaned up to levels of no more than 144 mg/kg arsenic and 400 mg/kg lead.

During the removal actions, soils were excavated to a maximum depth of 2 feet and replaced with clean soil well below background concentrations. If contamination above cleanup levels

[2] Figure 2 in the Technical Memorandum: Residential Response Action Supplement to Feasibility Study at the Iron King-Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona (Tetra Tech, 2023) shows the locations of the residential removal actions.

remained at the depth of excavation, a warning barrier was installed to advise persons excavating in the area in the future that contamination below the barrier was still present. Clean soil was then placed over these areas and yards were restored. Removed soils were placed on the mine tailings pile at the former mine property. EPA provided the town government with a map of all parcels with warning barriers in place for use in town permitting processes.

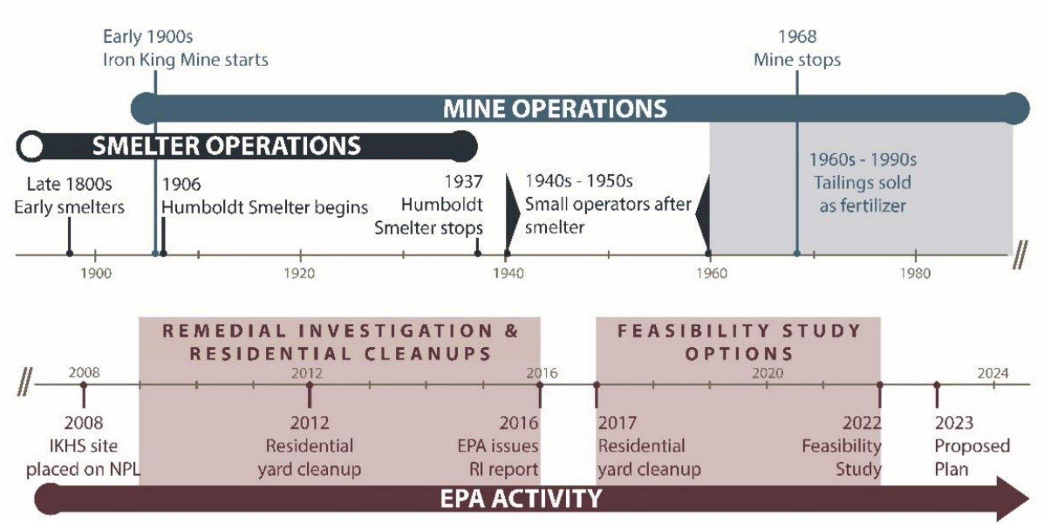
2.2.3 Remedial Investigation (RI)/Feasibility Study (FS)

EPA performed the RI in four phases, beginning in 2008. Overall, the RI spanned 16 non-residential (primarily waste) areas and 580 residential yards. The final RI Report was issued in 2016.

Between 2016 and 2021, EPA conducted the FS. Supplemental investigations were also conducted during the FS to include a supplemental groundwater study in 2018/2019, a supplemental Galena Gulch investigation in 2019 and a re-evaluation of the background concentration for arsenic in 2022. Further evaluation and revision to the background concentration for arsenic was performed in 2023, after issuance of the Proposed Plan, and is attached to this ROD as Appendix C.

EPA finalized the FS in September 2022. A supplemental FS that addressed potential cleanup of additional residential yards was completed in February 2023 (*Technical Memorandum: Residential Response Action Supplement to Feasibility Study at the Iron King-Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona* [Tetra Tech, 2023]).

Following the completion of the FS, EPA prepared a Proposed Plan, which identified the alternative that, based on the FS, best met the remedy selection requirements of 40 C.F.R. § 300.430(f)(1). EPA issued the Proposed Plan for public comment on March 15, 2023, and conducted a public meeting with the community on March 29, 2023. A public comment period was held from March 15, 2023, to May 13, 2023.



2.3 History of CERCLA Enforcement Activities

At the time the mining wastes were released, the former Iron King Mine was owned and operated by Shattuck Denn Mining Corporation, which was purchased and/or merged into several successor companies over time. The mine property is currently subdivided and owned by multiple parties. A portion of the mine tailings pile is currently owned by North American Industries, and another portion is owned by the State of Arizona's State Lands Department.

The former owners and operators of the Humboldt Smelter are out of business. The current owner of the smelter property is Greenfields Enterprises, LLC. There are more than 20 current landowners within the non-residential portions of the Site.

Following EPA's removal assessment in 2005, EPA and Ironite Products Company entered into an Administrative Settlement Agreement and Order on Consent, effective May 12, 2006. It required Ironite Products Company to excavate contaminated soil at four residential properties identified during the removal assessment. This occurred very early in the project before the RI identified the wider extent of contamination in residential areas.

EPA has issued letters to 19 parties indicating that EPA believes those parties are potentially responsible under CERCLA for the costs of cleaning up the Site. Among these 19 parties are several current and past owners of the mine property and the smelter property. EPA also has sent 84 requests for information under CERCLA Section 104(e) for the Site. Given the decades that have elapsed since operation of the Site as a mine and smelter, many potentially responsible parties appear to be defunct.

3.0 COMMUNITY PARTICIPATION

Since 2005, EPA and ADEQ have actively engaged with the community. In October 2009, EPA prepared a Community Involvement Plan to clarify how EPA will provide information to the community and to show how the community can be actively involved in the cleanup process. In 2009 and 2010, EPA worked with the community, site owners and other stakeholders to perform a reuse assessment for the former mine and smelter properties.

EPA has issued 24 fact sheets to the community during the course of the RI, FS and removal actions. EPA held or attended 21 meetings with local stakeholders; among these were its own public meetings, presentations to the Dewey-Humboldt Town Council with residents and community members in attendance, and presentations for other community groups. EPA also issued multiple press releases and the Site was addressed in several news articles.

In 2019 and 2020, EPA conducted an additional reuse assessment for the smelter property. A public workshop was held and invited community members to give input on the types of reuse in which they may be interested. The results of the assessment were presented to the community in a summary fact sheet in 2020. While EPA does not select, implement, or pay for property reuse after cleanup, it does consider the extent to which the remedial alternatives may be consistent with possible reuse options preferred by the community.

In 2021, EPA prepared a seven-part recorded presentation series about the Site, which can be viewed online. Hyperlinks to the presentations were made available in a fact sheet distributed to the community; the fact sheet was also made available on EPA's site profile page and in the Dewey-Humboldt town newsletter.

EPA made the Site's RI available to the public in September 2016 and the FS and Proposed Plan available to the public in March 2023. These and other site documents can be found in the Site's Administrative Record file, which is available online at www.epa.gov/superfund/ironkingmine. Hard copies are available at the Site information repositories:

- Dewey-Humboldt Town Library, located at 2735 S Corral Street in Humboldt, Arizona 86329.
- EPA Region 9 Records Center, located at 75 Hawthorne Street in San Francisco, California 94105.

EPA published a notice of the availability of the Proposed Plan and other site documents in the *Prescott Courier* and *Arizona Republic* on March 1, 2023. A public comment period for the Proposed Plan was held from March 15, 2023, to May 13, 2023. In addition, EPA held a public meeting on March 29, 2023, to present the Proposed Plan to the community.

EPA's responses to the comments received during the public comment period are included in the Responsiveness Summary, which is part of this ROD.

4.0 SCOPE AND ROLE OF THE RESPONSE ACTION

As with many mine and smelter sites, this Site poses a number of complex problems and technical challenges in dealing with large volumes of waste (tailings, mixed tailings and alluvium, dross, slag and waste rock) and contamination found in many different environments and locations. Conceptually, the Site can be broken down into residential areas (including areas that may be residential in the future), non-residential areas (including the mine and smelter properties and the Chaparral Gulch where most of the mine/smelter waste is located), surface water in the Agua Fria River and shallow groundwater beneath the primary waste areas on the former mine and smelter properties and the area between them.

The response actions selected in this ROD are intended to address threats to human health and the environment posed by site contamination and constitute the final response actions for soils in residential areas, mine and smelter waste and contaminated soils in non-residential areas and surface water in the Agua Fria River and the Chaparral Gulch on and downstream of the smelter property. This ROD also selects an interim response action for groundwater at the Site. A final response action for groundwater, if necessary, will be selected after the response actions for soils, mine and smelter wastes, and surface water have been implemented.

The response actions selected in this ROD address the Site as follows:

Non-Residential Areas

The ROD addresses final response actions for the mine and smelter properties, mine wastes, contaminated drainages, tailings, dross, slag and waste rock. This includes the non-residential and waste areas as seen on Figure 3. It also includes areas with contaminated soils north and south of the mine tailings pile for which 1) industrial use or 2) potential future residential land use are the reasonably anticipated future land uses (Figure 4). The response action addresses the threat posed by the Site to human health and the environment through the excavation and disposal of mine and smelter wastes in two sealed and permanently capped waste repositories. Soils with contaminant levels that exceed the cleanup criteria established by this ROD will also be excavated and contained within the repositories.

Residential Areas

Removal actions implemented between 2006 and 2017 addressed some residential areas with surface soil contamination. However, in this ROD, EPA is selecting cleanup levels for soil that are more conservative and protective than the cleanup levels used in the previous removal actions. Therefore, the response actions selected in this ROD will likely require additional residential cleanup.

The ROD addresses final response actions for soil contamination within areas where the current use or reasonable anticipated future land use is residential. This includes existing residential areas shown on Figure 3. It also includes areas north and south of the mine tailings pile that may be used for residential purposes in the future (Figure 4). Soil with contaminant levels that exceed the cleanup criteria established by this ROD will be addressed.

Surface Water

The ROD addresses final response actions for surface water in the Agua Fria River and the Chaparral Gulch on and downstream of the smelter property.

Groundwater

The ROD addresses an interim response action for groundwater at the Site that will be protective of human health and the environment in the short term. Final groundwater remedial actions will be addressed in a later remedy selection, as necessary, after re-evaluation of groundwater following the excavation and disposal of mine and smelter wastes and contaminated soils. The interim response action for groundwater will be consistent with the final action selected for the Site.

5.0 SITE CHARACTERISTICS

5.1 Conceptual Site Model

The conceptual site model (CSM) is a three-dimensional “picture” of site conditions that illustrates contaminant sources, release mechanisms, exposure pathways, migration routes and potential human and ecological receptors.

A CSM developed for the Site defined migration pathways of mine and smelter wastes from smelter and mine operations. During active operations at each property, release and transport of wastes out of the areas of primary mine and mill operations occurred. Releases of wastes resulted in Site contaminants affecting neighboring residential and municipal properties, as well as other areas surrounding the former mine and smelter properties. Figure 5 is the CSM plan view depiction of the primary contaminant transport mechanisms, such as historical operational discharges, surface water transport of sediment from erosion, stormwater discharges, impoundment failures, aerial dispersion and historical spills along rail lines. The resulting human and ecologic CSMs are presented in Figures 6 and 7.

5.2 Overview of the Site

The town of Dewey-Humboldt, the former Iron King Mine and Humboldt Smelter properties, Chaparral Gulch within the Site area, and the Agua Fria River sit within the Lonesome Valley in the high desert region of Yavapai County in central Arizona. Terrain west of the mine tailings pile at the former mine property rises rapidly into the Spud Mountain series. The town proper and old town lie mostly between Highway 69 and the Agua Fria River and north of the former mine and smelter properties. Residential parcels in these areas are concentrated and generally small. An agricultural area is north of the town proper and extends north to Highway 169. East of the Agua Fria River the terrain rises gradually toward the eastern foothills. Residential properties in this area are larger and more spread out.

The former Iron King Mine property lies on the west side of Highway 69 and occupies about 150 acres. A large portion of the property is covered with the mine tailings pile and multiple waste rock deposits. The former mine property is mostly bounded by two ephemeral surface water streams – the Chaparral Gulch to the north and the Galena Gulch to the south. A soil supplement plant is located on the former mine property but is currently idle. Several stormwater retention ponds are used to control surface water flow around the stockpiled tailings and the existing operations area.

Photo 5: Aerial view of the former mine property with the mine tailings pile.

The former Humboldt Smelter property lies about a half mile east of Highway 69 and occupies about 190 acres. No active facilities or businesses currently operate on the property. The former smelter property is bounded by the Agua Fria River (a rare perennial river in the region) to the east, the Chaparral Gulch to the south and residential areas of Dewey-Humboldt to the north and west.

The former smelter property is separated into three topographic features. On the west end of the property is a depression (otherwise known as a swale) that contains mine tailings (i.e., the smelter tailings depression).[3] These are separate from the Iron King Mine tailings and came from ore processing activities at the smelter property itself. The center of the property is a high plateau on which most of the smelting took place. The plateau has contaminated soils and a waste material called dross (a fine-grained, grey colored waste) imported by a metals reprocessing facility after the smelter closed. Also present is loose, pulverized slag, a waste that is essentially a hardened man-made lava which remains after molten metals of interest are removed and concentrated during smelting. The east end of the property is the Agua Fria River and a canyon. A large deposit of hardened smelter slag hangs from the plateau above the river. While molten, this slag was continually dumped over the side of the cliff while the smelter was in operation and hardened there.

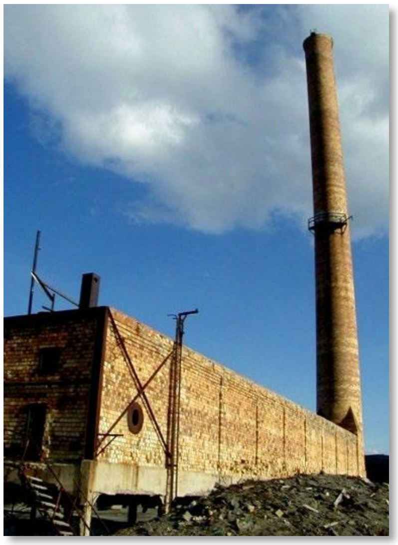


Photo 6: Former brick Humboldt Smelter stack and converter flue building on the smelter plateau.

The Chaparral Gulch is an intermittent stream that normally only flows during storm events. The gulch flows west-to-east, beginning in the mountains west of Dewey-Humboldt, advancing eastward along the north side of the former Iron King Mine property, crossing under Highway 69, and continuing a half-mile before opening into a wide and open floodplain along the south side of the former Humboldt Smelter property (i.e., the tailings floodplain). A concrete dam sits at the eastern end of the floodplain, downstream of the smelter property, through which the Chaparral Gulch flows before discharging into the Agua Fria River. Low-lying portions of both the former Iron King Mine and Humboldt Smelter properties lie within the Chaparral Gulch drainage basin, which drains about 10 square miles.

5.2.1 Size of Site

Not counting existing residential areas, the area to which contamination has come to be located (non-residential waste areas containing mine tailings, mixed tailings and alluvium, dross, slag, waste rock and associated contaminated soils; lying at the former mine property, smelter property, proximal to the Chaparral Gulch and the Agua Fria River) covers about 450 acres or 0.75 square miles, with a periphery of approximately 5 miles. The mine and smelter properties lie about 0.5 miles apart.

5.2.2 Site Topography, Geology and Hydrogeology

Section 5 of the RI and Section 1.2 of the FS present a detailed discussion of physical site characteristics, including topography, geology, and hydrogeology. A summary is below.

Topography

Topography over most of the Iron King Mine property generally slopes northeastward toward the Chaparral Gulch, with surface elevations ranging from approximately 4,600 to 4,800 feet. The former Humboldt Smelter property is approximately 3,000 feet southeast of the former Iron King

[3] The smelter tailings depression was previously referred to as the smelter tailings swale in the RI and FS. This ROD refers to this site feature as the smelter tailings depression.

Mine property on a plateau overlooking the Agua Fria River. Surface elevation over most of the former Humboldt Smelter property ranges from approximately 4,560 to 4,600 feet.

The northeastern half of the former Humboldt Smelter property slopes toward the Agua Fria River, which flows along the eastern portion of the former Humboldt Smelter. The Agua Fria River has incised a steep-walled canyon through volcanic rocks and underlying bedrock in this area. Approximately 200 feet of topographic relief occurs between the Humboldt Smelter plateau and the Agua Fria River. The southwestern half of the former Humboldt Smelter property slopes toward the Chaparral Gulch. More information on site topography can be found in Section 5.1 of the RI and Section 1.2.1.3 of the FS.

Geology

Lonesome Valley is part of a structural basin formed by vertical displacement along high angle faults. The basin fill consists of Tertiary volcanic and sedimentary rocks that were deposited on Precambrian metamorphic bedrock units, known as the Iron King Volcanics and the Spud Mountain Series. Massive sulfide vein deposits occur locally within the bedrock and were the target of mining operations at the former Iron King Mine property. Basin fill deposits of the Tertiary Hickey Formation overlie the bedrock. Quaternary alluvial deposits occur within the active river channels in the area, and include sand, gravel and silt consisting of reworked Hickey Formation and alluvium derived from the highlands surrounding Lonesome Valley. More information on site geology can be found in Section 5.4 of the RI and Section 1.2.1.4 of the FS.

Hydrogeology

The Site is in the Upper Agua Fria Groundwater Subbasin of the Chino-Prescott Valley Basin. The 28-mile-long structural basin is filled with a complex sequence of alluvial, volcanoclastic and volcanic deposits (Hickey Formation).

Locally, groundwater is divided into five hydrostratigraphic units.

- Upper Unit: The site tailings within the mine tailings pile and the Chaparral Gulch floodplain are identified as the uppermost water-bearing unit at the Site, characterized as an aquitard with low transmissivity.
- Middle Three Units: The Hickey Formation includes three hydrostratigraphic units: Upper Tertiary Hickey Basin Fill, Middle to Upper Tertiary Hickey Basalts, and Lower Tertiary Hickey conglomerate.
- Lower Unit: Precambrian basement rocks at the Site make up the fifth hydrostratigraphic unit.

Based on residential well logs, domestic water is sourced primarily from the three hydrostratigraphic units in the Hickey Formation, with depths of residential wells ranging from less than 100 feet to over 300 feet below ground surface. More information on site hydrogeology can be found in Section 5.5 of the RI and Section 1.2.1.5 of the FS.

5.2.3 Site Areas of Concern

At the largest scale, the overall Site can be broken down into four major parts. The first part is the former Iron King Mine, including the mine tailings pile, the industrial areas around the mine tailings pile and open land around the mine tailings pile. These areas include the mineworks and waste rock on the west side of Highway 69.

The second part is the contamination in the Chaparral Gulch. This consists of the Upper and Middle Chaparral Gulch, the tailings drainage area, the tailings floodplain and dam, and the Lower Chaparral Gulch. Points in the gulch downstream of the Middle Chaparral Gulch have wastes that are mixed from both the mine and the smelter.

The third part is the wastes and contamination at the former Humboldt Smelter property, including the smelter tailings depression, on the smelter plateau (including dross and slag) and the tailings deposits near the Agua Fria River.

The final part is the residential properties that are impacted by contamination from the Site within the town of Dewey-Humboldt.

At a scale suited to an overview and general understanding of the Site, the Site has 15 major areas of contamination, as seen in Figure 2. These areas are discussed in more detail in the sections of the ROD that follow. Sections 5.4 and 5.5 include photographs of the site areas.

At a finer scale, the RI and FS further divided these major areas into 31 distinct areas of concern, or AOCs, within 1) the former Iron King Mine, 2) the Chaparral Gulch and 3) the former Humboldt Smelter. Residential properties with site-related contamination are an AOC *in addition* to these 31 areas. Figure 3 shows the area within which these residential properties lie. Figure 8 is a map identifying the 31 non-residential/waste-bearing areas. Table 1, included in the Tables section at the end of this ROD, lists the 31 AOCs from the RI and FS and provides a narrative description of each area. Table 1 also includes residential areas outside the former mine and smelter properties that are affected by site-related contamination as an additional unnumbered AOC.

5.2.4 Areas of Archaeological or Historical Importance

As part of the RI/FS, a cultural resource and historical building survey was conducted in compliance with Section 106 of the National Historic Preservation Act (NHPA). Neither the Iron King Mine nor the Humboldt Smelter were recommended for listing on the National Register of Historic Places because many of the original structures have been demolished, a significant amount of ground disturbance has taken place and other factors. However, the survey identified certain features under NHPA Criterion D for the potential significance of buried deposits that can yield additional information important to history. For this reason, consultation with the State Historic Preservation Office will be necessary during the remedial design phase.

5.3 Sampling Strategy

The RI, completed in 2016, evaluated chemicals detected in surface and subsurface soil, sediment, groundwater, surface water, and ambient air. Samples of waste rock, tailings, slag, and dross were also collected. Sample analytes were a wide range of metals, many of which can be associated with mining and ore materials, but sampling was also conducted in appropriate locations for many other chemicals including hexavalent chromium, volatile organic compounds, semi-volatile organic compounds, pesticides/polychlorinated biphenyls, pH, perchlorate, asbestos, dioxins/furans, and anions (nitrates, nitrite and sulfate). The RI included:

- Sampling and chemical analysis of thousands of non-residential soil samples.
- Sampling and chemical analysis of over 4,600 residential soil samples.
- Over 150 borings drilled into soils and wastes.
- Geochemical and geophysical testing.
- 254 samples to evaluate background metals concentrations in soils.
- Measurement of water flow and chemistry during rain events.
- Installation and sampling of 26 EPA groundwater monitoring wells.
- Sampling of 64 private and public drinking water wells.
- Sampling of surface water and sediment at more than 35 locations along the Agua Fria River and surface water samples throughout the Chaparral Gulch.
- A six-month dust monitoring study.
- Other sampling, measurements and tests.

As part of the RI, EPA also completed a site-specific investigation of the bioavailability of lead and arsenic in soils.

5.3.1 Soil Background Assessments

As part of the RI completed in 2016 (see RI, Appendix E), EPA completed a background study using soil data collected between 2002 and 2013, including hundreds of surface soil samples collected in undisturbed locations surrounding the mine and smelter. Most of these samples were taken in residential areas and also in undeveloped open areas. The samples were spread out widely in regional areas from roughly 0.5 mile to as much as 3 miles from the mine and smelter. A statistical strategy was employed, and background threshold values (BTVs) were developed for the major metals. Copper and zinc were of particular importance as zinc is especially associated with the mine, and copper with the smelter (which smelted mostly copper). Appendix E of the RI evaluated various data, including background levels of indicator metals copper, zinc, and lead and ratios of surface to co-located 1-foot samples, to delineate an area called the Area of Potential Site Impact (APSI) – the area outside of which site influence ends and background begins. Only samples outside the APSI were used in the calculation of background concentrations.

For example, concentrations of metals are consistently higher (by greater than 2.5-fold) in soil samples collected from the surface compared to those from deeper underground. This is consistent with the understanding that site-related impacts near the surface within the APSI could be a result of particulate migration or surface water transport, rather than background conditions.

Lead and arsenic are the primary, most-prevalent and risk-driving chemicals of concern (COCs) at the Site. The BTV for lead was determined to be 35 mg/kg (equivalent to parts per million). The BTVs for arsenic are addressed below.

5.3.2 Arsenic Background Values

The BTV for arsenic is far more complex than for lead and the other metals at this Site. While the distribution of arsenic in soil at and around the Site contains areas related to the mine and smelter operations and mine site geology, arsenic also occurs naturally at relatively high and highly variable concentrations in the surrounding geology and soils. In addition, geologic conditions differ between areas east and west of the Agua Fria River. Levels of arsenic are variable even at considerable distance from the sources of contamination at the Site.

EPA has completed three separate background studies for the Site in which the BTV for arsenic has been derived and then refined. EPA also re-evaluated these background studies. The first background level for arsenic, 112 mg/kg, was developed as a sitewide value in Appendix E of the RI.

During the FS in 2022, EPA recalculated the BTV using subpopulations for the background data and statistical approaches not used in the original analysis. The arsenic BTV calculated in the 2022 assessment ranged between 86.2 mg/kg and 96.3 mg/kg (Appendix C-6 of the FS) and a single sitewide value of 92 mg/kg was determined. This is the background level that was stated in EPA's 2023 Proposed Plan. This value was proposed as the cleanup level for arsenic in residential areas. During this analysis, a single BTV was determined for all background data across the areas peripheral to the Site.

Since the Proposed Plan was issued, EPA has performed a final sophisticated statistical analysis that reexamined surface soil background for arsenic that was included in Appendix C-6 of the FS. A separate technical memorandum regarding arsenic soil background values is attached to this ROD as Appendix C. In this re-evaluation, EPA utilized independent experts who used additional highly advanced statistical methods to determine BTVs.

Based on conclusions from this study, EPA has modified the single BTV of 92 mg/kg arsenic in the 2023 Proposed Plan to two background values: 48 mg/kg west of the river and 99 mg/kg east of the river. In turn, the residential soil cleanup levels in the ROD have been modified to reflect the revised BTVs.

It was shown that dividing the Site background data population into subpopulations from areas east and west of the Agua Fria River was the most appropriate and health-protective way of evaluating the data. This was superior for many reasons compared to dividing the data based solely on soil types. Statistical chemical signatures from various metals east of the river and other lines of evidence were evaluated to show that higher background values of arsenic east of the river were due to differences in the underlying geology rather than aerial deposition of dust from the smelter property or the mine. Revised BTVs as shown above were derived. See Appendix C of this ROD for a more technical discussion.

The final BTVs for arsenic and lead are below.

Background Threshold Values for Risk-Driving Contaminants in Surface Soils	
Lead	35 mg/kg
Arsenic in soils west of the river	48 mg/kg
Arsenic in soils east of the river	99 mg/kg

5.4 Sources of Contamination

The sources of contamination at the former mine and smelter properties are associated primarily with stockpiled mine and smelter waste created during a long history of operations.

Substantial sources on the Iron King Mine property include:

- Mine Tailings Pile (also known as the Main Tailings Pile): Approximately 4.3 million cubic yards of milled waste (tailings) were deposited in historical drainages to the Chaparral Gulch.
- Former Small Tailings Pile: The small tailings pile, located north of the mine tailings pile within a drainage tributary to the Chaparral Gulch, was a source of contamination to the Chaparral Gulch prior to its removal and consolidation within the mine tailings pile as part of a removal action in 2011.

Photo 7: Mine tailings pile as seen from the north.

- Waste Rock: Waste rock associated with former mining operations occurs in piles and as a veneer across the former mineworks area and the former fertilizer plant area. Waste rock has also been deposited adjacent to the Galena Gulch.

Substantial source areas on the Humboldt Smelter property include:

- Tailings Depression and Floodplain: Tailings in the smelter tailings depression were produced as a waste product from concentrating ore to feed the smelter. Impoundment failures and historical discharges from Iron King Mine and Humboldt Smelter released tailings into the Chaparral Gulch, including the tailings floodplain.
- Smelter Slag Material: The primary smelter slag pile is located along the eastern side of the property, with a smaller satellite pile on the Smelter Plateau to the south. The slag deposits have formed a steep cliff overhanging the Agua Fria River, and slope failures/crevasses have occurred in some areas.

Photo 8: Floodplain in the Chaparral Gulch with visible tailings.

- Dross: Dross was imported after closure and dismantling of the Humboldt Smelter plant for reprocessing to recover aluminum and zinc. The dross is widely spread across much of the former pyrometallurgical operations area.
- Lower Chaparral Gulch and Agua Fria Tailings Deposits: Tailings deposits are located along Lower Chaparral Gulch and the Agua Fria River just downslope of the former Chaparral Gulch shaft and are likely the result of predecessor mining and milling operations.

Photo 9: Monolithic slag wall.

Photo 10: Heavily eroded tailings deposit in a depression at the smelter.

5.5 Nature and Extent of Contamination

The 2016 RI provides a summary of the nature and extent of contamination associated with each area of the Site. The 2022 FS includes supplemental data that further refines the nature and extent of contamination. These reports are available in the Site's Administrative Record file.

In the RI, EPA sampled and evaluated those chemicals that were detected in soil, sediment, surface water, ambient air, and groundwater. Among these were a wide range of metals, many of which can be associated with mining and ore materials, but sampling was also conducted for multiple other chemicals as defined in the RI.

5.5.1 Chemicals of Concern and Affected Media

The primary media of interest at the Site include mine and smelter wastes, soil, and surface water in the Lower Chaparral Gulch and Agua Fria River. Shallow groundwater beneath the main source areas is also a medium of concern.

The primary, most-prevalent and risk-driving COCs at the Site are arsenic and lead. Arsenic accounts for about 99% of the cancer risk attributable to the Site. Lead and arsenic contamination is co-located with other COCs because elevated levels substantially above background arise in the environment at the Site due to the presence and migration of the same wastes (e.g., tailings). The following COCs were identified for soil/waste and surface water:

- Soil/waste: COCs vary by site area and include antimony, arsenic, cadmium, cobalt, copper, hexavalent chromium, lead, manganese, selenium, thallium, and zinc, and, in localized areas at the former smelter, polycyclic aromatic hydrocarbons (PAHs) and dioxins/furans.[4]

- Surface water: aluminum, barium, beryllium, cadmium, cobalt, copper, cyanide, iron, manganese, mercury, selenium, vanadium, and zinc.

Table 2 in the Tables section of this ROD presents the maximum detected concentrations of COCs in soil and surface water from the RI. Figure 9 on the next page also presents maximum concentrations of lead and arsenic in the major site areas of concern.

Chemicals of interest (COI) in groundwater include arsenic, lead, and nitrate. Sulfate was also of interest as an indicator chemical for the extent of site-related arsenic migration in groundwater (see Section 5.7 of this ROD). Table 3 presents maximum detected concentrations of the COIs in groundwater.

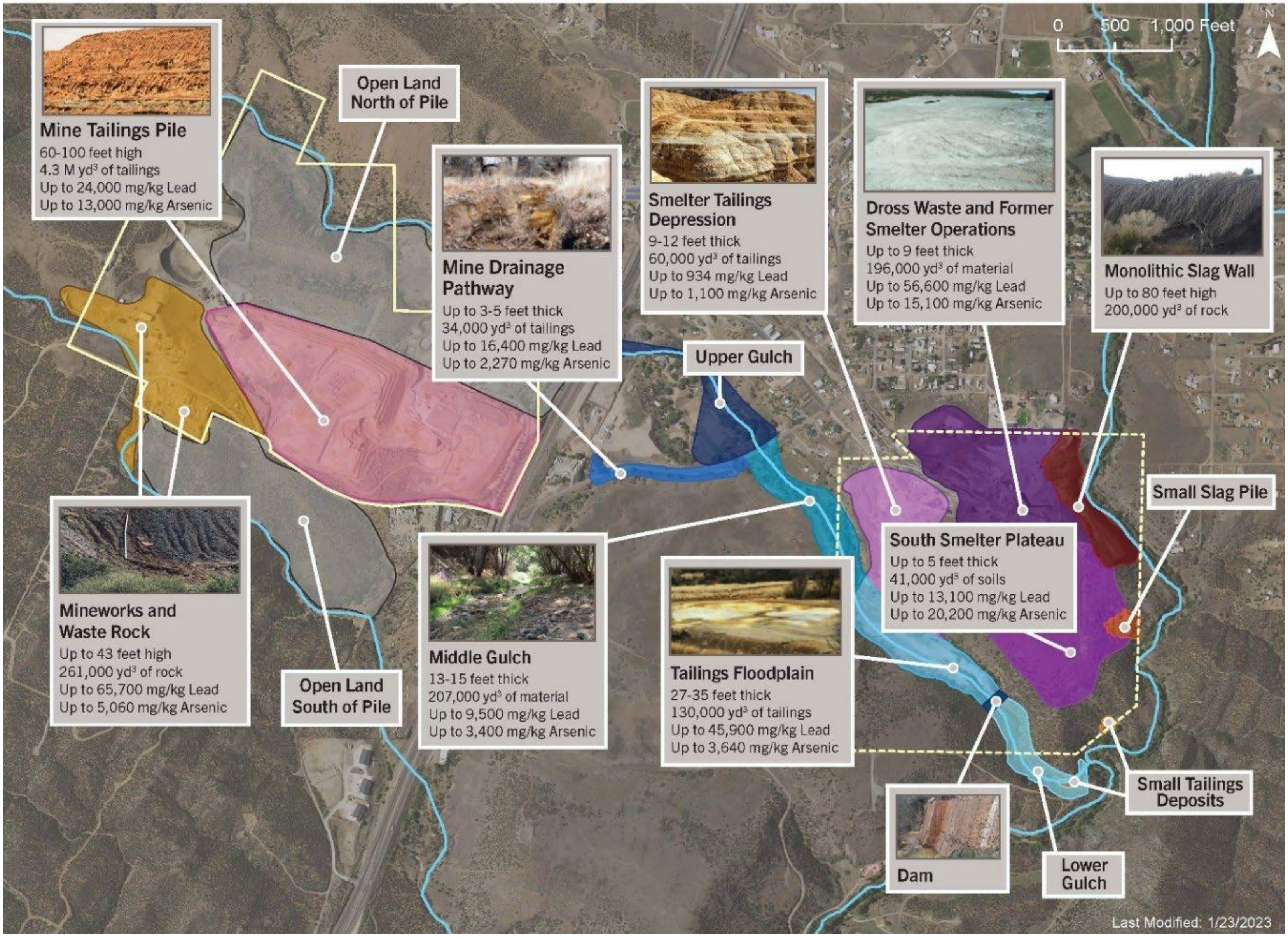
EPA investigated ambient air as part of the RI, including continuous air monitoring over several months and assessing risks to human health, and determined site-related contamination in ambient air was not creating unacceptable risks to human receptors. Based on the evaluation conducted during the FS, sediments in the Agua Fria River were not creating unacceptable risks.

5.5.2 Area-Specific Impacts

Figure 2 shows the major site areas of concern (combined and simplified from the 31 detailed AOCs), which are addressed further below. Figure 9 on the next page shows contamination levels in some of the major site areas of concern. This graphic is also included in the Figures section at the end of this ROD.

[4] Hexavalent chromium (CrVI) and PAHs (as benzo(a)pyrene equivalents [BaPe]) were identified as COCs in the human health risk assessment (HHRA) at AOCs 25 and 24, respectively, but are eliminated as COCs requiring remedial action in this ROD. See footnote in Section 7.1.4.4 of this ROD for more information.

Figure 9: Contamination Levels in Major Site Areas of Concern



5.5.2.1 Former Iron King Mine

Mine Tailings Pile: The mine tailings pile at the former mine is over 100 feet high at its eastern face, covers 62 acres and contains 4.3 million cubic yards of mine tailings with high levels of arsenic and lead. The tailings contain arsenic at levels up to 13,000 mg/kg. Lead levels in the tailings have been observed as high as 24,000 mg/kg. Due to the toxicity and potential mobility of tailings at the Site, EPA considers the mine tailings to be principal threat wastes.

Photo 11: Mine tailings pile as seen from Iron King Road.

Mineworks and Waste Rock: West of the mine tailings pile lies an area that was formerly used for ore processing (mineworks). This area contains surface soils contaminated at up to 5,060 mg/kg arsenic and 65,700 mg/kg lead. The former mine property west of the mine tailings pile also contains deposits, piles and a wall of waste rock – the earthen rock material that was removed from the mine shafts during mine operations.

Photo 12: Mineworks and waste rock.

Open Land North of Pile and Open Land South of Pile: Just north of the mine tailings pile, between the pile and the Chaparral Gulch, is hilly open chaparral land with sporadic surface soil contaminant levels up to 1,730 mg/kg arsenic and 4,270 mg/kg lead.

South of the mine tailings pile, between the pile and the Galena Gulch, lies steep terrain with sporadic levels of surface soil contaminant levels up to 1,280 mg/kg arsenic and 3,450 mg/kg lead. The affected area covers about 50 acres on the north side of the mine and 35 acres on the south side of the mine.

5.5.2.2 Chaparral Gulch to Agua Fria River

Mine Drainage Pathway to Chaparral Gulch: The mine tailings pile at the former mine began as a series of diked ponds on the mine property into which tailings were disposed. As the mine operations grew, these eventually merged into one large impoundment and then dried out, forming the mine tailings pile. These ponds had a series of outfalls that drained downslope, crossed to the east side of what is now Highway 69, and flowed into a drainage along what is now Third Street. Tailings from the mine are present along this pathway at intermittent locations both at the surface and buried. Soils in this area contain levels up to 2,270 mg/kg arsenic and 16,400 mg/kg lead, to depths of 3 feet to 5 feet, and with a volume of about 34,000 cubic yards. This land is zoned residential but is undeveloped.

Photo 13: Mine drainage pathway.

Upper Chaparral Gulch: Upper Chaparral Gulch is upstream (west) of Third Street and east of Highway 69. It is distinct from the mine tailings drainage path to Chaparral Gulch. Tailings have not been discovered in this area. However, it was affected by mine drainage water. Arsenic levels up to 991 mg/kg and lead levels up to 3,080 mg/kg have been found in the soils between the surface and 3 feet depth. The contamination identified is concentrated along the former main channel, near and along Third Street. This land is zoned residential and contains parcels owned by residents, although no residential structures are present in the channel because this land lies on the floor of the main channel in the gulch.

Photo 14: Middle Chaparral Gulch.

Middle Chaparral Gulch: The mine drainage to the Chaparral Gulch and the Upper Chaparral Gulch merge at the Middle Chaparral Gulch. Tailings in the Middle Chaparral Gulch are blended with alluvium washed in during storms from the mountains. Surface soils are the base for a riparian habitat of grasses, shrubs, and mature trees. In surface soils of the Middle Chaparral Gulch, neither arsenic nor lead are present at high enough levels to pose a significant health risk to humans walking through on trails, which is the anticipated future land use. However, the levels of arsenic and lead do pose a significant ecological risk to wildlife such as red-tailed hawks, desert shrews and coyotes. In deeper soils, the Middle Chaparral Gulch contains buried tailings mixed with alluvium. From 5 feet to 15 feet below the surface soils, there are soils with up to 3,400 mg/kg arsenic and 9,500 mg/kg lead. Erosion from storms causes movement of contaminations among depths and/or occasional exposure of tailings to the surface. The Middle Chaparral Gulch contains up to 206,000 cubic yards of tailings and contaminated alluvium/soil.

Tailings Floodplain: Farther downstream near the former smelter, the Middle Chaparral Gulch opens into a wide floodplain. The floodplain is about 11 acres in area and contains about 130,000 cubic yards of tailings waste and contaminated soils. The floodplain contains tailings and soils with up to 3,660 mg/kg arsenic and 45,900 mg/kg lead. The floodplain is intermittently covered with a layer of alluvium washing in from the mountains but otherwise contains tailings with thickness ranging from a few feet to more than 35 feet on the east end. A photo of the tailings floodplain can be seen in Photo 8 on page 21. On the east side of the floodplain, the tailings are held back by a concrete dam 26 feet high. The upstream side of the dam is filled with tailings to the top of the dam that are saturated with water a short depth below the surface.

Photo 15: Dam on Chaparral Gulch.

Lower Chaparral Gulch and Tailings Deposits: During monsoon rains, flowing water spills over the dam and flows into the Lower Chaparral Gulch and

Photo 16: Lower Chaparral Gulch.

toward the Agua Fria River. Some water flows under the dam. Concentrations in soil up to 4,140 mg/kg arsenic and 6,060 mg/kg lead can be found in this area, specifically in the tailings deposits described below. Surface water in Lower Gulch is ephemeral, limited to periods during and after storm events. The Chaparral Gulch joins the Agua Fria River about a quarter-mile downstream of the dam.

There are two tailings deposits next to the Agua Fria River. The first tailings deposit is located near the confluence of the Chaparral Gulch and the Agua Fria River. This deposit contains about 600 cubic yards of tailings with lead levels up to 6,060 mg/kg. The second tailings deposit lies on a promontory above the river also near the confluence. This deposit contains about 5,500 cubic yards of tailings. These were left by the smaller smelters that operated in the late 1800s – 1904, prior to the Humboldt Smelter.

Agua Fria River Surface Water and Lower Chaparral Gulch Surface Water: Chaparral Gulch empties into the Agua Fria River at the confluence of these two water bodies downstream of the dam. Lower Chaparral Gulch is between the dam and the confluence (Figure 2). Sixty-two surface water samples in the Agua Fria River and Lower Chaparral Gulch were collected during the RI and supplemental sampling events during the FS. Concentrations of metals in the samples varied significantly with time. During RI sampling events conducted between 2008 and 2020, 18 samples exceeded either risk-based criteria or water quality criteria for at least one of 15 metals analyzed. In the Agua Fria River, 20 samples exceeded either risk-based criteria or water quality criteria for at least one metal; however, only 13 of these samples had metals concentrations above background levels. Metals levels exceeded risk-based levels, applicable or relevant and appropriate requirement (ARAR)-based levels, and background were primarily observed near the slag wall at the smelter and downgradient of the confluence with Chaparral Gulch.

Photo 17: Agua Fria River facing south near the Site.

During the FS supplemental sampling events, only one sample in the Lower Chaparral Gulch (at the dam) exceeded water quality criteria for metals. This difference compared to the earlier RI sampling events over time is likely due to the timing of storm events and seasonal variations relative to sampling.

Agua Fria River Sediments: Based on evaluation conducted during the FS, sediments in the Agua Fria River do not require cleanup as part of the remedial action.

5.5.2.3 Former Smelter

Waste Dross and Former Smelter Operations Area: The former pyrometallurgical operations of the Humboldt Smelter (former blast furnaces, metal-purifying converters, coal and coke heating, sintering, power generation, etc.) were situated on the north end of a high plateau surrounded by steep slopes and lower terrain. This area contains about 50,000 cubic yards of soils contaminated with metals including arsenic and lead. It is covered by about 150,000 cubic yards of dross waste. The total volume of contaminated soils and dross is about 196,000 cubic yards. The dross contains up to 15,100 mg/kg arsenic and 56,400 mg/kg lead.

Photo 18: Dross waste at the smelter.

Smelter Tailings Depression: On the smelter property, below the plateau where the smelting operations took place, there is a bowl-shaped depression, called the smelter tailings depression (also known as the smelter tailings swale). It contains about 60,000 cubic yards of tailings from ore concentrating and grinding operations at the smelter property. In the tailings in the smelter tailings depression, the contaminant levels can be as high as 1,100 mg/kg arsenic and 934 mg/kg lead, respectively.

Photo 19: Smelter tailings depression.

South Smelter Plateau: South of the former pyrometallurgical operations area, the smelter plateau contains about 40,000 cubic yards of contaminated soils with concentrations of up to 20,200 mg/kg arsenic and 13,100 mg/kg lead.

Monolithic Slag Wall: On the eastern edge of the smelter plateau, the monolithic slag wall contains roughly 280,000 cubic yards of material and is similar to solidified lava rock. It is inert and does not pose a chemical health risk unless it is pulverized into soil-like material or sediments. Data indicates that pulverized slag is leachable, and slag falling into the river and being pulverized could release metals to the river over time.

Photo 20: Monolithic slag wall.

5.5.2.4 Existing Residential Areas

Multiple phases of sampling were performed in residential areas, with the most extensive sampling efforts occurring between 2008 and 2012, and between 2013 and 2017. Figure 10 shows residential areas sampled during the RI. Thousands of soil samples were collected from residential properties within the APSI, which was an approximate geographic extent of potential site-related impacts. The APSI was determined by a rigorous and statistically-based analysis of metals concentrations in soils spatially distributed up to three miles distant from the former mine and smelter operations. Soil sampling and screening investigations took place at about 580 existing residential yards. Based on the results of the investigations, three removal actions were conducted in existing residential areas. However, in this ROD, EPA is selecting cleanup levels for arsenic and lead that are lower than the cleanup levels used at the time of the removal actions.

The change in cleanup criteria may trigger response actions at up to 110 additional residential properties based on the adjusted cleanup level/benchmarks for lead (to 200 mg/kg from 400 mg/kg previously) and arsenic (to 48 mg/kg west of the river and 99 mg/kg east of the river from 144 mg/kg previously). This estimate of the properties requiring remediation does not include any residential properties cleaned up during previous removal actions. Residential properties previously addressed during removal actions will be evaluated to ensure that exposure point concentrations are below the new cleanup levels.

5.5.3 Amount of Waste to be Addressed

Nearly 6.4 million cubic yards of waste and affected soils are in non-residential/waste-bearing areas of the Site. Table 4 in the Tables section of this ROD presents waste and affected soils volumes for non-residential/waste-bearing areas. The volume of affected soils for currently residential areas will be determined during the remedial design.

5.5.4 Resource Conservation and Recovery Act Hazardous Waste and the Bevill Waste Exemption

The 1980 Solid Waste Disposal Act Amendments (SWDA) to the 1976 Resource Conservation and Recovery Act (RCRA) excluded from regulation under Subtitle C of RCRA certain “special wastes” that might otherwise be considered hazardous. The Bevill Amendment at 42 U.S.C. Section 3001(b)(3)(A) exempted from regulation under Subtitle C of RCRA waste from the processing of certain ores and minerals, among other materials. Certain waste materials at the Site, including the tailings, waste rock, slag, and soils contaminated by these materials, may be Bevill-exempt. Other waste materials at the Site, such as the dross waste at the smelter, may not meet the requirements of the Bevill exemption, and if not, may require treatment as a characteristic hazardous waste. Characteristic hazardous waste that is not exempted by the Bevill Amendment may be subject to different technical requirements than the Bevill-exempt waste materials. For example, approximately 150,000 cubic yards of dross may require stabilization to remove the hazardous waste characteristic of the material.

5.6 Location of Contamination and Known/Potential Routes of Migration

5.6.1 Lateral and Vertical Extent of Soil Contamination

Arsenic and lead are the primary COCs at the Site. Lead and arsenic contamination is co-located with other COCs. Figure 11 shows the sitewide distribution of arsenic in surface soil (0-2 feet below ground surface). Figure 12 shows the sitewide distribution of lead in surface soil. Outside of areas that contain tailings, dross, and waste piles, both arsenic and lead concentrations decrease with depth, which is consistent with impacts from windblown dust and stack emissions.

5.6.2 Migration of COCs to Other Media

Mining and smelting activities resulted in the formation of numerous waste piles (tailings, waste rock, and ore materials) at both the former Iron King Mine and Humboldt Smelter properties, and adjacent areas. Erosion of these materials into downstream drainages resulted in deposition of tailings and impacted soils in both the Galena Gulch and the Chaparral Gulch. All of these contaminated materials are now subject to further erosion and deposition within the drainages and to surface waters, or discharge to groundwater or surface water through formation of acid rock drainage (ARD) or metal leaching.

While the tailings on the mine tailings pile are largely crusted over, the tailings in piles at the mine and smelter both are still exposed to the elements and could move by way of aerial dust dispersion.

EPA has immobilized the dross at the smelter property with a crust-like cover material, but any eventual erosion of the cover could expose the underlying dross and allow for windblown aerial dispersion.

5.6.3 Potentially Affected Populations and Routes of Exposure

Potentially affected populations vary by area of the Site. The human health risk assessment (HHRA), included in the RI, evaluated the following current or future human receptor populations and exposure routes:

- Current or future residents: direct contact with surface soil (0-2 feet below ground surface) (incidental ingestion, dermal contact, inhalation of localized ambient dusts and vapors).
- Current or future occupational workers: direct contact with surface soil (incidental ingestion, dermal contact, inhalation of localized ambient dusts and vapors).
- Intermittent recreational visitors (for example, hikers): direct contact with soil/sediment (incidental ingestion, dermal contact and inhalation of localized dust and vapors; direct contact with surface water (incidental ingestion and dermal contact while swimming or wading).

Sampling of groundwater wells showed that site-related impacts to groundwater are confined to the shallow groundwater under the mine tailings pile, under the Chaparral Gulch and parts of the smelter property. Dissolved arsenic is present above state and federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs) in some of these areas. The shallow groundwater contributes to surface water flow in the Chaparral Gulch and is not in communication with the regional aquifer. EPA found there is no complete exposure pathway between site-related groundwater contamination and current human receptors. However, there are private water wells relatively close to the source areas at the Chaparral Gulch and the smelter, and additional monitoring wells and further monitoring will be necessary to select a final remedy for groundwater. Institutional controls are included as an interim remedy for groundwater to eliminate potential exposure pathways for human receptors.

Potentially affected ecological receptor populations include terrestrial receptors (exposures to soil and waste) and aquatic organisms (aquatic plants, water column invertebrates and fish) in the Agua Fria River.

5.7 Groundwater Contamination

During the RI, EPA installed 26 monitoring wells screened in the alluvium (and tailings), Hickey Formation and Precambrian bedrock. Numerous private wells as well as public supply wells in the Dewey-Humboldt area were also sampled prior to and during the RI. Figure 13 shows the locations of the wells sampled. EPA determined that site-related groundwater contaminants appeared to be confined to groundwater directly under the former Iron King Mine wastes, the Humboldt Smelter property, and in perched groundwater under the Chaparral Gulch between them. COIs for groundwater include arsenic, lead, and nitrate. Sulfate was used as an indicator chemical for the extent of site-related arsenic migration in groundwater. Figure 14 depicts total arsenic results in site monitoring wells sampled between 2012 and 2019.

The RI determined that arsenic is not generally mobile and does not migrate significantly in groundwater at the Site. The Site is not contributing soluble arsenic to groundwater, except for the shallow groundwater under the mine tailings pile, under the Chaparral Gulch, and parts of the smelter property. The data do not indicate an arsenic "plume" emanating from the Site. The perched groundwater contributes to surface water flow in the Chaparral Gulch and is not in communication with the regional aquifer. Soluble arsenic in groundwater other than these locations are due to naturally occurring geologic formations. Generally, ARD can mobilize arsenic in groundwater. ARD is acidic water that forms through the biogeochemical reaction of air and infiltrating water with tailings or weathered materials containing sulfur-bearing minerals and salts. ARD formation generally produces sulfate. Sulfate is more soluble and moves more rapidly in groundwater than soluble metals from ARD.

Therefore, elevated sulfate concentrations indicate the extent to which groundwater is impacted by soluble metals from ARD.

At the Site:

- Concentrations of sulfate beneath the waste bearing areas of the Site indicate that chemical reactions leading to ARD do occur, but the data do not indicate a statistically significant correlation between sulfate and arsenic at the Site.
- The area of elevated sulfate is limited to the shallow groundwater zones beneath and between the mine and smelter properties and along the Chaparral Gulch. This indicates that ARD impacts of metals from the Site are even more laterally localized than sulfate. Groundwater outside the immediate waste-bearing areas is not impacted by ARD from the Site.
- Sulfate concentrations in the deep Precambrian bedrock monitoring wells beneath and near the former mine and smelter properties are not elevated and the water chemistry signature is distinctly different, indicating a lack of hydraulic connection between the shallow groundwater and the bedrock. Therefore, the deeper groundwater is not being

impacted by ARD. There are relatively consistent levels of arsenic in the deep groundwater regardless of whether near the Site or side-upgradient of the Site.

- The groundwater pH is slightly lower in areas where elevated sulfate concentrations occur, but repeatable pH values below 6 were not observed, indicating that residual neutralizing capacity in waste materials, as well as local soils and groundwater matrix minerals, are buffering the ARD acidity. This likely is limiting the mobility of arsenic and other metals in groundwater.

Many of the private supply wells northeast of the former mine and smelter properties (to the east side of the Agua Fria River) and the two wells sampled to the south of the former smelter property have concentrations substantially exceeding the MCL for arsenic in comparison to those wells west of the river. These are areas where naturally-elevated concentrations of arsenic and other metals have been detected in soil and rock outcrops. These areas are not subject to groundwater transport of site-related contamination. Levels of metals in soils in areas east of the river can vary greatly, even over short distances depending on the local geology.

Because natural levels of arsenic in groundwater exceed drinking water standards, EPA has consistently urged private well owners to have their well water tested and, if necessary, install home treatment systems for their private well water.

As stated, this ROD contains interim, not final provisions for groundwater at the Site.

6.0 CURRENT AND POTENTIAL FUTURE USES

6.1 LAND USES

Current land uses near the Site include residential, commercial, industrial, and agricultural uses. Considered as a whole, the majority of the town of Dewey-Humboldt is zoned and used for residential purposes. The mine tailings pile is not in active use. The former mine property and smelter property are zoned for industrial uses but only some of the land is actively used. A fertilizer and soil supplement plant is located on the former mine property on the northeast side of the mine tailings pile. The plant is currently idle. There are small businesses currently in operation immediately west and immediately south of the mine tailings pile. The former smelter property is not currently in use for any purpose. Commercial areas lie mostly along and on both sides of Highway 69 and also along and near Main Street within Humboldt proper.

In selecting remedies, EPA determines the reasonably anticipated future land use (RAFLU) for the various pertinent areas at a site. The RAFLU is critical as it is a key factor in setting the cleanup levels to be used within a given site area. How land will be used determines how long and how often a receptor might spend in an area in the future, and in turn the possible health risk that could be posed by the contamination (called an “exposure scenario”).

The RAFLU for each site area is based, in part, on local land use zoning. However, in some areas the RAFLU is based on other factors. These can include various types of land ownership (e.g., public or private) and the likelihood of continued current land uses regardless of zoning. For example, some of the open land north of the former mine property is owned by the Bureau of

Land Management (BLM). Such land is not sold or developed. Accordingly, although the local zoning of this land is technically residential, the RAFLU is recreational. In another example, there is a small contiguous block of parcels in Humboldt proper that is zoned commercial but is currently used for residential purposes. The RAFLU for this area is residential. It is noted, therefore, that the RAFLU does not always match the zoning designation for a site area.

Figure 4 shows the RAFLU for the major areas of the Site. This figure also shows overlaid zoning boundaries for reference to the extent it was practicable to do so.

6.2 Groundwater and Surface Water Uses

Groundwater uses in the Upper Agua Fria Groundwater Subbasin include domestic supply, public supply, irrigation, and industrial uses. About 15% of the residential properties in Dewey-Humboldt receive water through a public water supply system run by water purveyor Humboldt Water Systems. The remaining 85% of residential properties obtain drinking water from private supply wells, which are usually screened from near the surface to about 300 feet in depth.

Drinking water from private wells is widely used in the area. There are no known drinking water supply wells within wastes at the Site, but there are supply wells north of the Chaparral Gulch and smelter property. Installation of wells, including wells for domestic use, is controlled by the Arizona Department of Water Resources permit program.

The Agua Fria River is the only perennial surface water body at the Site; the Chaparral Gulch is ephemeral – it flows only during very heavy rain events. The beneficial uses of the Agua Fria River (contained in Arizona Administrative Code [AAC] R18-11-104(B) and Appendix B of the Article) include aquatic and warm water wildlife, human health full body contact, domestic water source, fish consumption, and agricultural irrigation and livestock watering. The river is not used for domestic water in the vicinity of the Site.

The beneficial uses of the Galena Gulch include aquatic and ephemeral wildlife, human health partial body contact for recreation, and agricultural livestock watering. AAC R18-11-104(B) and Appendix B do not contain beneficial use designations for the Chaparral Gulch.

Currently, surface water at the Site is not used for drinking purposes. No drinking water intakes are known to exist in the Agua Fria River within 15 miles downstream of the Chaparral Gulch. It is used for recreation in that people occasionally walk in the river from Prescott Street downstream past the smelter toward the confluence of the Chaparral Gulch with the river.

Groundwater at the Site is designated as drinking water protected use by the State of Arizona at A.R.S. 49-224(B).

7.0 SUMMARY OF SITE RISKS

During the RI/FS, EPA conducted a HHRA and an ecological risk assessment (ERA) to estimate the current and potential future effects of contaminated media on human health and the environment in the absence of any actions or controls to mitigate such releases under current and future land uses. The risk assessments provide the basis for taking action and identify the contaminants and exposure pathways that need to be addressed by the remedial action.

The HHRA and ERA evaluated risks for 20 non-residential areas (including four non-residential areas that may be residential in the future) and 39 ecological areas, respectively. These areas were further divided or combined to arrive at the 31 areas of concern, or AOCs, for the RI. The HHRA also evaluated yard-specific risks for 396 residential yards and additionally for nine multi-yard residential screening areas covering 184 residential yards, as well as risks associated with exposures to sediment and surface water in the Agua Fria River. Figure 15 shows the human health risk management areas evaluated in the HHRA. Figure 16 shows the ecological areas. All but one of the areas (AOC 12) posed either an unacceptable human health risk, ecological risk, or both, as explained further below.

7.1 HUMAN HEALTH RISK ASSESSMENT

7.1.1 Hazard Identification

Hazard identification uses the analytical data collected to identify the chemicals of potential concern (COPCs) at the Site for each medium, with consideration of several factors explained below.

The HHRA used analytical data collected from the following environmental media:

- Soil (from 0 to 2 feet below ground surface).[5]
- Ambient air.
- Agua Fria River sediment (from 0 to 0.5 foot below sediment surface).
- Agua Fria River surface water.

Groundwater data were not evaluated as part of the HHRA because: 1) site-related impacts to groundwater appear to be confined to the former mine and smelter properties and the area between them; and 2) regional groundwater quality includes naturally elevated arsenic, and for reasons otherwise discussed in Section 5.7 of this ROD and Section 7.6 of the RI.

COPCs for risk assessment purposes were determined and carried forward in the risk assessment process independently from the main COCs discussed earlier in this ROD. The risk assessment COPCs include a wider range of metals to ensure that any metal posing even a potential risk was evaluated in the risk assessment.

[5] In residential areas, most sampling intervals were 0 to 2 inches, and 10 to 14 inches below grade.

For soil and sediment, a risk-based screening was conducted to select COPCs. If the maximum detected concentration within an exposure area was above the EPA Regional Screening Level (RSL), equating to 1 x 10^{-6} risk for carcinogens, or a hazard quotient (HQ) of 0.1 for noncarcinogens, then that chemical was selected as a COPC and evaluated further in the HHRA. During the RI, lead was selected as a COPC for any given site area in soil and sediment if the maximum concentration in soil was above the EPA soil RSL of 400 mg/kg for residential land use. In this ROD, the RSL for lead is being reduced from 400 mg/kg to 200 mg/kg, and areas of concern are adjusted accordingly.

For ambient air and surface water data, any detected chemical was considered a COPC for these media and included in the HHRA. The primary contaminant groups identified as COPCs at the Site are metals, but also include PAHs and dioxin/furan compounds in some areas influenced by historical smelter operations. Tables K3-1 through K3-7 of the RI include the risk assessment COPCs.

7.1.2 Exposure Assessment

The exposure assessment is used to identify and assess exposure scenarios, exposure pathways and exposure routes (ingestion, inhalation, dermal contact) to potential human receptor populations of concern, based on current and reasonably anticipated future land use. The exposure assessment also estimates the magnitude, frequency, and duration of potential exposures.

Consistent with the Site's CSM, included as Figure 6, current and future human receptor populations and exposure scenarios evaluated in the HHRA included the following:

- Current or future residents.
  - Incidental ingestion and dermal contact with soil, and inhalation of localized ambient dusts and vapors.
- Current or future occupational workers.[6]
  - Incidental ingestion and dermal contact with soil, and inhalation of localized ambient dusts and vapors.
- Intermittent recreational visitors (for example, hikers or trespassers).
  - Incidental ingestion and dermal contact with soil/sediment, and inhalation of localized ambient dusts and vapors.
  - Incidental ingestion and dermal contact with surface water while wading or swimming.

The HHRA included evaluation of the unrestricted residential exposure scenario for all soil exposure areas, regardless of current or future anticipated land use, to determine whether to consider the implementation of land use restrictions.

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[6] A construction worker is also considered a potential receptor but is not identified in the HHRA. The occupational worker was assumed to be exposed over a longer duration than a construction worker (20 years versus 1 year), and therefore, any cleanup levels for an occupational worker would be protective for the construction worker. In addition, EPA's Adult Lead Methodology does not distinguish between commercial and industrial workers; rather, it is applicable to non-residential exposure scenarios.

As part of the exposure assessment, exposure point concentrations as 95% upper concentration limits (UCLs) were calculated for each COPC in each medium, by exposure area. For lead in soil, EPA guidance indicates that the arithmetic mean should be used as the concentration term when modeling blood-lead levels in children and adults. For the HHRA, both the mean and 95% UCL concentration of lead for each exposure area were compared to the risk-based screening levels. When a UCL is used, the result could be interpreted as a more conservative estimate of the risk of an elevated blood-lead level.

Soil Bioavailability: A site-specific bioavailability study was completed during the RI to evaluate the oral bioavailability of arsenic and lead in soil that may have been affected by site-related releases. Estimates of exposure to arsenic in soil were adjusted to account for the site-specific bioavailability identified for arsenic, and thus allow more realistic estimates of risk.

EPA collected 70 in-vitro samples in both waste and residential areas as well as six in-vivo (animal) results. From these a site-specific regression was developed to determine relative predicted bioavailability (RBA) for arsenic and lead. The complete study can be found in Appendix H of the RI. The RBA for lead ingestion for soils and tailings for the Site is 30%. The RBA for arsenic ingestion for soils and tailings at this Site is 22.5%. This is considerably lower than the default RBA of 60%, which in turn results in 1×10^{-6} residential excess lifetime cancer risk of 1.5 mg/kg than 0.68 mg/kg. The residential cancer risk range specific for this Site is therefore from 1.5 mg/kg arsenic at 1×10^{-6} to 150 mg/kg arsenic at 1×10^{-4}.

7.1.3 Toxicity Assessment

The toxicity assessment determines the types of adverse health effects associated with chemical exposures, and the relationship between magnitude of exposure (dose) and severity of adverse effects (response).

Several contaminants with both carcinogenic and noncarcinogenic effects were identified in soils, sediment, and surface water at the Site. A summary of the toxicity data relevant to the COPCs in these media is presented in Table 9-3 of the RI.

7.1.4 Risk Characterization

The risk characterization summarizes and combines outputs of the exposure and toxicity assessments to provide a quantitative assessment of site-related risks. The risk characterization also identifies contamination with concentrations which exceed acceptable levels, defined by the NCP as an excess lifetime cancer risk greater than 1×10^{-6} to 1×10^{-4}, or a noncancer hazard index (HI) greater than 1. Site-related contaminants at these concentrations that are also above background levels will typically require remedial action.

The HHRA identified incremental lifetime human health risks that exceeded acceptable thresholds in risk management areas within the former mine and smelter properties, as well as in adjacent areas.[7] No unacceptable human health risks were identified from recreational surface

[7] Consistent with EPA guidance, potential risks and hazards were estimated in the HHRA by computing incremental site risks for soil. Incremental risk is defined as the portion of site risk exceeding that resulting from normal regional background/ambient concentrations of metals, and presumably attributable to site-related releases of hazardous substances.

water and sediment exposures within the Agua Fria River. Concentrations of arsenic in ambient air sampled at Dewey-Humboldt proper and on the former smelter property were similar to background concentrations. No residential health risks exceeding EPA risk thresholds were identified at any of the ambient air monitoring stations in currently residential areas.

The sections below summarize the risk characterization results for non-residential/waste-bearing areas (Section 7.1.4.1) and currently residential areas (Section 7.1.4.2). Risks from lead are addressed by a different method, which is discussed further in Section 7.1.4.3.

7.1.4.1 Non-Residential/Waste-Bearing Areas

The HHRA evaluated risks for 20 non-residential areas/waste-bearing areas (including four non-residential areas that may be residential in the future). Table 5 presents the incremental lifetime cancer risk and incremental lifetime noncancer HI for each human health risk management area in the non-residential/waste-bearing areas. For comparison, risk estimates are included for three separate exposure scenarios: hypothetical residential use, occupational (or industrial) use, and recreational use. The HHRA included evaluation of the unrestricted residential exposure scenario for all soil risk management areas, regardless of current or future anticipated land use.

As seen in Table 5, estimated potential human health risks from direct contact exposure to surface soils exceed EPA risk thresholds in several risk management areas, given anticipated future land uses. The HHRA showed that arsenic accounts for more than 99% of the cancer risk attributable to site-related contamination in non-residential/waste-bearing areas. In the former pyrometallurgical operations area at the smelter, dioxins, benzo(a)pyrene, and/or hexavalent chromium (chromium VI) also contribute to the total estimated risk.

Potential adverse health effects from lead are evaluated using different methods than those conventionally used for other chemicals. See Section 7.1.4.3 for discussion of risks associated with lead. Based on the evaluation, lead has been identified as a soil COC in non-residential/waste-bearing areas of the Site. Table 5 presents lead exposure point concentrations for each risk management area.

Although potential human health risks do not exceed EPA risk thresholds in some areas, such as Middle Chaparral Gulch, under anticipated future land use scenarios, EPA has determined that such areas also must be addressed to prevent source waste material at depth from continuing to migrate. Most such areas also exceed acceptable ecological hazard levels.

7.1.4.2 Currently Residential Areas

The HHRA evaluated yard-specific (i.e., yard by yard) risks, based on 10 to 15 samples per yard, for 396 residential yards. In addition, in areas on the periphery of the APSI, EPA collected samples for nine multi-yard residential screening areas, which taken together included 184 yards. The estimated potential human health risks from direct contact exposure to surface soils at several of the individual residential yards evaluated exceeded the EPA target risk range of 1×10^{-6} to 1×10^{-4} and/or HIs were greater than 1. Arsenic (in addition to lead, which is discussed separately in Section 7.1.4.3 below) is the primary risk driver in the individual residential yards evaluated. As with the non-residential/waste-bearing areas, the HHRA showed that arsenic accounts for more than 99% of the cancer risk attributable to site-related contamination in residential areas. Numerous residential properties have arsenic concentrations in surface soil such that exposure point concentrations exceed the revised, lower cleanup levels set in this ROD. The total number of residential properties that may require a response action based on these cleanup levels will be determined during remedial design.

None of the yards in the nine multi-yard residential screening areas described above reported incremental risks or hazards above EPA risk thresholds.

7.1.4.3 Risk Characterization for Lead in Non-Residential/Waste-Bearing Areas and Currently Residential Areas

Potential adverse health effects from lead are evaluated using different methods than those conventionally used for other chemicals. This is because, for lead, most human health effects data are based on blood-lead concentrations rather than on the external dose. The adverse health outcomes, which include neurotoxic and developmental effects, may occur at exposures so low that they may be considered to have no threshold. Because of the uncertainties in the dose-response relationship between exposures to lead and biological effects, there is no EPA-derived reference dose for lead. Instead, an integrated exposure uptake biokinetic (IEUBK) model is used that relates exposure to measured lead concentrations in the environmental media with an estimated blood-lead level.

Based on available science, lead exposure point concentrations above the cleanup levels selected in this ROD, and discussed further in Section 8.1 of this ROD, indicate the need for further action. Table 5 summarizes the lead exposure point concentrations in non-residential/waste-bearing areas, which range from 39 mg/kg lead in soil in open land south of the mine tailings pile to 8,726 mg/kg lead in the former mineworks area.

EPA previously used a cleanup level of 400 mg/kg lead in soil based on the use of the IEUBK lead model for the removal actions conducted at 47 residential properties. The 400 mg/kg cleanup level was derived from the IEUBK model with a target blood level of 10 micrograms per deciliter (µg/dL). Because of developments in the toxicological science regarding the toxicity of lead, EPA is updating the final cleanup level for the residential exposure scenario, based on a target blood level of 5 µg/dL. This results in a new residential cleanup level of about 200 mg/kg lead. This change will result in the need for additional residential cleanup. Residential yards to be addressed as part of the response action have lead exposure point concentrations up to 660.1 mg/kg.[8]

7.1.4.4 Chemicals of Concern for Human Receptors

The human health COCs based on RAFLU (which varies by AOC at the Site) are the following:

[8] Table 1 of the Technical Memorandum: Residential Response Action Supplement to Feasibility Study at the Iron King-Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona (Tetra Tech, 2023).

- COCs for soil in current or future residential land use: antimony, arsenic, cobalt, lead, manganese, and thallium.[9]
- COCs for soil in AOCs with current or future occupational land use: arsenic and lead; dioxins/furans are also COCs only for the smelter pyrometallurgical operations area.
- COCs for soil in AOCs with intermittent recreational use: arsenic and lead.

It is important to note that not all AOCs with the same RAFLU share the same COCs. In some AOCs, levels of some chemicals in soils are too low to be considered COCs. As will be noted in Section 8.1, soil cleanup levels for the COCs based on RAFLU are shown in Table 6; soil cleanup levels arranged by AOC are shown in Table 7.

7.2 Ecological Risk Assessment

As discussed in Section 10 of the RI Report, the ERA involved an analysis of potential for adverse effects on ecological receptors (species of plants or animals) associated with the Site. An ERA identifies and characterizes toxicities of contaminants of potential ecological concern, potential exposure pathways, potential ecological receptors, and likelihood of adverse ecological effects under current and reasonably anticipated future land- and water-use conditions. The ERA applied the tiered approach and included both a screening-level ERA (Tier 1) and a baseline ERA (Tier 2).

An ecological CSM developed for the Site focused the ERA on the most plausible ecological receptors and pathways (Figure 7). Potentially complete ecological exposure pathways at the Site include the following:

- Potential exposure of soil invertebrates and terrestrial plants to site-related constituents in soil.

[9] Individual AOCs may have a smaller list of these COCs based on their site-specific analytical data and the results of the HHRA. See Table 7 for AOC-specific COCs.

Iron was carried into the HHRA, and residential noncancer HQs for some residential areas exceeded 1. However, iron was eliminated as a residential COC because it is an essential nutrient, and the EPA RSL is overly conservative for actual health effects. The residential soil RSL of 55,000 mg/kg very conservatively yields an iron daily dose level from incidental ingestion of soil (11 mg iron/day) that is similar to or lower than the daily Recommended Dietary Allowance (RDA) ranges for humans, and much lower than the upper tolerance level of 45 mg iron/day. The Food and Nutrition Board of the National Academies of Sciences, Engineering, and Medicine has set iron RDAs for reproductive-age girls and women of 18 mg/day, during pregnancy of 27 mg/day, for men and post-menopausal women of 8 mg/day, and for children during different age ranges from 7 to 11 mg/day.

Hexavalent chromium and benzo(a)pyrene equivalents (BaPe) were identified as risk-driving chemicals for occupation receptors in the HHRA for industrial AOCs 25 and 24, respectively. However, hexavalent chromium was eliminated as a COC for the ROD because the maximum detected concentration of hexavalent chromium (18 mg/kg) is lower than cleanup levels that would be calculated based on RAFLU. The 10^{-4} risk-level occupational cleanup target would be 630 mg/kg, and 10^{-5} risk-level recreational clean up target would be 26.6 mg/kg. BaPe was eliminated as a COC for the ROD because the maximum detected concentration (0.843 mg/kg) is orders of magnitude lower than the cleanup level of 211 mg/kg based on occupational RAFLU. Neither hexavalent chromium nor BaPe were associated with any current or potential residential parcel or AOC.

- Potential exposure of terrestrial wildlife (birds and mammals) through ingestion of site-related constituents in soil, terrestrial forage, or prey items.
- Potential exposure of aquatic and benthic resources within the Agua Fria River (aquatic plants, benthic and water column invertebrates, and fish) to site-related constituents present in sediment or surface water.
- Potential exposure of semi-aquatic wildlife (birds and mammals) through ingestion of site-related constituents in sediment, aquatic forage/prey, and surface water.

Because the Site covers a large geographic area, it was divided into numerous ecological exposure areas (Figure 16). Areas surrounding the residential areas and along the Agua Fria River were identified as the primary areas of exposure for ecological receptors. Potential ecological exposures were evaluated using representative endpoint species from the functional feeding guilds that have potentially complete exposure pathways for terrestrial and semi-aquatic/aquatic exposures. In all, 33 terrestrial exposure areas were evaluated for 10 representative species, three sediment exposure areas were evaluated for six representative species, and three surface water exposure areas were evaluated for five representative species. Potential ecological risks were estimated by computing incremental site risks from soil. Incremental risk is defined as the portion of the site risk exceeding that resulting from normal regional background/ambient concentrations of metals, and presumably attributable to site-related releases.

The ERA indicated potential for adverse risk to ecological receptors from selected metals detected in soil, sediment, and surface water at the Site. The ERA identified 15 of the 33 terrestrial exposure areas evaluated as having limited, moderate or high potential for adverse effects. The areas with high potential for adverse effects were waste source areas (such as areas with tailings) on the former mine and smelter properties (including the mine tailings pile, former mineworks area, NAI operations area, former pyrometallurgical operations area, smelter plateau and Agua Fria tailings pile). The areas with low to moderate potential for adverse effects were on or immediately adjacent to the former mine and smelter properties, and generally coincided with exposure areas where human health risk estimates also exceeded risk thresholds. The ERA also identified potential risk from exposure to surface water and sediment in the Agua Fria River in areas impacted by source areas at the former smelter, the Agua Fria tailings pile, and discharges from Chaparral Gulch. During additional sampling and analysis during the FS, EPA determined that more recent data collected between 2018 and 2020 do not indicate unacceptable risk in sediment.

The ERA and subsequent evaluations conducted during the FS identified chemicals of ecological concern (COECs) for soil and surface water.

- COECs for soil in AOCs with terrestrial ecological habitat areas: antimony, arsenic, cadmium, copper, lead, selenium, and zinc; dioxins/furans are also COECs only at the smelter pyrometallurgical operations area.

- COECs for aquatic/surface water protection: aluminum, barium, beryllium, cadmium, cobalt, copper, cyanide, iron, manganese, mercury, selenium, vanadium, and zinc.

Table 5 lists number of species affected by HQs of increasing values (for example, HQ of 1, HQ of 3, and HQ of 10) for each area evaluated.

7.3 Basis for Action

The remedy selected in this ROD is necessary to protect public health or welfare and the environment from actual or threatened releases of hazardous substances into the environment. The HHRA identified several areas of the Site with incremental lifetime human health risks greater than 1×10^{-4} and/or a noncancer HI greater than 1 based on current or reasonably anticipated future land uses, which include residential, occupational, and recreational uses. Concentrations of lead in soil also exceed levels protective of human health. The risks at the Site are a result of direct contact exposure to contaminated soil and waste (including tailings, waste rock, dross, and slag). The ERA also indicated potential for adverse risk to ecological receptors from primarily metals detected in soil and surface water at the Site.

Groundwater at the Site is a potential or actual source of drinking water. Groundwater directly beneath the former mine and smelter properties and the area between them is contaminated with arsenic, lead, and nitrate above federal and state MCLs. It has been determined that the interim remedial action for groundwater is necessary to protect human health and the environment from actual or threatened releases of hazardous substances at the Site. A final response action for groundwater, if necessary, will be selected after the response actions for soils, mine and smelter wastes, and surface water have been implemented and a re-evaluation of groundwater impacts has been completed.

8.0 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) describe what a proposed site cleanup is expected to accomplish. They explain how the risks driving the need for action will be addressed by the response action. RAOs take into account the medium of concern, exposure pathways and receptors, COCs, cleanup levels and current and potential land use.

The RAOs for contaminated solids (including tailings, soils, waste rock, dross, and slag) and surface water are:

- Prevent human ingestion, inhalation and/or direct contact exposure to COCs in site wastes and contaminated soils above levels that would pose an acceptable health risk given current and future anticipated land uses.
- Prevent ecological exposure to COCs in site wastes and soils above levels protective of ecological populations.
- Prevent migration (due to erosion, leaching, windblown dust, acid rock drainage, or other transport mechanisms) of site source materials including tailings, dross, waste rock and contaminated soils such that it would pose an unacceptable risk to human or ecological receptors given future anticipated land uses.
- Prevent ecological exposure to site COCs in surface water above levels protective of ecological populations.

The interim RAO for groundwater is:

- Prevent consumption of shallow groundwater from within and under the waste areas subject to the remedial action.

EPA will develop final RAOs for groundwater, if necessary, pending completion and reassessment of groundwater after implementation of the source control remedial actions in this ROD.

8.1 Cleanup Levels

Table 6 presents the cleanup levels for waste/soil based on residential, occupational, recreational, and ecological receptors by RAFLU. Table 7 presents the cleanup levels organized by area of concern, or AOC. As stated above, not all AOCs with the same RAFLU share the same COCs. In some AOCs, levels of some chemicals in soils are too low to be considered COCs. Table 8 presents the surface water cleanup levels for protection of aquatic receptors.

For each COC and COEC, the cleanup level selected is the lowest value among ARARs-based cleanup levels and risk-based cleanup levels for a given RAFLU. When a risk-based potential cleanup level or ARAR was less than the background concentration of a given COC, the background concentration was identified as the selected cleanup level.

Each cleanup level is chosen for an AOC within the Site and the type of human or ecological receptor present based on anticipated future land use. If more than one type of receptor or land use is present, the lowest of the applicable residential, occupational, recreational, and ecological values is chosen as the cleanup level. The FS, in Appendix B, provides further information on development of the cleanup levels for each AOC.

***Specific Discussion Regarding Arsenic Cleanup Levels in Areas with Residential Land Use*:** In previous removal actions, EPA used (or attained) a soil cleanup level of 144 mg/kg for arsenic at 47 residential properties. However, in the final action selected in this ROD, EPA is lowering the cleanup level for arsenic in residential soil. At this Site, the observed distribution of natural background arsenic concentrations in residential soils is substantially elevated. The cleanup objective for arsenic is therefore to clean up to background. Under CERCLA, cleanup levels are generally not set at concentrations below natural background levels (EPA, 2018).

As discussed in Section 5.3.2 and in Appendix C of this ROD, EPA has derived two arsenic BTVs for residential soils at the Site - one BTV for the east and west sides of the river, respectively. The basis for two BTVs is due to geological differences between the two sides. The BTVs that EPA has derived are based on the 95% upper confidence limit of the 95th percentile of the background surface soil data set (95-95 Upper Tolerance Limit, or 95-95 UTL). As discussed earlier, during the RI, EPA performed an extensive investigation of the natural background concentrations of metals in surface soils in areas surrounding the Site and outside the range of site influence (see RI, Appendix E).

The soil arsenic concentrations corresponding to 1×10^{-6} and 1×10^{-4} excess lifetime cancer risk for residents at this Site are 1.5 mg/kg and 150 mg/kg, respectively; the soil arsenic concentration corresponding to a noncancer HI of 1 at this Site is 79 mg/kg (for child residents, the most sensitive resident population). It is noted that these values are higher than EPA default values used at many other sites because the site-specific relative bioavailability (RBA) is 22.5%, which is based on both *in vitro* and *in vivo* assays with site soils (see RI, Appendix H).

For residential areas west of the Agua Fria River, the BTV and cleanup level is 48 mg/kg. This level corresponds to an excess lifetime cancer risk of 3.2×10^{-5} and a noncancer HI of 0.6 for arsenic. This is within EPA's risk management risk range (i.e., 1×10^{-6} to 1×10^{-4} excess lifetime cancer risk and an HI of ≤ 1).

For residential areas east of the river, the BTV is 99 mg/kg arsenic. This corresponds to an excess lifetime cancer risk of 6.6×10^{-5} and a HI of 1.3 for arsenic. This BTV exceeds EPA's risk management range for noncancer effects (i.e., HI > 1). To ensure both protection of human health and the environment within EPA's risk management range and attainment of the CERCLA objective of not cleaning up below background, EPA is selecting a cleanup level of 79 mg/kg (HI = 1) for soils in residential areas east of the river. Because the cleanup level for residential areas east of the river (79 mg/kg) is below the corresponding BTV, statistical evaluation will be used for properties with exposure point concentrations exceeding the cleanup level, to ensure that cleanup below background does not occur. This statistical evaluation will be performed in accordance with EPA guidance (EPA 1989, EPA 1992, EPA 2002a, EPA 2002b).

Specific Discussion Regarding Cleanup Levels for Arsenic as a Carcinogen in Areas with Industrial and Recreational Land Uses*:* For areas at the Site with industrial/commercial and recreational future land uses, EPA has selected cleanup levels for arsenic that depart from the 10^{-6} excess lifetime cancer risk point of departure but remain within the 10^{-4} to 10^{-6} risk range. EPA believes that it is highly likely that these areas will remain consistently under the same uses in the future. It would not be technically feasible or cost effective to excavate the many hundreds of acres of open industrial/commercial lands at the Site to attain 10^{-6} risk levels.

Specific Discussion Regarding Lead Cleanup Levels**:** Two exposure models were used to determine cleanup levels for lead. The IEUBK model, applied to assess potential exposure to children, was used to determine a cleanup level for residential exposures. EPA's Adult Lead Methodology (ALM) was applied to calculate cleanup levels for an adult occupational and recreational receptor. The target reference blood level of 5 µg/dL was used in the calculation of a cleanup level for lead.

EPA previously used a cleanup level of 400 mg/kg lead in residential soil based on the use of the IEUBK lead model for the removal actions conducted at 47 residential properties. The former 400 mg/kg cleanup level was derived from the IEUBK model with a target blood level of 10 µg/dL. Because of developments in the toxicological science regarding the toxicity of lead, for this remedial action, EPA is setting the cleanup level for the residential exposure scenario to 200 mg/kg in soil, based on a target blood level of 5 µg/dL. A similar change for the occupational exposure scenario has resulted in an occupational cleanup level of 460 mg/kg. This change will result in the cleanup of additional residential yards.

9.0 DESCRIPTION OF ALTERNATIVES

Remedial alternatives were developed to address the extraordinary volume of mine and smelter wastes, mixed wastes and alluvium, and contaminated soils with concentrations exceeding the cleanup levels established in the ROD. Except for the No Action alternative, the alternatives would remove the wastes and contaminated media at the Site and isolate it in on-site repositories or an off-site disposal facility. Dross waste will be treated prior to disposal if it is determined that it is Bevill-exempt.[10] The alternatives also include removing and replacing surface soils in existing residential yards that have exposure point concentrations above the revised cleanup levels established in the ROD.

Because surface water contamination is directly tied to this contamination, remedial alternatives that address waste and contaminated soils will also address any surface water contamination and achieve the surface water RAO.

The remedial alternatives were screened and evaluated in accordance with the nine decision criteria set forth in the NCP, 40 C.F.R. § 300.430I(9)(iii). This section presents a summary of each of the following remedial alternative developed in the FS, with information about the residential cleanup in the 2023 supplement to the FS:

- Alternative 1: No Action.
- Alternative 2: On-Site Consolidation and Containment at One Repository at the Mine Tailings Pile.
- Alternative 3A: On-Site Consolidation and Containment at Two Repositories with Chaparral Gulch Waste to the Mine Tailings Pile.
- Alternative 3B: On-Site Consolidation and Containment at Two Repositories with Waste Remaining East and West of Highway 69.
- Alternative 4: Removal and Off-Site Disposal.

Why Recovery of Metals is Not Considered as a Remedial Alternative

Some members of the community have asked about the possibility of cleaning up the tailings at the Site using metals recovery. While recovery of metals from tailings may be possible in concept, the vast volume of tailings renders such resource recovery impracticable in a timeframe that would allow an adequate protection of human health and the environment. During the intervening reclamation and processing over a decade or more, the remaining tailings would remain exposed to the environment. If the wastes were placed in a repository before processing, reclamation would compromise the repository cover and therefore the protectiveness and permanence of the remedy, and greatly increase cost. In addition, metals reclamation from tailings leaves behind large quantities of waste products that would still need to be addressed through on-site or off-site disposal. There are presently no proven and technically and financially viable technologies for economic recovery of both tailings and mixed waste/contaminated soils on such a scale as is found at the Site.

[10] The Bevill Amendment at 42 U.S.C. Section 3001(b)(3)(A) exempted from regulation under Subtitle C of RCRA waste from the processing of certain ores and minerals, among other materials. Certain waste materials at the Site, including the tailings, waste rock, slag, and soils contaminated by these materials, may be Bevill-exempt. Other waste materials at the Site, such as the dross waste at the smelter, may not meet the requirements of the Bevill exemption, and if not, may require treatment as a characteristic hazardous waste. Characteristic hazardous waste that is not exempted by the Bevill Amendment may be subject to different technical requirements than the Bevill-exempt waste materials (see Section 5.5.4 of this ROD).

9.1 ALTERNATIVE DESCRIPTIONS

The following sections describe major elements of Alternatives 1, 2, 3A/3B and 4. In addition, Section 9.2 describes the remedial components common to all of the alternatives, except for the No Action alternative.

9.1.1 Alternative 1: No Action

Capital Cost:	$0
Present Worth Operation and Maintenance (O&M) Cost:	$0
Total Present Worth:	$0
Time Hauling Waste/Borrow on Roads:	Not applicable
Time to Complete Remedial Action:	Not applicable

The NCP set forth at 40 C.F.R. § 300.430I(6) requires the No Action alternative as a baseline for comparison to other remedial alternatives. This alternative entails no future activities to contain or remediate contaminants, provides no treatment for contaminants, and provides no additional legal or administrative protection of human health or the environment. This alternative assumes physical conditions at the Site remain unchanged, and the 6.4 million cubic yards of mine and smelter wastes remain in their current state. Wastes would continue to move in the environment and contaminate site media.

This alternative is readily implementable and has no cost. However, the No Action alternative will not meet the threshold criteria of protecting human health and the environment and complying with ARARs. This alternative will not achieve RAOs, and unacceptable risks to human health and the environment would persist indefinitely.

9.1.2 Alternative 2: On-Site Consolidation and Containment at One Repository at the Mine Tailings Pile

Capital Cost:	$70.7 million
Present Worth O&M Cost:	$2 million
Total Present Worth:	$72.7 million
Time Hauling Waste/Borrow on Roads:	At least 81 weeks
Time to Complete Remedial Action:	2.1 years
Residential Yard Cleanup Capital Cost:	$15 million[11]

Non-Residential/Waste-Bearing Areas of the Site

Under Alternative 2, the mine tailings pile at the mine property would be reconfigured and used as one repository for all wastes with contaminant concentrations exceeding the cleanup levels

[11] The cost to clean up existing residential yards was evaluated separately from the rest of the alternatives. More information on costs for the residential cleanup is in the 2023 supplemental FS. This cost applies to all remedial alternatives except for the No Action alternative.

from both sides of Highway 69 that are excavated from the Site. Alternative 2 includes excavation and removal of most mine and smelter wastes and soils.[12]

The estimated 4.3 million cubic yards of tailings currently in the mine tailings pile would remain in the repository. An additional 890,000 cubic yards (1.1 million loose cubic yards) of waste from all locations east of Highway 69 (including all wastes at the smelter and in the Chaparral Gulch) would be moved across the highway and added to the mine tailings pile waste repository.[13] About 80,000 cubic yards of excavated wastes from the west side of Highway 69 and additional contaminated soils from the residential cleanups would also be added to the mine tailings pile repository. About 350,000 cubic yards of soil and topsoil would be imported from off-site sources to construct the cover.[14] The repository would be reconfigured and regraded to ensure a stable structure. Once completed, the single repository would hold a final waste volume of 5.6 million cubic yards, including the material needed to build the cover. The repository footprint would be about 65 acres.

The waste repository at the mine tailings pile would receive a permanent engineered cover. The cover would be designed to prevent human and wildlife exposure to the waste, prevent infiltration of water into the waste, prevent future mobility of the waste including leaching of COCs to groundwater, and limit, to the extent practicable, wind and water erosion to the repository. EPA would determine the type of covers that would be used during the remedial design phase of the project.

After constructing, filling, grading, and capping the mine tailings pile repository, EPA would construct appropriate engineered drainage structures and revegetate the repository. Figure 17 presents a visual depiction of Alternative 2's waste movement and repository location.

In the future, the repository would be regularly inspected to ensure it remained effective and repaired if necessary to address any impacts from processes such as erosion. Details of repository maintenance would be established during the remedial design.

Because Highway 69 bisects the Site, Alternative 2 would pose highly significant logistical and safety challenges ensuing from the hauling of waste by trucks from the east side of the highway to the mine tailings pile repository on the west side of the highway.

Institutional Controls

The following institutional controls would be implemented for Alternative 2:

- At the mine tailings pile repository, all land use would be restricted, and excavation would be prohibited to prevent cap and cover damage.

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[12] Examples of exceptions include the remaining monolithic slag wall after stabilization and the stabilized waste rock piles northwest of the mine tailings pile. See Section 9.2 for common elements of the remedial alternatives.

[13] 1.25 loose cubic yards is assumed to approximately equal one bank cubic yard. This ROD presents soil/waste volume primarily in terms of bank cubic yards, except where noted.

[14] The Proposed Plan presented the amount of backfill needed in tons rather than cubic yards. Approximately 645,000 tons of soil would be brought in from a nearby off-site location to build the repository cover and other ancillary requirements.

- In the few areas where waste and contaminated media would not be removed and would remain under appropriate controls such as localized simple capping, land use and zoning restrictions would be applied to maintain the integrity of the controls and prevent residential use.
- Access to, and building on, the remaining stabilized slag would be prohibited because of fractures within the slag, steep slopes and cliffs, and fall danger above the Agua Fria River.
- Land use restrictions to prohibit residential use would be imposed on the industrial areas peripheral to the mine tailings pile repository.
- As an interim remedial action, potable groundwater use would be prohibited at the mine tailings pile, at the smelter property, and near and under Chaparral Gulch.

Existing Residential Areas of the Site

Alternative 2 (along with Alternatives 3A, 3B and 4) would include remedial actions in existing residential yards where exposure point concentrations in surface soils exceed the revised, lower cleanup values for arsenic and lead selected in this ROD. Sufficient soil would be removed in these yards to bring the exposure point concentrations below the cleanup levels. Contaminated soils would be disposed of safely and replaced with clean soils. Detailed plans for this cleanup action would be developed in the remedial design phase of the project.

9.1.3 Alternative 3A: On-Site Consolidation and Containment at Two Repositories with Chaparral Gulch Waste to the Mine Tailings Pile

Capital Cost:	$72.7 million
Present Worth O&M Cost:	$2.5 million
Total Present Worth:	$75.2 million
Time Hauling Waste/Borrow on Roads:	At least 46 weeks
Time to Complete Remedial Action:	1.4 years
Residential Yard Cleanup Capital Cost:	$15 million

Non-Residential/Waste-Bearing Areas of the Site

Alternative 3A is similar to Alternative 2 in that most mine and smelter wastes and soils with contaminant concentrations that exceed the cleanup levels would be excavated and disposed of (exceptions are addressed in Footnote 12 and Section 9.2 of this ROD). However, two waste repositories instead of one repository would be constructed to contain the waste. As in Alternative 2, EPA would reconfigure the mine tailings pile at the former mine property as one of the repositories. A second waste repository would be built on the smelter property, either in the existing smelter tailings depression or on the smelter plateau.

EPA's strong preference during remedial design would be to build the repository in the depression because this would make the repository less visually imposing to the surrounding community and also maximize the uses to which the smelter plateau could be used in the future. The repository may be placed on the plateau only if design limitations arose that made placing it in the depression impracticable.

In Alternative 3A, wastes excavated from areas around the mine tailings pile and from the Chaparral Gulch upstream of the dam would be disposed of in the mine tailings pile repository, not the smelter repository. Wastes excavated from areas around the smelter would be disposed of in the second repository at the smelter, east of Highway 69.

The estimated 4.3 million cubic yards of tailings currently in the mine tailings pile would remain in the repository. In addition, approximately 450,000 cubic yards of waste from the east side of the highway and approximately 80,000 cubic yards of waste from the west side of the highway as well as contaminated soils from the residential cleanups would be excavated and placed at the reconfigured mine tailings pile repository for disposal. About 350,000 cubic yards of soil and topsoil would be imported from off-site sources to construct the cover. Once completed, the mine tailings pile repository would hold a final waste volume of 5.2 million cubic yards, including the material needed to build the cover. The mine tailings pile repository footprint would be about 65 acres.

The second repository constructed at the smelter property would be the disposal location for approximately 430,000 cubic yards of wastes around the smelter, including dross, slag, the Agua Fria tailings piles near the Agua Fria River, and mixed wastes from the smelter blowout area. Approximately 125,000 cubic yards of borrow material would be imported to build the cover on the repository. Once completed, the smelter repository would contain about 550,000 cubic yards of material before final grading and compaction and have a footprint of 21 acres.

Both repositories would receive a permanent engineered cover. The covers would be designed to prevent human and wildlife exposure to the waste, prevent infiltration of water into the waste, prevent future mobility of the waste including leaching of COCs to groundwater, and limit, to the extent practicable, wind and water erosion to the repository. EPA would determine the type of covers that would be used in the remedial design phase of the project. After constructing, filling, grading, and capping the repositories, EPA would construct appropriate engineered drainage structures and revegetate the repository.

In the future, both repositories would be regularly inspected to ensure they remained effective and repaired if necessary to address any impacts from processes such as erosion. Details of repository maintenance would be established during the remedial design.

Figure 18 presents a visual depiction of waste movement and repository locations under Alternative 3A.

Similar to Alternative 2, Alternative 3A would pose logistical and safety challenges ensuing from the hauling of waste by trucks from the east side of Highway 69 to the mine tailings pile repository on the west side of Highway 69.

Institutional Controls

The institutional controls anticipated under Alternative 3A would be the same as those for Alternative 2, except that land use would be restricted and excavation prohibited at both the mine tailings pile repository and the second repository at the smelter property.

Existing Residential Areas of the Site

As with Alternatives 2, 3B and 4, Alternative 3A would include remedial actions in existing residential yards where exposure point concentrations in surface soils exceed the revised, lower cleanup values for arsenic and lead selected in this ROD. Sufficient soil would be removed in these yards to bring the exposure point concentrations below the cleanup levels. Contaminated soils would be disposed of safely and replaced with clean soils. Detailed plans for this cleanup action would be developed in the remedial design phase of the project.

9.1.4 Alternative 3B: On-Site Consolidation and Containment at Two Repositories with Waste Remaining East and West of Highway 69

Capital Cost:	$69.6 million
Present Worth O&M Cost:	$2.5 million
Total Present Worth:	$72.1 million
Time Hauling Waste/Borrow on Roads:	At least 37 weeks
Time to Complete Remedial Action:	1.2 years
Residential Yard Cleanup Capital Cost:	$15 million

Non-Residential/Waste-Bearing Areas of the Site

Alternative 3B is similar to Alternative 3A in that EPA would excavate most mine and smelter wastes and contaminated soils with concentrations of COCs that exceed the cleanup levels and dispose of the waste in two repositories, with one repository on each side of Highway 69. Exceptions, such as monolithic slag remaining after stabilization, are addressed in Footnote 12 and Section 9.2 of this ROD.

As in Alternative 3A, EPA would reconfigure the mine tailings pile at the former mine property as one of the repositories. A second waste repository would be built on the smelter property, either in the existing smelter tailings depression or on the smelter plateau. EPA's strong preference during remedial design would be to build the repository in the depression because this would make the repository less visually imposing to the surrounding community and also maximize the uses to which the smelter plateau could be used in the future. The repository would be placed on the plateau only if design limitations arose that made placing it in the depression impracticable.

The difference between Alternative 3A and Alternative 3B is that wastes excavated from east of Highway 69, *including* from the Chaparral Gulch, would be disposed of in the second repository at the former smelter property, east of Highway 69. Unlike Alternative 3A, no waste would be transported across the highway for disposal under Alternative 3B.

The estimated 4.3 million cubic yards of tailings currently in the mine tailings pile would remain in the repository. An additional 80,000 cubic yards of waste from the west side of the highway would be added to the repository. Once completed, the mine tailings pile repository would hold a final waste volume of 4.7 million cubic yards, including the material needed to build the cover. The mine tailings pile repository footprint would be about 65 acres.

The second repository constructed at the smelter property would be the disposal location for approximately 900,000 cubic yards of wastes around the smelter, including dross, slag, the Agua Fria tailings piles near the Agua Fria River, and mixed wastes from the smelter tailings blowout area. Approximately 125,000 cubic yards of borrow material would be imported to build the cover on the repository. Once completed, the smelter repository would contain about 1 million cubic yards of material before final grading and compaction and have a footprint of 22 acres.

Both repositories would receive an engineered cover. The covers would be designed to prevent human and wildlife exposure to the waste, prevent infiltration of water into the waste, prevent future mobility of the waste including leaching of COCs to groundwater, and limit to the extent practicable wind and water erosion to the repository. EPA would determine the type of covers that would be used during the remedial design.

After constructing, filling, grading, and capping the repositories, EPA would construct appropriate engineered drainage structures and revegetate the repositories.

In the future, both repositories would be regularly inspected to ensure they remained effective and repaired if necessary to address any impacts from processes such as erosion. Details of repository maintenance would be established during the remedial design.

Figure 19 presents a visual depiction of waste movement and repository locations under Alternative 3B.

Institutional Controls

The institutional controls anticipated under Alternative 3B would be the same as those for Alternative 3A.

Existing Residential Areas of the Site

As with Alternatives 2, 3A, and 4, Alternative 3B would include remedial actions in existing residential yards where exposure point concentrations in surface soils exceed the revised, lower cleanup values for arsenic and lead selected in this ROD. Sufficient soil would be removed in these yards to bring the exposure point concentrations below the cleanup levels. Contaminated soils would be disposed of safely and replaced with clean soils. Detailed plans for this cleanup action would be developed in the remedial design phase of the project.

9.1.5 Alternative 4: Removal and Off-Site Disposal

Capital Cost:	$567.4 million
Present Worth O&M Cost:	$2.5 million
Total Present Worth:	$568.6 million

Time Hauling Waste/Borrow on Roads: 487 weeks (>9 years)
Time to Complete Remedial Action: 9.9 years

Residential Yard Cleanup Capital Cost: $15 million

Non-Residential / Waste-Bearing Areas of the Site

Under Alternative 4, EPA would excavate nearly all tailings, including the mine tailings pile, most soils, loose slag, dross, and other mine wastes with contaminant levels that exceed the cleanup levels and transport the wastes off site for disposal. Exceptions, such as monolithic slag remaining after stabilization, are addressed in Footnote 12 and Section 9.2 of this ROD. There would be no waste repositories. This alternative would include transportation of approximately 5.2 million cubic yards of waste at least 85 miles to the nearest waste transfer station, likely near Phoenix, Arizona, where the waste would be unloaded and reloaded into other transport containers (i.e., trucks or railcars) and transferred to a permitted treatment, storage and disposal facility. After excavation, the removal areas would be backfilled where necessary and vegetated. With a few exceptions, the land would be reusable for industrial/commercial activities and for residential development in residential areas. Approximately 190,000 cubic yards of soil would be brought in from a nearby off-site location to backfill the excavations.

This alternative would require 260,000 truckloads of waste from the Site and would require a tremendously large traffic load on streets through Dewey-Humboldt and Highway 69 to the disposal facility. Finding a disposal facility that could and would accept this tremendous volume of waste would be difficult.

Under Alternative 4, double-handling of wastes would be necessary during excavation and transport of all wastes to the off-site disposal facility. In double-handling, waste must be transferred from off-road haul trucks to smaller on-road haul trucks before reaching the off-site disposal location. On-road haul trucks are less efficient and cost more to operate, thereby resulting in higher costs per unit volume transported. Off-road haul trucks would transport the wastes from the point of excavation in areas difficult to access to a transfer area. Wastes would then be transferred to on-road haul trucks that would transport it to the off-site disposal facility. Figure 20 depicts the waste removal areas under Alternative 4.

Institutional Controls

The following institutional controls would be implemented for Alternative 4:

- Access to, and building on, the remaining stabilized slag would be prohibited because of fractures within the slag, steep slopes and cliffs, and fall danger above the Agua Fria River.
- In the few areas where waste and contaminated media would not be removed and would remain under appropriate controls such as localized simple capping, land use and zoning restrictions would be applied to maintain the integrity of the controls and prevent residential use.
- Land use restrictions to prohibit residential use would be imposed on the industrial areas peripheral to the former mine tailings pile.

- As an interim remedial action, potable groundwater use would be prohibited at the mine tailings pile, smelter property, and near and under the Chaparral Gulch.

Existing Residential Areas of the Site

As with Alternatives 2, 3A and 3B, Alternative 4 would include remedial actions in existing residential yards where exposure point concentrations in surface soils exceed the revised, lower cleanup values for arsenic and lead selected in this ROD. Sufficient soil would be removed in these yards to bring the exposure point concentrations below the cleanup levels. Contaminated soils would be disposed of safely and replaced with clean soils. Detailed plans for this cleanup action would be developed in the remedial design phase of the project.

9.2 Common Elements for Alternatives

With the exception of the No Action alternative, all alternatives include the following common elements.

9.2.1 Treatment of Dross at the Smelter Prior to Disposal

The dross at the smelter may not be subject to the exclusion for mining materials in the Bevill Amendment to RCRA (see Section 5.5.4). Some dross samples exceeded toxicity characteristic leaching procedure (TCLP) limits for RCRA 8 metals. If the dross is determined to be a RCRA Subtitle C hazardous waste, then dross at the smelter property with concentrations exceeding the TCLP limits will be excavated and treated (e.g., solidification with Portland cement) to stabilize the waste and remove the hazardous waste toxicity characteristic before disposal either in an on-site repository, or an off-site disposal facility, depending on the remedial alternative.

9.2.2 Stabilization of the Monolithic Slag Wall at the Smelter

In contrast to the loose (crumbled or pulverized) slag at the smelter, the monolithic slag at the smelter property is a single solid mass. There is not an exposure pathway for slag to pose a health risk so long as the slag remains in this solid form. However, there is unstable monolithic slag overhanging the Agua Fria River. When chunks of this slag break off, they fall into the river, pulverize, and are then eroded by streamflow. This can release small slag particles with potentially leachable metals into the water. Removal of all of the monolithic slag is not practicable. Under all alternatives, the monolithic slag will be stabilized to prevent further dropping of slag materials from the monolithic slag wall into the Agua Fria River. This may include partially removing slag to lay back the angle of the slag face to a point that it is stable.

Other means of stabilization may be developed in the remedial design phase. Any slag removed from the monolithic slag will be disposed of in an on-site repository, or an off-site disposal facility, depending on the alternative. The remaining stabilized monolithic slag will be managed through institutional controls and engineering controls.

9.2.3 Demolition of the Lower Chaparral Gulch Dam

All alternatives, except for the No Action alternative, include removal of the Chaparral Gulch dam to allow access to waste in Lower Chaparral Gulch and restore the natural hydraulics and vegetation of the drainage.

9.2.4 Former Mineworks Area West of the Mine Tailings Pile

Some areas west of the mine tailings pile are built on waste rock. While surface soils can be removed as necessary, the underlying waste rock is deep and cannot be removed entirely. The waste rock is also beneath operating facility structures. In these areas, limited soil removal to meet occupational cleanup levels will take place. Where removal is not practicable, simple capping will be used to prevent exposure to the waste left in place. There are also small satellite piles of loose waste rock west of the mineworks area that will be removed and moved to an on-site repository, or an off-site disposal facility, depending on the alternative.

9.2.5 Open Lands North and South of the Mine Tailings Pile

The open lands just north and south of the mine tailings pile have subareas with differing reasonably anticipated future land uses including occupational, recreational, and residential (Figure 4). In the specific portions of these areas where the anticipated land use is recreational, contaminants are not present at levels exceeding cleanup levels protective of recreational receptors. Where the anticipated land use is occupational or residential, there is open chaparral land with locally high levels of contaminants with exposure point concentrations above cleanup levels. The boundaries of these areas will be further refined during remedial design. In the areas with residential or occupational anticipated land use, soil with exposure point concentrations above cleanup levels will be removed to a maximum depth of two feet and disposed of in an on-site repository or an off-site disposal facility, depending on the alternative.

In areas with either residential or occupational anticipated land use, if exposure point concentrations above cleanup levels remain after excavation, a warning barrier will be placed in the excavation.

9.2.6 Removal of Satellite Tailings and Waste Rock Piles

Alternatives 2, 3A, 3B and 4 also include removal and disposal of the satellite piles of waste rock west of the mine property and the small tailings piles in the Lower Chaparral Gulch and adjacent to the Agua Fria River. The materials will be disposed of either in an on-site repository or an off-site disposal facility, depending on the alternative.

9.2.7 Removal of Contaminated Soil at Existing Residential Properties

EPA is selecting cleanup levels for arsenic and lead that are lower than the cleanup levels used at the time of the removal actions in 2006, 2011 and 2017. Therefore, this will result in the cleanup of soils in additional residential yards. All alternatives, except for the No Action alternative, include excavation of soils with exposure point concentrations of contaminants exceeding the residential soil cleanup levels to a maximum depth of two feet in affected residential yards, replacement with clean soil, and yard restoration. Additional work will include preparation of access agreements and a pre-remediation work plan for each identified property.

Following excavation, confirmatory soil samples will be collected to verify that cleanup levels have been met. In cases where contaminated soil is still found at the two-foot depth, a warning barrier, such as plastic snow fence material, will be placed at that depth as a visual barrier before placing backfill material in the excavation. Landowners with warning barriers left on their parcel after cleanup will receive instructions from EPA on how to handle a warning barrier if the barrier is exposed. Also, the town government will receive instructions and a map of all parcels with a warning barrier.

Excavated materials will be transported to an on-site repository (in Alternatives 2, 3A and 3B) or an off-site disposal facility (in Alternative 4).

9.2.8 Surface Water and Groundwater Monitoring

After implementing source removal by excavating wastes from the Lower Chaparral Gulch and removing the slag in the Agua Fria River that has pulverized off the overhead monolithic slag near the smelter, levels of metals in the water of the Agua Fria River are expected to decline to levels below water quality standards. All alternatives, except for the No Action alternative, include monitoring of the Agua Fria River water for the surface water COCs to verify this is occurring.

In addition, the alternatives include groundwater monitoring to support a final remedy decision for groundwater in the future.

9.2.9 Five-Year Reviews (FYRs)

Remedial actions that result in hazardous substances, pollutants, or contaminants remaining at a Site above levels that allow for unlimited use and unrestricted exposure are required, by Section 121I of CERCLA, to be reviewed every five years to ensure protection of human health and the environment. FYRs would be required for all of the alternatives except for the Alternative 1 – No Action. Implementation and performance of the remedy will be evaluated every five years through review of monitoring and site inspection results. Results of the review and any required follow-up actions will be discussed in the FYR Report.

9.3 Distinguishing Features of Each Alternative

Except for the No Action alternative, the primary distinguishing features among the remaining alternatives is the final disposition of mine and smelter wastes and contaminated soils and the degree and nature of long-term operation and maintenance. Alternatives 2, 3A and 3B include disposal of the wastes and contaminated soils in one (Alternative 2) or two (Alternatives 3A and 3B) on-site repositories that must be maintained indefinitely. The degree and nature of long-term operation and maintenance of waste repositories is dependent on the number of repositories and the areal footprint of the cover(s) that must be maintained. Two repositories require more maintenance than one repository.

Alternative 4 does not have on-site repositories, as all waste would be disposed of off site. Therefore, it eliminates the need for on-site long-term repository maintenance. However, waste hauled off site under this alternative would likely necessitate long-term maintenance of a distant off-site disposal facility.

The following features apply:

- Alternative 2: One repository covering 65 acres.
- Alternative 3A: Two repositories, covering 65 acres and 20.5 acres, respectively.
- Alternative 3B: Two repositories, covering 65 acres and 22 acres, respectively.
- Alternative 4: Waste to an off-site distant disposal facility, which would require maintenance and management by a waste vendor.

Additional distinguishing features of each alternative are addressed in Sections 9.1.2 through 9.1.5.

It is noted that all alternatives except for the No Action alternative involve remedial action in residential yards to achieve lower cleanup levels, and this is not a distinguishing feature among the alternatives.

9.4 Expected Outcomes of Each Alternative

Under Alternative 1, the Site would remain in its current state. The mine tailings pile and other waste and contaminated soil would remain and could continue to move in the environment and contaminate site media. Some residential properties would continue to have soils with levels of contaminants above the revised cleanup levels set in this ROD. Unacceptable risks to human and ecological receptors would remain.

Under Alternative 2, all waste would be removed and contained in a single repository at the mine tailings pile. Isolated contaminated soil that remains in place outside the repository would be managed with engineering and institutional controls, allowing continued industrial use near the mine tailings pile. Levels of contaminants in soils in residential yards would be reduced to below the revised, lower cleanup standards set forth in this ROD. Alternative 2 would address all risks to human and ecological receptors under the anticipated land use for each area of the Site (Figure 4). The top of the mine tailings pile repository cover could become open space. The top of the repository most likely could not be developed, though appropriate uses can be evaluated during and after remedial design. Under any reuse scenario, the waste would remain contained. The smelter property would be restored and would be ready for the anticipated future land use, which could include a mix of industrial, residential, and recreational uses (Figure 4).

With removal of the sources of contamination at the Site, surface water contamination is expected to decrease in concentration over time to meet water quality standards in this ROD. Alternative 2 would prevent consumption of shallow groundwater from within and under the waste areas subject to the remedial action. This is an interim measure pending selection of a permanent groundwater remedy at a later date.

Under Alternatives 3A and 3B, most waste would be removed and contained in two separate repositories. Isolated contaminated soil that remains in place outside the repositories would be managed with engineering and institutional controls, allowing continued industrial use near the mine tailings pile. Levels of contaminants in soils in residential yards would be reduced to below the revised, lower cleanup standards set forth in this ROD. Alternatives 3A and 3B would address all risks to human and ecological receptors under the anticipated land use for each area of the Site (Figure 4). The top of the repositories most likely could not be developed, though appropriate uses can be evaluated during and after remedial design. Under any reuse scenario, the waste would remain contained. Other areas at the smelter property would be restored and would be ready for the anticipated future land use, which could include a mix of industrial, residential, and recreational uses (Figure 4).

With removal of the sources of contamination at the Site, surface water contamination would decrease in concentration over time to meet water quality standards in this ROD. Both Alternatives 3A and 3B would prevent consumption of shallow groundwater from within and under the waste areas subject to the remedial action. This is an interim measure pending selection of a permanent groundwater remedy at a later date.

Under Alternative 4, most waste and contaminated soils would be removed from the Site. Exceptions include the remaining monolithic slag pile after stabilization and the stabilized waste rock piles northwest of the mine tailings pile. Levels of contaminants in soils in residential yards would be reduced to below the revised, lower cleanup standards set forth in this ROD. Alternative 4 would address all unacceptable risks to human and ecological receptors under the anticipated land use for each area of the Site (Figure 4). With few exceptions, land would be ready for the anticipated future land use, which could include a mix of industrial, residential, and recreational uses (Figure 4). Under any reuse scenario, the waste would remain contained.

With removal of the sources of contamination at the Site, surface water contamination would decrease in concentration over time to meet water quality standards in this ROD. Alternative 4 would prevent consumption of shallow groundwater from within and under the waste areas subject to the remedial action. This is an interim measure pending selection of a permanent groundwater remedy at a later date.

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The remedial alternatives summarized in this ROD have been evaluated against the nine decision criteria set forth in the NCP, 40 C.F.R. § 300.430I(9)(iii). These nine criteria are organized into three categories: threshold criteria, primary balancing criteria and modifying criteria. Threshold criteria must be satisfied in order for an alternative to be eligible for selection. Primary balancing criteria are used to weigh major trade-offs among alternatives. Modifying criteria are taken into account after public comments have been received.

The NCP criteria are:

Threshold Criteria

1) Overall Protection of Human Health and the Environment addresses whether or not an alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced or controlled, through treatment, engineering controls and/or institutional controls.

2) Compliance with ARARs considers whether or not an alternative will meet all federal or state standards required by environmental laws or whether there is justification for waiving the standards.

Primary Balancing Criteria

3) Reduction of Toxicity, Mobility and Volume through Treatment indicates EPA's preference for alternatives that include treatment processes to lower or eliminate the hazardous nature of material, its ability to move in the environment, and the amount left after treatment.

4) Long-Term Effectiveness and Permanence considers the long-term effectiveness and permanence of maintaining the protection of human health and the environment after implementing each alternative.

5) Short-Term Effectiveness considers the effect of each remedial alternative on the protection of human health and the environment during the construction and implementation phase.

6) I considers the technical and administrative feasibility of implementing each alternative and the availability of the services and materials required during implementation.

7) Cost considers construction costs as well as long-term operation and maintenance costs of each alternative by considering whether costlier alternatives provide additional public health benefits for the increased cost.

Modifying Criteria

8) State Acceptance considers whether the State agrees with, disagrees with, or has no comment on EPA's preferred alternative.

9) Community Acceptance considers the concerns or support the public may offer regarding each alternative.

EPA uses the nine criteria to evaluate the remedial alternatives individually and against each other to select a remedy. This section of the ROD profiles the relative performance of each alternative against the nine criteria, noting how it compares to the other options under consideration. The FS includes a detailed evaluation of the remedial alternatives. Table 9 includes a summary of the comparative analysis.

10.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 1 (No Action) would not be protective of human health and the environment. It would not achieve RAOs and all estimated risks to human health and the environment would continue. Continued migration of contaminants could occur.

Alternatives 2, 3A, 3B and 4 would be protective of human health and the environment and compare similarly with respect to this criterion. Alternatives 2, 3A and 3B would meet all the RAOs by isolating site wastes and contaminated soils in consolidated and capped repositories that prevent exposure and migration of contaminants. In areas where contaminated soil/waste remain in place and outside the repositories, engineering controls such as soil covers and institutional controls would be used to prevent exposure.

Alternative 4 would also be protective of human health and the environment and meet RAOs by removing nearly all wastes from the Site and managing any remaining site risk with engineering controls such as soil covers and institutional controls.

10.2 Compliance with ARARs

Section 121(d) of CERCLA and the NCP set forth at 40 C.F.R. § 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate federal and more stringent state environmental requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4). See NCP Definitions of 'Applicable requirements' and 'Relevant and appropriate requirements' at 40 C.F.R. § 300.5.

Other than Alternative 1 (No Action), the remaining alternatives would meet ARARs identified in Appendix A of the FS. Among the key chemical-specific ARARs are specific provisions of: 1) Arizona Soil Remediation Standards, and 2) the federal Clean Water Act (CWA) and associated State provisions and requirements including water quality criteria (e.g., CWA Sections 303 and 304) with respect to the Chaparral Gulch and the Agua Fria River. Among the key location-specific ARARs are CWA Section 404 provisions with regard to wetlands and Federal Emergency Management Agency (FEMA) regulations with regard to activities in floodplains (such as the tailings floodplain in the Chaparral Gulch). Additionally, the NHPA applies to portions of the Site based on a cultural resource and historic building survey that was conducted during the RI.

CWA § 304 is the controlling potential federal chemical-specific ARAR for surface water standards for aluminum, cadmium, copper, cyanide, iron, and zinc for the protection of aquatic receptors. The water quality standards for beryllium, mercury, and selenium in the Arizona Administrative Code (AAC) R18-11-104 are identified as the controlling potential state chemical-specific ARARs. The point of compliance for these potential chemical-specific ARARs is the Agua Fria River at the confluence of the Chaparral Gulch and the Agua Fria River.

Alternatives 2, 3A and 3B would achieve compliance with these surface water ARARs directly by preventing runoff to entrain the waste and flow to surface water bodies. Alternatives 2, 3A and 3B also protect surface water indirectly by limiting infiltration through waste to groundwater (that may surface) by capping the waste. Alternative 4 mostly removes the source of contamination directly by excavation and disposal off-site; both runoff and surfacing groundwater are protected. All alternatives involve water quality monitoring to confirm the expected efficacy of the remedial action.

Finally, Alternatives 2, 3A and 3B, and 4 would achieve compliance with federal and state action-specific ARARs, including the federal Clean Air Act requirements governing control of fugitive dust during excavation and removal of various wastes set forth in AAC R18-2-604, -606, -607, and -608.

10.3 Long-Term Effectiveness and Permanence

Other than Alternative 1, Alternatives 2, 3A and 3B would all be effective and permanent over the long term provided that long-term repository maintenance is performed. Because it requires only one repository, Alternative 2 would be somewhat easier to maintain than Alternatives 3A and 3B. Alternative 4 would have the highest degree of long-term effectiveness and permanence by removing nearly all wastes from the Site, eliminating the need for long-term maintenance of an on-site repository.

Under Alternatives 2, 3A, 3B and 4, some waste would remain in place in limited areas of the Site but with appropriate physical barriers and institutional controls that are also effective and permanent.

10.4 Reduction of Toxicity, Mobility and Volume

Other than Alternative 1 (No Action), the alternatives would consolidate and therefore reduce the volume of contaminants and eliminate their mobility. By requiring only one repository, Alternative 2 would reduce the volume of contamination more than Alternatives 3A and 3B, which require two repositories. However, the difference in volume would be small. The extraordinary volume of the wastes at the Site makes the implementation of treatment technologies impracticable. EPA therefore expects to use engineering controls instead of treatment for this waste under all the alternatives evaluated. See 40 C.F.R. § 300.430(a)(1)(iii)(B).

Other than treatment of the dross at the smelter before placement in the repository or transportation off site for disposal, the statutory preference for treatment would not be met under any of the evaluated alternatives.

10.5 Short-Term Effectiveness

The community would experience short-term impacts under all the cleanup alternatives except for Alternative 1 (No Action).

Each cleanup alternative would excavate and move large quantities of mine and smelter wastes. Continuous hauling by large trucks over extended periods of time (about 1 to 2 years) would be required for Alternatives 2, 3A and 3B. This would also be required for Alternative 4, which could require 10 years of hauling wastes and borrow material on public roadways. During the period of cleanup, residents, businesses and drivers would need to accommodate construction activities and trucks entering and leaving work areas. Traffic delays and congestion along haul routes would be possible, especially on Highway 69 and along Third Street from the Chaparral Gulch to Highway 69. EPA would maintain controls for traffic and dust.

The cleanup alternatives differ most dramatically with regard to these short-term impacts. The most important differentiating factor is whether waste must be moved across (or on) Highway 69. Alternative 2 and Alternative 3A require wastes to be moved across Highway 69 from the east side of the highway to the mine tailings pile at the former mine property. Alternative 3B does not. Alternative 4 requires nearly all the waste at the Site to be hauled not only across but on Highway 69. Hauling waste across or on the highway would dramatically increase traffic congestion, delays, and community disruption. The short-term impacts of the cleanup alternatives other than Alternative 1 (No Action), which would have no short-term impacts, rank in this order:

- Alternative 3B would pose the least short-term impacts (including highway traffic impacts) because no waste would cross the highway, and the time to haul the wastes would be the shortest. The time to haul wastes on the roads would be the least of any alternative (37 weeks), compared to Alternative 2 (81 weeks), Alternative 3A (46 weeks) and Alternative 4 (487 weeks, or more than 9 years).
- Alternative 3A would pose more short-term impacts than Alternative 3B but not as much as Alternative 2. Wastes would have to cross the highway, but not as much as in Alternative 2.
- Alternative 2 would pose greater short-term impacts than Alternatives 3A or 3B because all waste on the east side of the highway would have to cross the highway. Also, the hauling of wastes would take place for a longer time.
- Alternative 4 would pose by far the most highway traffic impacts because all the wastes at the Site would be hauled not only across Highway 69, but on Highway 69 for 85 miles for 10 years.

10.6 Implementability

Although the project is large, complex and requires complicated logistics, staging and phasing across different areas of the Site, all of the action alternatives are technically feasible to implement. Alternatives 2, 3A, 3B and 4 all involve mainly earthwork and material hauling of wastes with equipment that is readily available. Services and materials to complete the work are readily available. Some specialized but available equipment may be needed for steep slopes, potential blasting and/or breakup of monolithic slag and the dam.

One repository (Alternative 2) is somewhat easier to build and implement than two repositories (Alternatives 3A and 3B). A single repository would require less design, permitting (or meeting substantive permit requirements), approvals, coordination with agencies for repository construction and required O&M compared to Alternatives 3A and 3B with two repositories.

Alternatives 2 and 3A involve moving wastes across Highway 69, which presents more implementability concerns than Alternative 3B in which no wastes have to cross the highway. Alternatives 2 and 3A would require approval and coordination with the Arizona Department of Transportation (ADOT). Alternative 3B would also require coordination with ADOT since borrow material would still need to be hauled on site for the repository covers and caps. At the Highway 69 and Third Street and/or Main Street intersections, ADOT may require right-hand turn lanes, new traffic signals, synchronization of traffic flow with the Highway 69 and Main Street traffic light, timed lights, reduced speeds, and other traffic control features.

Alternative 4 would be much more difficult to implement than Alternatives 2, 3A or 3B because it would involve excavating nearly all of the waste at the Site and transporting it on Highway 69 and other roads to a remote off-site facility in an effort that would take nearly 10 years. Alternative 4 could also require agreements and coordination with ADOT. At the Highway 69 and Third Street intersection and/or Main Street intersection, ADOT may require right-hand turn lanes, new traffic signals, synchronization of traffic flow with the Highway 69 and Main Street traffic signals, timed traffic signals, reduced speeds, and other traffic control features. ADOT may also have to permit traffic flows all the way from the Site to the off-site disposal facility.

10.7 Cost

Alternative 1 would have no cost.

The costs of Alternatives 2, 3A and 3B are similar. The 30-year estimated net present cost values of these alternatives would vary by only 5%, ranging from $72.1 million to $75.2 million. EPA (1988) guidance suggests that alternative cost estimates in the FS should be within +50% to -30%. Given this, the net present values of Alternatives 2, 3A and 3B are equivalent within the margin of accuracy of the estimates. The estimated cost of Alternative 4 is $568.6 million, nearly eight times the cost of the other alternatives other than No Action. Table 9 summarizes capital, O&M and total present worth costs for Alternatives 2, 3A, 3B and 4. Note that costs for the remedial action at existing residential properties is not included in the cost estimates for each alternative in the FS. Costs for the residential cleanup were evaluated separately in the 2023 supplemental FS and are expected to add an additional $15 million to the total present values in Table 9.

10.8 State Acceptance

ADEQ, the support agency, has engaged continually with EPA on the Site project, has reviewed the RI, FS and Proposed Plan for the Site, and has expressed its preference for Alternative 3B. The State would not accept the selection of Alternative 1 (No Action) or Alternative 4. The State concurs with the selected remedial action in residential yards to reduce exposure point concentrations to below the cleanup levels selected in this ROD. Having reviewed this ROD in draft, the State concurs with the action selected in this ROD. Appendix B provides the State concurrence letter.

10.9 Community Acceptance

Responses to public comments received on the Proposed Plan for this remedy are provided in Part 3 of this ROD. The Dewey-Humboldt Town Council has expressed its support in writing for Alternative 3B, under which there would be one repository on each side of the highway and no wastes would have to cross the highway. The community would not accept Alternative 1 (No Action) because the wastes and contaminated soils would remain exposed, continue to move in the environment, and continue to pose a risk to the community. The community is frustrated with the length of time it has taken to address the Site and urgently wants to see the cleanup completed. The community would not accept Alternative 4 due to the extreme length of time it would take to implement, the extreme disruption to the community that would be involved, and the public perception that funding would not ever be available to cover the extreme cost.

There were some public comments received expressing a preference for Alternative 2, in which the mine tailings pile is the only repository and all waste on the east side of the highway is moved across the highway to the west side. Those community members expressing this view preferred not to have any new waste repository within the town east of Highway 69 so that full use of all the smelter property could be retained. They would like all the waste consolidated in one place on the mine tailings pile. There was also an interest in implementing Alternative 2 by building a tunnel under Highway 69 to move waste rather than trucking it across the highway. EPA has examined the possibility of a tunnel and found that, while it is technically conceivable, it would be far more costly than the Alternative 2 evaluated in the FS and Proposed Plan and present significant hurdles with respect to implementability. Specifically, excavating and constructing a tunnel under an active high-volume highway such as Highway 69 that is the primary link between the town and greater Prescott area and metropolitan Phoenix presents challenges as it is located in a major drainage subject to intense flooding. No comments were submitted expressing a preference for Alternative 3A.

11.0 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site, wherever practicable (40 C.F.R. § 300.430(a)(1)(iii)(A)). The "principal threat" concept is applied to the characterization of source materials at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for the migration of contamination to groundwater, surface water or air, or act as a source for direct exposure.

The mine tailings pile, other mine and smelter wastes, and soil contaminated with high concentrations of COCs are considered principal threat wastes at the Site as they are potentially mobile due to wind entrainment and surface runoff. However, the high volume of waste and contaminated soils at the Site makes treatment impracticable. Therefore, EPA expects to use engineering controls where treatment is impractical (40 C.F.R. § 300.430(a)(1)(iii)(B)).

Except for the No Action alternative, all alternatives will address principal threat waste at the Site with removal and containment either in an on-site repository (Alternatives 2, 3A and 3B) or off-site disposal facility (Alternative 4), thereby reducing the volume of principal threat waste and eliminating its mobility.

In addition, dross waste at the smelter property will be excavated and treated with Portland cement to stabilize the waste and remove the hazardous waste toxicity characteristic before disposal in an on-site repository or off-site disposal facility.

12.0 SELECTED REMEDY

Based on consideration of the results of site investigations, the requirements of CERCLA, the detailed analysis of remedial alternatives and public comments, EPA's selected remedy is **Alternative 3B: On-Site Consolidation/Containment at Two Repositories with Waste Remaining East and West of the Highway**. As with all alternatives other than Alternative 1 (No Action), the selected alternative includes remedial actions in existing residential soils to reduce exposure point concentrations below the revised, lower cleanup levels selected in this ROD.

The selected remedy is the final remedy for soils in residential areas, mine and smelter waste and contaminated soils in non-residential areas, and surface water in the Agua Fria River and the Chaparral Gulch on and downstream of the smelter property. It is an interim remedy for groundwater at the Site (see Section 4.0, Scope and Role of the Response Action, of this ROD).

12.1 SUMMARY OF THE RATIONALE FOR THE SELECTED REMEDY

Based on currently available information, EPA has determined that Alternative 3B meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. EPA expects the selected remedy to satisfy the following statutory requirements of CERCLA §121(b): 1) be protective of human health and the environment; 2) comply with ARARs; 3) be cost effective; and 4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and 5) satisfy the preference for treatment as a principal element.

Under Alternative 3B, most mine and smelter wastes and soils with contaminant levels that exceed the cleanup levels would be removed and disposed of in two waste repositories, with one repository on each side of Highway 69. All waste currently located on the east side of the highway would remain in the repository on the east side at the former smelter property. Waste currently located on the west side of the highway would be moved to the mine tailings pile, which would be reconfigured as a repository.

Alternative 3B, like Alternatives 2 and 3A, would fully protect human health and the environment over the long term by sealing the site waste and contaminated soils in a permanently capped and maintained repository. It would prevent people and wildlife from being exposed to site wastes and contamination and prevent the wastes from moving in the environment.

EPA believes that Alternative 3B is superior to Alternatives 2 and 3A because it achieves protection of human health and the environment as well as Alternatives 2 and 3A and at about the same cost, but without requiring wastes to be moved across Highway 69. Unlike Alternative 3B, Alternatives 2 and 3A would impose greater impacts on the community due to trucks with waste having to cross continuously from the east to the west side of Highway 69 for about one to two years. Those impacts would include higher highway traffic congestion and delays, in-town congestion, an increase in the chance of traffic accidents, and more disruption to residents. Alternative 3B avoids most of these impacts by placing waste in a repository that is located on the same side of the highway as where it currently lies. Alternative 3B, as with Alternatives 2 and 3A, would still require that trucks on Highway 69 haul in clean soils from off-site locations in order to build the repository covers.

The Superfund law requires that a "No Action" option (Alternative 1) be retained and compared to the other alternatives. At the Site, this alternative would result in unabated threats to human health and the environment. People and wildlife would remain exposed to mining and smelting wastes, which would remain open to the environment and free to move. This alternative does not meet the threshold requirements for protecting human health and the environment, and therefore EPA considers it highly unacceptable.

Alternative 4 would require hauling 5.3 million cubic yards of material on Highway 69 for nearly 10 years at a cost of $569 million, or eight times the cost of Alternatives 2 and 3A/3B and requiring up to 13 times as long to achieve cleanup as any other alternative. It would impose extreme impacts on the Dewey-Humboldt community and communities southward on the Highway 69 in terms of traffic congestion, disruption, and increased chances of traffic accidents. For these communities, Highway 69 is the primary roadway connecting them to the greater Phoenix area and beyond. It would not confer appreciable additional benefits over the other alternatives in terms of protecting human health and the environment.

EPA finds that the statutory preference for treatment will not be attainable due to the exceedingly high volume of tailings, mine wastes and contaminated soils at the Site, which renders treatment impracticable. It is noted that under the remedy the dross at the smelter will be treated.

12.2 DETAILED DESCRIPTION OF THE SELECTED REMEDY

12.2.1 Selected Remedial Action in Non-Residential / Waste-Bearing Areas

12.2.1.1 Excavation of Waste with Disposal In Repositories

As the fundamental element of the remedial action for the Site, wastes and contaminated soils at the Site posing an unacceptable risk to human health or the environment shall be subject to on-site consolidation and containment. With the exceptions specifically identified below, mine and smelter wastes, mixed wastes and alluvium, and contaminated soils with exposure point concentrations exceeding the cleanup levels selected in this ROD shall be excavated, if necessary, and moved to one of two waste repositories constructed on site. The areas from which wastes and contaminated soils shall be excavated and disposed (where cleanup levels are exceeded) include the areas listed below, and *also* those discussed in subsections following this subsection.

- Mine Tailings Pile Upper and Lower Tier.
- Mine Drainage (Blowout) Pathway.
- Upper Chaparral Gulch Surface Soils.
- Middle Chaparral Gulch.
- Tailings Floodplain.
- Lower Chaparral Gulch.

- Smelter Tailings Depression.
- Lower Chaparral Gulch.
- Pyrometallurgical / Dross Area at the Smelter.
- South Smelter Plateau.
- Smelter Land East of the River.

12.2.1.2 Repositories

Repository Locations

One repository shall be constructed, filled, and capped on each side of Highway 69. The mine tailings pile at the former mine property will be reconfigured and regraded as a waste repository and will be engineered to have a stable and permanent structure. Waste currently located on the west side of the highway shall stay on the west side of the highway and be moved and disposed of in the mine tailings pile repository.

A second repository shall be constructed, filled with wastes, and permanently capped at the former smelter property. Waste currently located on the east side of Highway 69 shall stay on the east side of the highway and be moved and disposed of in the smelter property repository.

Priority for Smelter Repository Location

It shall be a priority during remedial design to build the smelter property repository in the bowl-shaped depression at the smelter property, which lies below the smelter plateau that currently contains tailings. This location will make the repository the least visually imposing to the surrounding community and maximize the uses to which the smelter plateau could be used in the future. However, the final location of the smelter property repository shall be determined during remedial design and may be changed from the preferred location in the smelter tailings depression to the smelter plateau, only if field or design limitations or engineering constraints are found that would require such a change.

Figure 21 shows conceptual before-and-after cleanup depictions for the repository on the mine tailings pile. Figure 22 shows conceptual before-and-after cleanup depictions for the repository at the former smelter property.

Repository Construction and Covers

Each waste repository shall be a permanently-capped holding cell that keeps waste in and water out, so that waste can no longer move in the environment or expose people or wildlife. The repositories shall be engineered to prevent human and wildlife exposure to wastes or associated drainages, prevent rainwater infiltration into and run-on onto the waste, prevent erosion and migration of wastes, and control drainage to prevent aqueous wastes or any possible acid rock drainage from leaving the repository-controlled area. EPA will decide the type of covers (caps) that will be used during the remedial design phase of the project. The covers may be based on a geotextile fabric liner covered with compacted clay and soils, an evapotranspirative cover that forces water to evaporate before it can infiltrate into the waste, or another type of construction that provides equivalent performance. After constructing, filling, grading, and capping the repositories, appropriate engineered drainage structures shall be constructed, and the repositories shall be revegetated.

Repository Borrow Soil; Backfill Soil

The soil component of each repository cover shall be constructed with borrow material with proper geotechnical properties to meet the cap specifications. Sufficient sampling shall be performed during remedial design to evaluate soils for such properties, in supplement to information already in the FS. Suitable borrow material may be brought to the Site preferably from the locations identified in the FS. There is sufficient borrow material at these locations to build the repository covers and provide backfill for the remedy. However, other locations of borrow may be identified and used for these purposes should borrow from those locations identified in the FS be unsuitable, unavailable, or otherwise costly or inappropriate.

Similar to borrow material obtained for repository covers, borrow material will also be imported and used to backfill excavations in this remedy where needed. The remedial design shall provide for backfill to ensure proper drainage, prevent erosion, lend stable topography (contouring), provide appropriate grading, and promote vegetation.

Repository Maintenance

The waste repositories shall be maintained indefinitely with inspections and corrective actions at a frequency and with elements to be determined in the remedial design. Inspection, maintenance, and corrective action (repair) factors shall include, but not be limited to, slope and slope stability, slumping, subsidence, degradation, material movement, water erosion, penetration, bioturbation, infiltration, drainage, onflow, and wind erosion.

12.2.1.3 Slag at the Smelter

The monolithic (solid wall) slag hanging over the Agua Fria River will be stabilized to prevent further dropping of slag material, including pulverized slag, into the Agua Fria River. This may include partially removing slag to lay back the angle of the slag face to a point that it is stable. An alternate means of physical stabilization other than, or in addition to, slag removal may be developed and employed in the remedial design phase. Any slag removed during stabilization will be disposed of in the smelter property repository. Loose and pulverized slag on the smelter plateau and in the Agua Fria River shall be removed and disposed of in the smelter property repository. Slag removal from the river shall be performed in a manner that prevents the downstream migration of slag material.

12.2.1.4 Treatment of Dross at the Smelter

The dross at the smelter may not be subject to the exclusion for mining materials in the Bevill Amendment to RCRA (see Section 5.5.4). Some dross samples exceeded TCLP limits for RCRA 8 metals. If the dross is determined to be a RCRA Subtitle C hazardous waste, then dross at the smelter property with concentrations exceeding the TCLP limits will be excavated and treated to stabilize the waste and remove the hazardous waste toxicity characteristic before disposal in the on-site repository. The method of treatment will be determined during remedial design, although stabilization by treating the dross with Portland cement appears to be the preferred method.

12.2.1.5 Dam in Lower Chaparral Gulch

The Lower Chaparral Gulch Dam shall be removed to allow access to waste in the Lower Chaparral Gulch and restore the natural hydraulics and vegetation of the drainage. This shall include reasonable watershed and habitat restoration. The dam will only be removed when tailings, ARD or contaminated water can no longer flow downstream into the Lower Chaparral Gulch as a result of the remedial action. A specific plan for removal of the dam will be developed during remedial design.

12.2.1.6 Localized Soil Removal in Open Land North and South of the Mine Tailings Pile

In specified areas located on open land north and south of the mine tailings pile that have localized surface soils with exposure point concentrations exceeding the cleanup levels selected in this ROD given future anticipated land uses, soils shall be excavated and replaced by clean soil such that future anticipated land uses may safely ensue. Areas for remediation shall be identified during remedial design. Some portions of these lands are zoned for potential future residential use and others are zoned for industrial/commercial use. Open land south of the tailings pile and also south of the Galena Gulch does not require remediation. The land specifically owned by the BLM north of the mine tailings pile and north of the Chaparral Gulch does not require remediation.

12.2.1.7 Removal of Small Tailings Piles near Chaparral Gulch/Agua Fria River Confluence

The two small tailings piles in the Lower Chaparral Gulch and adjacent to the Agua Fria River, called the elbow tailings pile and the Agua Fria tailings pile, shall be removed and disposed of in the smelter property waste repository.

12.2.1.8 Waste Rock Wall and Waste Piles/Deposits West of the Mine Tailings Pile

The waste rock wall above the Galena Gulch shall be excavated and laid back to a stable angle or otherwise stabilized such that waste rock can no longer slough off into the gulch. Removed waste rock, as well as loose waste rock in the gulch, shall be excavated and removed to the mine tailings pile repository. The small satellite waste piles (west waste rock pile, rear waste rock pile) near the Galena Gulch waste rock pile shall be excavated, moved, and disposed of in the mine tailings pile repository.

12.2.1.9 Soils in Industrial Areas West of the Mine Tailings Pile

Soils that lie on top of waste rock deposits in industrial locations west of the mine tailings pile (mineworks and processing area, former fertilizer plant area) with exposure point concentrations above the cleanup levels in this ROD shall be excavated and moved to the mine tailings pile and/or capped with simple covers to render surface soil suitable for safe occupational/industrial use.

12.2.1.10 Open Adit and Mine Shafts

There is one open adit (i.e., a horizontal passage leading into a mine for the purposes of access or drainage) and several open mine shafts identified during the RI. A survey for additional open adits or mine shafts shall be conducted. Open shafts and adits shall be closed as necessary to protect human health.

12.2.1.11 Additional Sampling in Non-Residential / Waste Bearing Areas

The remedial design shall include planning for and implementation of any additional sampling and assessment as may be necessary to refine areas for excavation and for other needs to carry out the components and achieve the standards and requirements of this ROD effectively and cost efficiently.

12.2.1.12 Pre-Design Studies

Studies to support the development of remedial design shall be performed to the extent necessary to develop a sound design and achieve the standards and requirements of this ROD effectively and cost efficiently. The studies to be conducted shall be identified during design but are anticipated at a minimum to include:

- Wetland jurisdictional delineation.
- Floodplain delineation and stormwater management needs assessment.
- Borrow source geotechnical evaluation.
- Utility and infrastructure survey.
- Topographic survey.
- Refinement of depth and volume of dross.
- Evaluation of easements and entitlements.
- Monolithic slag geophysical assessment.
- Refinement of open land areas and smelter properties needing cleanup.

12.2.2 Selected Remedial Action in Residential Areas

12.2.2.1 Excavation and Replacement of Surface Soils in Residential Areas

Within the APSI determined in the RI, where exposure point concentrations in residential properties exceed cleanup levels in areas with residential land use, sufficient soil shall be removed in these yards to bring the exposure point concentrations below the cleanup levels. Surface soils shall be removed, replaced with clean borrow soil, and yards restored. Contaminated soils shall be disposed of safely. Detailed plans for this cleanup action shall be developed in the remedial design phase of the project.

Additional work shall include preparation of property access agreements and a pre-remediation work plan for each identified property. Following excavation, confirmatory soil samples shall be collected to verify that cleanup requirements have been met in accordance with this ROD. In cases where contaminated soil is still found at the two-foot depth, a warning barrier shall be placed at that depth as a visual marker before placing backfill material in the excavation.

Excavated materials shall be transported to one of the on-site repositories for disposal or in a safe, temporary location established during remedial design pending final disposition. Excavated materials may also be disposed of in a permitted disposal facility as determined in remedial design.

12.2.2.2 Additional Sampling in Residential Areas

The remedial design for the residential remedial action shall include any additional sampling and assessment as may be necessary to refine areas for excavation, determine which residential yards shall be subject to cleanup, verify previous sampling results, and other needs to carry out the components, and achieve the standards and requirements of this ROD effectively and cost efficiently.

12.2.3 Selected Remedial Action for Surface Water

Because the sources of contamination at the Site will be removed, it is expected that concentrations of COCs in the Agua Fria River will decline to meet the water quality cleanup standards selected in this ROD. Surface water in the Agua Fria River downstream of the slag at the smelter and downstream of the confluence between the river and the Chaparral Gulch shall be monitored and results reported to ensure that metals levels are declining to below the cleanup levels selected in this ROD. At a minimum, the river will be monitored for COCs for up to one quarter mile downstream of the confluence at a frequency to be developed during the remedial design in a Surface Water Sampling Strategy/Plan.

12.2.4 Selected Interim Groundwater Actions

The following provisions for groundwater are selected on an interim basis pending a final decision on groundwater in a later remedy selection.

12.2.4.1 Restrictions on New Water Supply Wells

Restrictions shall be implemented and enforced by the Arizona Department of Water Resources to prevent installation of new private or public water supply wells within and adjacent to the waste areas that are the subject of this remedial action (e.g., mine tailings pile and waste rock, the Chaparral Gulch including the tailings floodplain, the smelter tailings depression, and the dross/smelter operations area at the smelter).

12.2.4.2 Groundwater Monitoring

Existing groundwater wells shall be periodically sampled for the COCs, and results reported at a frequency to be determined during remedial design in a Groundwater Sampling Strategy/Plan. Additional groundwater monitoring wells will be installed and monitored if and as determined necessary in a subsequent remedial selection phase. In addition, periodic sampling shall take place at existing private wells adjacent to the waste areas that are the subject of this remedial action. Data from the sampling will be evaluated to determine whether an unacceptable site-related groundwater risk develops during the interim period and more immediate actions may be considered if necessary.

As part of these sampling events, EPA will continue to educate well owners of the need to install home treatment systems to address natural arsenic in groundwater.

12.2.5 Interim Controls and Restrictions

The remedial action selected by this ROD shall be implemented through a design that accomplishes the following during project execution:

- Prevent movement of airborne dust beyond the immediate vicinity of excavation equipment and trucks or other conveyance or transport equipment, especially during periods of high winds which are expected seasonally.
- Prevent migration of contaminated water and/or acid rock drainage into drainages or waterways downstream of areas of excavation, especially during periods of heavy/monsoon rains which are expected seasonally.
- Prevent erosion of tailings, dross, or other wastes in air or in water to points downstream of their origin, from areas of concern that are either intact or are under active excavation, especially during period of heavy/monsoon rains or heavy winds which are expected seasonally.
- Prevent the contamination of areas to which the public could become exposed (such as roadways or open unfenced land).
- Prevent, as much as possible, the access of unauthorized persons into contaminated areas, regardless of whether the areas are subject to ongoing excavation at the time.

12.2.6 Institutional Controls

The following institutional controls shall be implemented as part of this remedial action:

- At the waste repositories, all land use shall be restricted, and excavation shall be prohibited to prevent any cap and cover damage. Development, construction, filling, grading, excavating, drilling, mining, or vehicle parking or transit/transport shall be prohibited on, and in surrounding functional areas (e.g., drainage structures and access roads) near repository covers.
- In the few areas where waste and contaminated media will not be removed and would remain under appropriate controls such as localized simple capping, land use and zoning restrictions shall be applied to maintain the integrity of the controls and prevent residential use.
- Access to, and building on, the remaining stabilized slag shall be prohibited because of fractures within the slag, steep slopes and cliffs, and fall danger above the Agua Fria River.
- Land use restrictions to prohibit residential use shall be imposed on the industrial areas peripheral to the waste repositories.
- As an interim remedial action, potable groundwater use shall be prohibited at the waste repositories and near and under the Chaparral Gulch.

12.3 Cost Estimate for the Selected Remedy

The total present worth of the selected remedy, excluding costs associated with the residential cleanup, is $72.1 million. Capital costs are estimated at $69.6 million and O&M costs, including costs associated with FYRs, are estimated at $2.5 million. Table 10 includes the cost breakdown for the selected remedy. An additional $15 million is estimated for the residential yard cleanup. However, the cost for the residential cleanup is dependent on the number of residential yards that will require cleanup, which will be determined during remedial design.

The information in this cost estimate and summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the remedial design. Major changes may be documented in the form of a memorandum in the Administrative Record file, an Explanation of Significant Differences or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50% to -30% of the actual project cost.

12.4 Estimated Outcomes of Selected Remedy

Under the selected alternative, most waste will be removed and contained in two separate repositories. Isolated contaminated soil that remains in place outside the repositories will be managed with engineering and institutional controls, allowing continued industrial use near the mine tailings pile. Exposure point concentrations of contaminants in soils in residential yards would be reduced to below the revised, lower cleanup standards set forth in this ROD. The selected remedy will address unacceptable risks to human and ecological receptors under the anticipated land use for the various land uses of the Site (Figure 4).

The top of the repositories cannot be freely developed, though limited, appropriate uses can be evaluated during and after remedial design. Under any reuse scenario, the waste will remain contained. Elsewhere the smelter property will be restored and will be ready for the anticipated future land use, which could include a mix of industrial, residential, and recreational uses (Figure 4). Stabilized monolithic slag would remain at the former smelter property but slag would no longer calve and drop into the Agua Fria River. Pulverized slag would be removed from the Agua Fria River adjacent to the smelter property. Surface water contamination is expected to decrease in concentration to meet water quality standards over time and would be monitored to ensure progress until standards are met.

This alternative will prevent consumption of shallow groundwater from within and under the waste areas subject to the remedial action. This is an interim measure pending selection of a permanent groundwater remedy at a later date.

Figure 21 shows before-and-after cleanup depictions for the repository on the mine tailings pile. Figure 22 shows before-and-after cleanup depictions for the repository at the former smelter property. Repositories will be inspected and maintained indefinitely.

Table 6 and Table 8 of this ROD present final cleanup levels for soil/waste and surface water at the Site, respectively.

13.0 STATUTORY DETERMINATIONS

Under CERCLA §121 and the NCP, EPA must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity or mobility of hazardous wastes as a principal element and a bias again off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

13.1 Protection of Human Health and the Environment

The selected remedy, Alternative 3B, will achieve protection of human health and the environment and meet all RAOs. It will address all unacceptable site-related human health and environmental risks primarily by relocating the waste and contaminated media to two permanently covered and maintained repositories. This will prevent current and future exposure of receptors to contaminants and eliminate contaminant leaching and migration that could allow for future unacceptable risks.

In the few areas where all waste is not placed in a repository (for example, the stabilized smelter slag, the stabilized waste rock piles or the simple covers over remaining waste rock in the former mineworks areas), institutional controls will be implemented. This will ensure the remedy is and remains fully protective.

13.2 Compliance with ARARs

The selected remedy will comply with federal and state ARARs that have been identified. EPA has not sought any waiver of any ARAR for the selected remedy. Because almost all waste will be relocated to repositories designed for long-term containment, chemical-specific ARARs would be met through removal of waste from source areas. Location- and action-specific ARARs will also be satisfied. Tables 11 through 16 present the chemical-specific, location-specific, and action-specific ARARs and to-be-considered (TBC) criteria for the Site.

13.3 Cost Effectiveness

EPA has determined that the selected remedy is cost effective and represents a reasonable value for the funds to be spent. In making this determination, the following definition was used: "A remedy shall be cost effective if its costs are proportional to its overall effectiveness" (the NCP, C.F.R. § 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost effectiveness. The relationship of the overall effectiveness of the selected remedy was determined to be proportional to its costs and therefore, represents a reasonable value for the money to be spent.

The selected remedy is cost effective because it satisfies the criteria above and offers a permanent solution through the long-term containment of waste and contaminated soil. The selected remedy will pose the least short-term impacts (including highway traffic impacts) on the community because no waste will cross Highway 69, and the time to haul the wastes will be the shortest. The estimated present worth cost of the selected remedy is $72.1 million, with an additional $15 million estimated for the residential cleanup. The selected remedy is comparable in cost to Alternatives 2 and 3A and much lower in cost than Alternative 4.

13.4 Use of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practical manner at the Site. While the selected remedy does not utilize treatment technologies with the exception of the treatment of dross waste, it is intended to provide permanent solutions for mine and smelter waste and contaminated soil. Removal of the wastes and contaminated soil will achieve site RAOs and thereby permanently prevent any unacceptable risk to human health or the environment.

13.5 Preference for Treatment as a Principal Element

The selected remedy does not satisfy the statutory preference in CERCLA to use treatment to address principal threats as a principal element of the remedy because such large volumes of mine and smelter waste cannot be treated cost effectively. The selected remedy of placing the mine and smelter waste in engineered waste repositories for long-term containment is consistent with the NCP's expectation that EPA use engineering controls for wastes where treatment is impracticable (40 C.F.R. § 300.430(a)(1)(iii)(B)).

13.6 Five-Year Review Requirements

Because the selected remedy will result in hazardous substances, pollutants or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, statutory reviews will be conducted every five years after remedial action initiation. Such reviews will ensure that the selected remedies are, or will be, protective of human health and the environment.

14.0 DOCUMENTATION OF SIGNIFICANT CHANGES FROM PREFERRED ALTERNATIVE OF PROPOSED PLAN

EPA released the Proposed Plan for public comment on March 1, 2023. The Proposed Plan identified Alternative 3B as the preferred alternative for the Site. This includes remedial actions in both non-residential / waste bearing areas and in residential areas. EPA reviewed all written and verbal comments submitted during the public comment period. The following significant changes were made between the Proposed Plan and this ROD:

- EPA re-evaluated the background threshold values for arsenic in surface soils. See Section 5.3.2 of this ROD. The background concentration of arsenic in residential soil was changed from 92 mg/kg in the Proposed Plan to 48 mg/kg west of the Agua Fria River and 99 mg/kg east of the Agua Fria River.

- The cleanup standard for arsenic in residential soil was changed from 92 mg/kg in the Proposed Plan to 48 mg/kg west of the Agua Fria River and 79 mg/kg east of the Agua Fria River. See Section 5.3.2 of this ROD. Because the BTV for the *east* side of the river (99 mg/kg) exceeds EPA's risk management range, EPA will use statistical tests to ensure that residential properties with exposure point concentrations above 79 mg/kg are not below background. This will ensure that both attaining environmental protectiveness of human health within EPA's risk management range and attaining the CERCLA objective of not cleaning up below background can be met. See Section 8.1, under the heading *Specific Discussion Regarding Arsenic Cleanup Levels in Areas with Residential Land Use,* in regard to residential areas east of the river.
- EPA has rounded up the cleanup level for lead in residential soil from 197 mg/kg in the Proposed Plan to 200 mg/kg. This is simpler and appropriate because the derivation of risk-based values is not accurate to three significant digits, as would be implied by the value 197. This change makes no difference in the anticipated remedial action.
- After modifying an exposure assumption made in the risk assessment, the cleanup level for arsenic in soil in areas with commercial/industrial anticipated future land use (occupational scenario) has been reduced from 884 mg/kg in the Proposed Plan to 618 mg/kg.
- EPA has refined, enhanced and expanded the map and associated discussion of anticipated future land use from what was in the Proposed Plan. See Figure 4 in this ROD.

15.0 REFERENCES

CH2M Hill, Inc. 2016. Remedial Investigation Report, Iron King Mine – Humboldt Smelter Superfund Site, Dewey-Humboldt, Yavapai County, Arizona. Prepared for U.S. Environmental Protection Agency, Region 9. September. https://semspub.epa.gov/src/document/09/1231338

Tetra Tech, Inc. 2023. Residential Response Action Supplement to Feasibility Study at the Iron King-Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona. February 13.

Tetra Tech, Inc. 2022. Feasibility Study, Iron King Mine / Humboldt Smelter Superfund Site, Addressing Remedial Action Alternatives for Non-Residential and Potential Future Residential Portions of the Site. Prepared for U.S. Environmental Protection Agency, Region 9, San Francisco, California. September. https://semspub.epa.gov/src/document/09/1247699

U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). 2006a. Balon Series Description. Series Established: Western Yavapai County Area, Arizona. May.

U.S. EPA. 2018. Frequently Asked Questions about the development and use of background concentrations at Superfund sites: Part One, General Concepts. OLEM Directive 9200.2-141 A.

U.S. EPA. 2002a. Guidance for comparing background and chemical concentrations in soil for CERCLA sites. EPA 540-R-01-003, OSWER 9285.7-41.

U.S. EPA. 2002b. Role of background in the CERCLA cleanup program. OSWER 9285.6-07P.

US EPA. 1992. Statistical methods for evaluating the attainment of cleanup standards. Volume 3: Reference-based standards for soils and solid media.

US EPA. 1989. Methods for evaluating the attainment of cleanup standards. Volume 1: Soils and solid media. EPA 230/02-89-042.

U.S. EPA Region 9. 2023. Iron King Mine – Humboldt Smelter Superfund Site Proposed Plan. https://semspub.epa.gov/src/document/09/100032066

PART 3: RESPONSIVENESS SUMMARY

The Responsiveness Summary for the Site has been prepared in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Contingency Plan (NCP), 40 Code of Federal Regulations (C.F.R.) § 300.430(f). The Responsiveness Summary documents, for the public record, EPA's responses to comments received on the Proposed Plan during the public comment period.

EPA made the Site's Proposed Plan available to the public in March 2023. The Proposed Plan and other site documents can be found in the Site's Administrative Record file, which is available online at www.epa.gov/superfund/ironkingmine.

EPA published a notice of the availability of the Proposed Plan and other site documents in the *Prescott Courier* and *Arizona Republic* on March 1, 2023. A public comment period for the Proposed Plan was held from March 15, 2023, to May 13, 2023. In addition, EPA held a public meeting on March 29, 2023, to present the Proposed Plan to the community.

EPA received 38 comments from the general public during the Proposed Plan public comment period and 67 pages of comments from the Town of Dewey-Humboldt government. The Comment and Response Index in Appendix A contains a complete listing of all comments and EPA's responses.

Comments and EPA's responses to the comments are divided into four categories:

- Summary of Public Comments and Lead Agency Responses.
- EPA Responses to Letter from Town Council to Jeffrey Dhont (EPA, dated May 13, 2023, regarding "Town of Dewey-Humboldt's Comments on the U.S. Environmental Protection Agency's Proposed Remedial Action Plan, dated March 1, 2023, for the Iron King Mine-Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona."
- EPA Responses to "Town of Dewey-Humboldt Comment Package: Technical Memorandum: Specific Comments on EPA's Remedy Selection Process, The Iron King Mine-Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona, May 13, 2023."
- EPA Responses to "Town of Dewey-Humboldt Comment Package: Technical Memorandum: Technical Review & Findings, USEPA Feasibility Study, IKMHS Superfund Site, May 28, 2023."

TABLES

Table 1: Areas of Concern

Group Title	Area of Concern (No.)[a]	Description
Existing Residential Properties		
Residential	Existing Residential Properties (Unnumbered)	Residential parcels in the town of Dewey-Humboldt that may have become contaminated via blowing tailings, historical smelter stack emissions and private use of tailings as fill. This area is limited to the Area of Potential Site Impact (APSI), defined in Appendix E of the RI.
Former Mine Area		
Mine Tailings Pile	Mine Tailings Pile Upper Tier (1)	The primary waste left over from the Iron King Mine's mine operations. Tailings are a waste product left over after ores are finely ground and the ore of interest is removed for sale. During former mine concentrating operations, the mine tailings pile was a series of ponds that merged and grew to 4.3 million cubic yards. There are two levels, or tiers to the mine tailings pile. The upper tier sits more than 100 feet above native rock, and is notched with a blowout area that liquified, slumped and flowed downhill in 1964. The upper tier has rills down its side and has been subject to significant erosion. The lower tier contains slumped material, drainage ponds, rills and the toe of the pile with a catch basin just west of the frontage road along Highway 69.
	Mine Tailings Pile Lower Tier (2)	
Industrial Areas around Mine Tailings Pile	NAI Operations Area (15)	NAI owns most of the mine tailings pile.
	Former Mineworks and Processing (3)	An area west of the mine tailings pile built on waste rock that had been removed from mine shafts. This was the location of the former mine headworks, ore processing, grinding and concentrating and other operations. This area is north of Iron King Road.
	Galena Gulch Waste Rock Wall (5)	The nearly vertical face of the waste rock under the Former Fertilizer Plant that drops into the Galena Gulch. This area is south and slightly west of the mine tailings pile.
	Former Fertilizer Plant (4)	Also, a former mineworks area that sits on built-up waste rock/spoils. It was later used as a plant for making fertilizer from the tailings. This area is south of Iron King Road.
Open Land Around Mine Tailings Pile	Rear Waste Rock Pile (8)	A free-standing, crescent-shaped waste rock pile west of the main mine property on open chaparral land near the Galena Gulch and north of Iron King Road.
	Galena Gulch Satellite Waste Rock Piles (6)	At least two waste rock piles lying in or directly on Galena Gulch that are separate from the Galena Gulch Waste Rock Wall. These are composed of highly cementitious, angular rock.
	Galena Gulch Sediment (7)	Sediments of Galena Gulch to the extent they pose an unacceptable ecological risk. These sediments are affected by erosion of the Galena Gulch Waste Rock Wall and Galena Gulch Waste Rock Pile.
	West Waste Rock Pile (9)	A smaller free-standing waste rock pile west of the mine tailings pile and main Iron King Mine property on open chaparral land.
	Open Adit & Shafts (10)	One open adit (i.e., a horizontal passage leading into a mine for the purposes of access or drainage) emptying onto the Galena Gulch and a few abandoned mine shafts that lie under and south of the Galena Gulch Waste Rock Wall, which is in turn south of the mine tailings pile.
	Open Land South of Mine Tailings Pile – North of Galena Gulch (11)	Open chaparral land south of the mine tailings pile but north of the Galena Gulch after it turns east. The terrain is very steep with many ridges.

Group Title	Area of Concern (No.)[a]	Description
	Open Land South of Mine Tailings Pile – South of Galena Gulch (12)[b]	Open chaparral land south of the mine tailings pile and south of Galena Gulch after it turns east. This is less steep and has less contamination than Open Land South of Mine Tailings Pile – North of Galena Gulch.
	Open Land North of Mine Tailings Pile – Area 19 (13)	Known as "Area 19," this is an area of open chaparral land north of the mine tailings pile but south of a boundary formed by the Chaparral Gulch and the northern former mine property boundary. There is steep terrain. It includes mine shafts, mine spoils, operational elements and contaminated soils.
	Open Land North of Mine Tailings Pile – Area 20 (14)	Area of open chaparral land north of mine tailings pile and north of the Area 19 boundary. This is a gently and gradually increasing slope to a high ridge north of the mine that was largely a tailings windbreak over decades. No mine operations are known to have occurred in this area. There are considerably lower concentrations of contaminants here than in Area 19.
Chaparral Gulch		
Upper Chaparral Gulch	Mine Blowout Path (16)	A former drainage pathway leading east from Highway 69 near the current JT Septic facility, and along the Third Street. As the tailings pond grew at the mine, the natural drainages carried outfall water along this path down to the Chaparral Gulch. When the blowout occurred in 1964, tailings followed this path, and tailings deposits remain along the path.
	Upper Chaparral Gulch (17)	An area zoned for residential use in the Chaparral Gulch east of Highway 69 and upstream of Third Street. A floodplain exists at the eastern end (near Third Street). No tailings are apparent here, and contamination is shallower than in the reaches of the Chaparral Gulch farther downstream. This drainage received discharged processing and shaft dewatering water.
Middle and Lower Chaparral Gulch	Middle Chaparral Gulch (18)	The portion of the Chaparral Gulch east of Third Street and west of the tailings floodplain below the smelter tailings depression. This is a riparian habitat receiving water from the Mine Blowout Area and Upper Chaparral Gulch. Heavy clean fluvium (sediment) loads cover and rework historical contamination in this area. Presently there are braided subchannels with bars with grasses, shrubs and mature trees. Soils here are more contaminated with depth than at the surface.
	Tailings Floodplain (19)	A floodplain of about 9 acres in which tailings from the Humboldt Smelter and tailings washing from the mine upstream commingled at varying points in time. Reworked tailings lie in layers, with comparatively cleaner and discontinuous alluvial layers between. The tailings floodplain is confined by terrain on the south and north and narrows into a canyon near the dam. Tailings on the west are orange (oxidized [ferric]), and those behind the dam are in a wedge of saturation and mostly green (anoxic [ferrous]). Tailings depths vary from 6 feet at the west end to more than 20 feet behind the dam.
	Smelter Blowout Fan (20)	On the northern rim of the tailings floodplain below the smelter tailings depression, where tailings fanned out after passing through several broken tailings berms over time. Characterized on surface by white efflorescent salts of very high biological toxicity and concentration.
	Smelter Tailings Depression (21)	A natural bowl-shaped depression bounded by the smelter plateau on the north and east, and a ridge on the west, and open to the tailings floodplain below on Chaparral Gulch. Contains large deposits of

Group Title	Area of Concern (No.)[a]	Description
		eroded tailings from previous operations at the Humboldt Smelter and its successor operators in the 1940s.
	Dam (22)	A 25-foot-high concrete dam in the canyon above Lower Chaparral Gulch and at the end of the tailings floodplain. It is keyed into uplifted Precambrian rock. Tailings are present to the rim of the dam. Some water leaks through the dam through holes and under the dam. Pools at its base are intermittently present. Ferric oxide deposition occurs where water emerges. The canyon here is steep and not visible from any ridge or high location in the area.
	Lower Chaparral Gulch (23)	Area of Chaparral Gulch defined by the dam upstream (on the west) and the confluence of Chaparral Gulch with the Agua Fria River downstream (on the east). This lies in a narrow canyon, frequently heavily vegetated. Water subchannels crisscross the stream bed, and in dryer times water flows underground. Access to this area is limited.
	Elbow Tailings Pile (28)	A tailings deposit in the far lower portion of the Lower Chaparral Gulch canyon just as the gulch makes a sharp left turn (the “elbow”) into the confluence with the Agua Fria River. These tailings were most likely produced by the Agua Fria Mill, a predecessor operation to the Humboldt Smelter in the late 1800s. They are very high in lead.
Former Smelter		
Pyrometallurgical and South Smelter Plateau	Pyrometallurgical Operations Area (24)	The most active operational area of the former Humboldt Smelter, which included blast furnaces, converters, slag conveyors, stacks, power plant, cooling ponds, etc.
	Dross (24)	Aluminum dross imported from dye-casting plants. It currently is seen in piles and flat deposits in this area.
	South Smelter Plateau (25)	South of the Dross/Pyrometallurgical Operations on the smelter plateau that lies above the Chaparral Gulch, the tailings floodplain, dam, and Agua Fria River. The Humboldt Smelter proper was on this plateau. Deep loamy soils and some waste piles are present in this area. Soils are contaminated.
Slag	Slag – Monolithic (26)	The portion of the slag deposits that were dumped over the side of the cliff overhanging the Agua Fria River and formed a monolithic mass, extending over the cliff. Crevasses are present, and some slag has calved off into the River.
	Slag – Loose (27)	The northern portion of the slag deposit and the satellite slag pile to the south that include loose (broken up) slag and mixture of this slag with other wastes. The satellite waste pile is the location of the former Val Verde smelter (a predecessor to the Humboldt Smelter).
Agua Fria River	Agua Fria Tailings Pile (29)	Another tailings deposit sitting atop a high sediment wall above the Agua Fria River. These tailings were generated by smelters preceding the Humboldt Smelter in the late 1800s and first years of the 1900s.
	Agua Fria River (30)	This is a provision for the Agua Fria sediments themselves, either near the slag or farther downstream near the confluence.
East of Agua Fria River	East of River (31)	Humboldt Smelter property that extended a short distance east of the Agua Fria River at some locations, into a rocky outcropping directly across from the slag. This was not used for operations, but contamination is sporadically present in this area in surface soil. This land is currently scrub and is vacant.

Group Title	Area of Concern (No.)[a]	Description

Notes:
a) Area of Concern (AOC) Nos. are from Table 1-1 of the FS.
b) Remedial action is not warranted at AOC 12 and AOC 30 sediment because investigations supplemental and subsequent to the ROD indicate remaining risk to be below the risk management range (see Section 1.5.2 and Table 2-2 of the FS).

Table 2: Maximum Detected Concentrations of COCs in Soil and Surface Water

COC[a]	Maximum Detected Site Concentration[b]
Soil (mg/kg)	
Antimony	360
Arsenic	20,200
Cadmium	210
Cobalt	102
Copper	39,800
Hexavalent chromium (CrVI)[c]	18
Lead	65,700
Manganese	74,000
Selenium	160
Thallium	15.4
Zinc	75,000
PAHs (located at the north end of the smelter)[c]	0.54[d]
Dioxins/furans (located at the north end of the smelter)	0.00206 (TEQ Bird) 0.0013 (TEQ Fish) 0.00116 (TEQ Mammal)
Surface water (mg/L) (dissolved fraction / total fraction)	
Aluminum	964 / 969
Barium	0.314 / 3.7
Beryllium	0.0228 / 0.025
Cadmium	2.88 / 2.88
Cobalt	1.31 / 11.8
Copper	92.8 / 402
Cyanide	NA / 0.183
Iron	11,900 / 13,000
Manganese	49.8 / 205
Mercury	0.0012 / 0.0801
Selenium	0.731 / 2.24
Vanadium	2.06 / 2.17
Zinc	1,740 / 1,610

Notes:
a) Soil and surface water COCs from Table 2-3 of the FS.
b) Maximum detected concentrations from Tables 6-2 and 6-4 of the RI.
c) Hexavalent chromium (CrVI) and PAHs were eliminated as COCs requiring cleanup (see footnote in Section 7.1.4.4 of this ROD).
d) Multiple polycyclic aromatic hydrocarbons (PAHs) were detected. Maximum detected concentration of benzo(a)pyrene is presented.

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
TEQ = calculated toxicity equivalents for dioxins and furans
NA = not applicable

Table 3: Maximum Detected Concentrations of COIs in Groundwater

COI[a]	Maximum Detected Site Concentration[b]
Groundwater (mg/L) (dissolved fraction / total fraction)	
Arsenic	1.01 / 1.95
Lead	0.0564 / 1.37
Nitrate as N	NA / 360

Notes:
a) Groundwater COIs from the Proposed Plan.
b) Maximum detected concentrations from Table 6-5 of the RI.
mg/L = milligrams per liter
NA = not applicable

Table 4: Waste and Impacted Soils Volumes in Non-Residential/Waste-Bearing Areas

Area of Concern	Area	Volume (Cubic Yards)[c]
East of Highway 69		
16	Mine Tailings Outfall Drainage Blowout Path	33,971
17	Upper Chaparral Gulch	64,638
18	Middle Chaparral Gulch	206,554
19	Tailings Flood Plain	130,000
20	Smelter Blowout Fan	15,707
21	Smelter Tailings Depression	59,854
22	Dam	2,900
23	Lower Chaparral Gulch	11,548
24	Smelter Pyrometallurgical Operations Area (excluding dross)	48,469
24	Dross	147,674
25	South Smelter Plateau (excluding dross)	40,651
26	Monolithic Slag[a]	200,000
27	Slag (loose)[a]	77,398
28	Elbow Tailings Pile	614
29	Agua Fria Tailings Pile	5,500
30	Agua Fria River	0
31	East of River surface soils	29,100
Subtotal		**1,100,000**
West of Highway 69		
1	Mine Tailings Pile Upper Tier	3,500,000
2	Mine Tailings Pile Lower Tier	800,000
3	Former Mine Processing	225,793
4	Former Fertilizer Plant[b]	13,863
5	Galena Gulch Waste Rock Wall	7,000
6	Galena Gulch Satellite Waste Rock Piles[b]	2,652
7	Galena Gulch Sediment[d]	0
8	Rear Waste Rock Pile	12,718
9	West Waste Rock Pile	12,600
10	Open Adit And Shafts	0
11	Open Land South of Mine Tailings Pile, North of Galena Gulch[b]	137,606
13	Open Land North of Mine Tailings Pile – Area 19[b]	183,382
14	Open Land North of Mine Tailings Pile – Area 20[b]	299,606
14	Chaparral Gulch Northwest of Highway[b] – Area 20	65,272
15	North American Industries Operations Area[b]	19,962
Subtotal		**5,300,000**
TOTAL		**6,400,000**

Area of Concern	Area	Volume (Cubic Yards)[c]

Notes:
a) Lack of lower elevation data of the monolithic slag makes volume estimates difficult.
b) No subsurface data; depth of contamination assumed as 2 feet below ground surface.
c) Estimated volume in bank cubic yards (CY) exceeding the remediation goal.
d) In Galena Gulch (Area of Concern 7), the channel bottom is solid rock, so any sediment represents a thin layer of surficial deposits, possibly originating from the Galena Gulch Waste Rock Pile, that would be removed from the rock pile.

Source: Table 3-4, FS.

Table 5: Human Health and Ecological Risk in Non-Residential Areas

Area of Concern (No.)	Risk Management Area	Anticipated Future Land Use	Lead EPC[a] (mg/kg)	Incremental Lifetime Human Health Risk[b]						Ecological Risk[c]			
				Residential Scenario		Occupational Scenario		Recreational Scenario		Number of Species			
				Cancer Risk	Non-cancer HI[d]	Cancer Risk	Non-cancer HI[d]	Cancer Risk	Non-cancer HI[d]	HQ>1	HQ>3	HQ>5	HQ>10
Mine Tailings Pile Upper and Lower Tiers (1, 2)	Mine Tailings Pile (NR17)	Occupational/ Ecological	3,150	2×10^{-3}	15	5×10^{-4}	3	8×10^{-5}	2	7	7	6	5
Former Mineworks and Processing / Former Glory Hole (3)	Former Mineworks Area (NR16) / (Glory Hole Area is part of Former Glory Hole and North of Mine Tailings Pile [NR19])[e]	Occupational/ Ecological	8,726 / 458	6×10^{-4} / 1×10^{-4}	5 / 0.8	1×10^{-4} / 3×10^{-5}	NC / NC	2×10^{-5} / 4×10^{-6}	NC / NC	7 / 4	6 / 3	6 / 0	5 / 0
Former Fertilizer Plant, Galena Gulch Waste Rock Wall (4, 5)	Former Mineworks Area (NR16)	Occupational/ Recreational/ Ecological	8,726	6×10^{-4}	5	1×10^{-4}	NC	2×10^{-5}	NC	7	6	6	5
Open Adit & Shafts, Open Land South of MTP – North of Galena Gulch (10, 11)	South of Former Iron King Mine Property (NR14)	Residential/ Occupational/ Recreational/ Ecological	1,748	2×10^{-4}	4	5×10^{-5}	NC	9×10^{-6}	NC	6	5	4	2
NAI Operations Area (15)	NAI Operations Area (NR18)	Occupational	5,333	3×10^{-4}	3	6×10^{-5}	NC	1×10^{-5}	NC	6	6	3	2

Area of Concern (No.)	Risk Management Area	Anticipated Future Land Use	Lead EPC[a] (mg/kg)	Incremental Lifetime Human Health Risk[b]						Ecological Risk[c]			
				Residential Scenario		Occupational Scenario		Recreational Scenario		Number of Species			
				Cancer Risk	Non-cancer HI[d]	Cancer Risk	Non-cancer HI[d]	Cancer Risk	Non-cancer HI[d]	HQ>1	HQ>3	HQ>5	HQ>10
Galena Gulch Waste Rock Piles, Rear Waste Rock Pile, West Waste Rock Pile (6, 8, 9)	Former Mineworks Area (NR16)	Recreational/ Ecological	8,726	6×10^{-4}	5	1×10^{-4}	NC	2×10^{-5}	NC	7	6	6	5
Galena Gulch Sediments (7[i, k])	South of Former Iron King Mine Property (NR14)	Recreational/ Ecological	125	3×10^{-4}	11	5×10^{-5}	NC	1×10^{-5}	NC	6	5	4	2
Open Land South of MTP – South of Galena Gulch (12[i, k])	South of Former Iron King Mine Property (NR14)	Recreational/ Residential/ Ecological	39	3×10^{-5}	7	5×10^{-6}	NC	9×10^{-7}	NC	6	5	4	2
Open Land North of MTP – RI Area 19 (13)	Former Glory Hole and North of Mine Tailings Pile (NR19 Partial)	Occupational/ Residential/ Ecological	458	1×10^{-4}	0.8	3×10^{-5}	NC	4×10^{-6}	NC	4	3	0	0
Open Land North of MTP – RI Area 20 (14)	North of Chaparral Gulch (NR20)	Occupational/ Residential/ Recreational/ Ecological	62	5×10^{-5}	0.3	1×10^{-5}	NC	2×10^{-6}	NC	0	0	0	0
Mine Blowout Path (16)	JT Septic Facility (NR4) and Mine Tailings Pile 1964 Blow Out Path (NR5)[f]	Residential/ Occupational/ Recreational/ Ecological	1,887 / 1,681	6×10^{-4}/ 3×10^{-4}	4 / 2	1×10^{-4} / 6×10^{-5}	NC/NC	2×10^{-5}/ 1×10^{-5}	NC / NC	5	5	3	1
Upper Chaparral Gulch (17)	Upper Chaparral Gulch (NR3)	Residential/ Occupational/ Ecological	253	6×10^{-5}	NC	1×10^{-5}	NC	2×10^{-6}	NC	0	0	0	0
Middle Chaparral Gulch (18)	Middle Chaparral Gulch (NR6)	Recreational/ Ecological	633	2×10^{-4}	3	4×10^{-5}	NC	7×10^{-6}	NC	5	4	1	0

Area of Concern (No.)	Risk Management Area	Anticipated Future Land Use	Lead EPC[a] (mg/kg)	Incremental Lifetime Human Health Risk[b]						Ecological Risk[c]			
				Residential Scenario		Occupational Scenario		Recreational Scenario		Number of Species			
				Cancer Risk	Non-cancer HI[d]	Cancer Risk	Non-cancer HI[d]	Cancer Risk	Non-cancer HI[d]	HQ>1	HQ>3	HQ>5	HQ>10
Tailings Flood Plain, Smelter Blowout Fan (19, 20)	Tailings Floodplain (NR8) (a small portion of SBO is in Smelter Tailings Depression [NR7])	Recreational/ Ecological	1,338	3×10^{-4}	4	6×10^{-5}	NC	1×10^{-5}	NC	5	5	4	0
Smelter Tailings Depression (21)	Smelter Tailings Depression (NR7)	Occupational/ Recreational/ Ecological	263	1×10^{-4}	2	2×10^{-5}	NC	4×10^{-6}	NC	5	5	0	0
Dam (22)	Tailings Floodplain (NR8)	Recreational/ Ecological	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lower Chaparral Gulch, Elbow Tailings Pile (23, 28)	Lower Chaparral Gulch (NR9)	Recreational/ Ecological	1,869	7×10^{-4}	6	2×10^{-4}	1	3×10^{-5}	NC	6	6	5	4
Dross/Pyro-metallurgical Operations Area (24)	Former Pyrometallurgical Operations Area (NR11)	Occupational/ Recreational/ Ecological	2,093	6×10^{-4}	10	1×10^{-4}	2	2×10^{-5}	NC	7	6	6	6
South Smelter Plateau (25)	Smelter Plateau (NR12)	Occupational/ Recreational/ Ecological	1,029	7×10^{-4}	7	2×10^{-4}	2	3×10^{-5}	NC	6	6	6	4
Agua Fria Tailings Pile (29)	Agua Fria Tailings Pile (NR10)	Recreational/ Ecological	5,579	2×10^{-3}	11	4×10^{-4}	2	6×10^{-5}	NC	6	5	4	4
Slag – Monolithic[j] (26)	Former Pyrometallurgical Operations Area (NR11)	Recreational/ Ecological	2,093	6×10^{-4}	10	1×10^{-4}	2	2×10^{-5}	NC	7	6	6	6

Area of Concern (No.)	Risk Management Area	Anticipated Future Land Use	Lead EPC[a] (mg/kg)	Incremental Lifetime Human Health Risk[b]						Ecological Risk[c]			
				Residential Scenario		Occupational Scenario		Recreational Scenario		Number of Species			
				Cancer Risk	Non-cancer HI[d]	Cancer Risk	Non-cancer HI[d]	Cancer Risk	Non-cancer HI[d]	HQ>1	HQ>3	HQ>5	HQ>10
Slag – Loose (27)	Partially in both Former Pyrometallurgical Operations Area (NR11) and Smelter Plateau (NR12)[g]	Recreational/ Ecological	2,093 / 1,029	6×10^{-4} / 7×10^{-4}	10 / 7	1×10^{-4} / 2×10^{-4}	2 / 2	2×10^{-5} / 3×10^{-5}	NC / NC	7 / 6	6 / 6	6 / 6	6 / 4
Agua Fria River (30)	Agua Fria River (NA)[h]	Recreational/ Ecological	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
East of River (31)	Former Humboldt Smelter Property East of the Agua Fria River (NR13)	Residential/ Occupational/ Recreational/ Ecological	260	4×10^{-5}	NC	8×10^{-6}	NC	1×10^{-6}	NC	2	0	0	0

Notes:
a) The reported values are the lower of the calculated UCL or the maximum detected concentration.
b) Risk estimates are presented for all exposure scenarios for comparison purposes.
c) The reported value is based on the LOAEL. The value is the total number of evaluated receptors that have at least one contaminant of concern that exceed the HQ. Plants, soil invertebrates, and eight species of vertebrates were evaluated.
d) Noncancer HI is for child/adult.
e) First reported value is for Mine Blowout Path (NR16) and second reported value is for Tailings Floodplain (NR19).
f) First reported value is for Former Fertilizer Plant (NR4) and second reported value is for Galena Gulch Waste Rock Wall (NR5).
g) First reported value is for Open Land South of MTP – North Galena Gulch (NR11) and second reported value is for Open Land South of MTP – South of Galena Gulch (NR12)
h) See Section 9.7.1.3 of the RI for Agua Fria surface water and sediment sample results, which show there is a completed pathway, but no human health risk for sediment or surface water.
i) Area of Concern 12 was removed for remedial action. See Section 2.3.3 of the FS.
j) Monolithic slag only becomes a risk when slag breaks apart and becomes loose or granulated. The annual freeze-thaw cycle will eventually break up the monolithic slag.
k) Occupational and recreational risks and hazards calculated based on ratios of risk from NR14 EPCs and Area of Concern-specific EPCs.

EPC = exposure point concentration
HI = hazard index
HQ = hazard quotient
LOAEL = lowest observed adverse effect level

Area of Concern (No.)	Risk Management Area	Anticipated Future Land Use	Lead EPC[a] (mg/kg)	Incremental Lifetime Human Health Risk[b]						Ecological Risk[c]			
				Residential Scenario		Occupational Scenario		Recreational Scenario		Number of Species			
				Cancer Risk	Non-cancer HI[d]	Cancer Risk	Non-cancer HI[d]	Cancer Risk	Non-cancer HI[d]	HQ>1	HQ>3	HQ>5	HQ>10

mg/kg = milligrams per kilogram
MTP = mine tailings pile
NC = not calculated; only exposure areas with a site HI >1 were evaluated for incremental risk
NA = not applicable
UCL = upper confidence limit
Source: Table 2-2 of the FS.

Table 6: Waste/Soil Cleanup Levels

COC / COEC[a]	Human Health-Based Cleanup Levels (mg/kg)			Ecological-Based Cleanup Levels[e] (mg/kg)
	Residential[b]	Occupational[c]	Recreational[d]	
Antimony	31	NC	NC	56
Arsenic	79✦ East of Agua Fria River 48 West of Agua Fria River (background)	618	274	1,414
Cadmium	Not a human health COC			30
Cobalt	44 (background)	NC	NC	NC
Copper	Not a human health COC			2,245
Dioxins/furans[f]	NC	0.00072	0.00011	0.000052
Lead	200[g]	460[h]	2,212[i]	559
Manganese	1,800	NC	NC	NC
Selenium	Not a human health COC			38
Thallium	2.8 (background)	NC	NC	NC
Zinc	Not a human health COC			5,688

Notes:

✦ See Section 8.1: Cleanup Levels under the heading *Specific Discussion Regarding Arsenic Cleanup Levels in Areas with Residential Land Use.* The cleanup level for arsenic on the *east* side of the Agua Fria River in residential areas is based on a HI of 1 for child residents. The BTV, which is based on a 95-95 Upper Tolerance Limit, is 99 mg/kg for residential areas east of the river. Because the BTV exceeds the risk-based cleanup level of 79 mg/kg, EPA has chosen 79 mg/kg as the cleanup level but will also perform statistical evaluations to ensure that cleanup does not occur below background.

a) COCs/COECs differ for each of the areas of concern (including residential properties), although arsenic and lead are common COCs for all soil/waste areas. Although several COCs were originally identified as human health COCs under a hypothetical residential exposure scenario in areas of the former mine and smelter, they are not considered COCs under the RAFLU in any of the areas of concern evaluated. For updated RAFLU, see Figure 4.
b) Residential cleanup levels, except for the lead cleanup level, are based on the lower of ELCR of 1×10^{-6} or a HQ of 1, unless otherwise noted as a background concentration.
c) Occupational cleanup levels, except for lead, are based on the lower of ELCR of 1×10^{-4} or a HQ of 1. Occupational cleanup levels are also protective of construction workers.
d) Recreational cleanup levels, except for lead, are based on the lower of ELCR of 1×10^{-5} or a HQ of 1.
e) Ecological-based cleanup levels are based on lowest LOAEL HQ = 5.
f) Dioxins/furans were identified as COCs only in AOCs 24 and 25, which have potential future occupational and recreational land use and ecological habitat, but no potential residential land use.
g) Calculated using the IEUBK model for child with a target blood lead level of 5 µg/dL.
h) Calculated using the ALM (2017) with outdoor exposure assumptions. The ALM does not distinguish between commercial and industrial workers; rather, it is applicable to non-residential exposure scenarios.
i) Calculated using the ALM (2017) with teenager exposures assumed at 52 days per year.

ALM = EPA Adult Lead Model
AOC = area of concern
BTV = background threshold value
COC = chemical of concern
COEC = chemical of ecological concern

COC / COEC[a]	Human Health-Based Cleanup Levels (mg/kg)			Ecological-Based Cleanup Levels[e] (mg/kg)
	Residential[b]	Occupational[c]	Recreational[d]	

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient
IEUBK = Integrated Exposure Uptake Biokinetic
LOAEL = lowest observed adverse effect level
µg/dL = micrograms per deciliter
mg/kg = milligrams per kilogram
NC = not a COC or COEC for the exposure scenario based on the RI HHRA and RAFLU in the areas of concern
RAFLU = reasonably anticipated future land use

Source: FS, Table B-1, Appendix B and confirmation with updated RAFLU (Figure 4) and revised residential cleanup levels for arsenic and lead.

Table 7: COCs and Soil Cleanup Levels by Area of Concern

Group Title	Area of Concern	Area of Concern Description	Applicable Receptors	COC / COEC[a]	Receptor for Cleanup Level[b, c, d, e]	Cleanup Level (mg/kg)
Residential	Unnumbered	Existing Residential Properties	Residential	Arsenic	Residential	79✦ – East of River 48 – West of River (background)
				Lead	Residential	200
				Antimony	Residential	31
				Cobalt	Residential	44 (background)
				Manganese	Residential	1800
				Thallium	Residential	2.8 (background)
Mine Tailings Pile (MTP)	1, 2	Mine Tailings Pile Upper and Lower Tiers	Occupational/ Ecological	Antimony	Ecological	56
				Arsenic	Occupational	618
				Cadmium	Ecological	30
				Lead	Occupational	460
				Selenium	Ecological	38
				Zinc	Ecological	5688
Industrial Areas around MTP	3	Former Mineworks and Processing Area	Occupational/ Ecological	Antimony	Ecological	56
				Arsenic	Occupational	618
				Cadmium	Ecological	30
	4	Former Fertilizer Plant		Lead	Occupational	460
				Selenium	Ecological	38
Open Land Around MTP	5	Galena Gulch Waste Rock Wall	Occupational/ Ecological	Antimony	Ecological	56
				Arsenic	Occupational	618
				Cadmium	Ecological	30
				Lead	Occupational	460
				Selenium	Ecological	38
	11	a. Portion of Open Land South of MTP – North of Galena Gulch that is Zoned Industrial	Occupational/ Ecological	Antimony	Ecological	56
				Arsenic	Occupational	618
				Lead	Occupational	460
		b. Portion of Open Land South of MTP – North of Galena Gulch that is Zoned Residential	Residential/ Ecological	Antimony	Residential	31
				Arsenic	Residential	48 (background)
				Lead	Residential	200
				Thallium	Residential	2.8 (background)
	15	North American Industries Corporation	Occupational	Arsenic	Occupational	618
				Lead	Occupational	460
	8	Rear Waste Rock Pile	Occupational/ Ecological	Antimony	Ecological	56
				Arsenic	Occupational	618
				Cadmium	Ecological	30
				Lead	Occupational	460
				Selenium	Ecological	38
	9	West Waste Rock Pile	Occupational/ Ecological	Antimony	Ecological	56
				Arsenic	Occupational	618
				Cadmium	Ecological	30

Group Title	Area of Concern	Area of Concern Description	Applicable Receptors	COC / COEC[a]	Receptor for Cleanup Level[b, c, d, e]	Cleanup Level (mg/kg)
				Lead	Occupational	460
				Selenium	Ecological	38
Open Land Around MTP (Continued)	6	Galena Gulch Waste Rock Piles	Occupational/ Ecological	Antimony	Ecological	56
				Arsenic	Occupational	618
				Cadmium	Ecological	30
				Lead	Occupational	460
				Selenium	Ecological	38
	7	Galena Gulch Sediments[f]	Recreational/ Ecological	Antimony	Ecological	56
				Arsenic	Recreational	274
				Lead	Ecological	559
	13/14	c. Portion of Open Land North of MTP – that is Zoned Industrial	Occupational/ Ecological	Arsenic	Occupational	618
				Lead	Occupational	460
		d. Portion of Open Land North of MTP – not owned by BLM or State of AZ and is Zoned Residential	Residential/ Recreational/ Ecological	Arsenic	Residential	48 (background)
				Lead	Residential	200
	13/14	e. Portion of Open Land North of MTP – that is owned by BLM or State of AZ	Recreational/ Ecological	Arsenic	Recreational	274
				Lead	Ecological	559
Upper Chaparral Gulch	16	Mine Blowout Path	Residential/ Ecological	Antimony	Residential	31
				Arsenic	Residential	48 (background)
				Lead	Residential	200
				Selenium	Ecological	38
	17	Upper Chaparral Gulch	Residential/ Recreational/ Occupational/ Ecological	Arsenic	Residential	48 (background)
Middle and Lower Chaparral Gulch	18	Middle Chaparral Gulch	Recreational/ Ecological	Arsenic	Recreational	274
				Lead	Ecological	559
	20	Smelter Blowout Fan	Occupational/ Ecological	Arsenic	Occupational	618
				Copper	Ecological	2245
				Lead	Occupational	460
	19	Tailings Floodplain	Recreational/ Ecological	Arsenic	Recreational	274
				Copper	Ecological	2245
				Lead	Ecological	559
	21	Smelter Tailings Depression	Occupational/ Ecological	Arsenic	Occupational	618
				Cadmium	Ecological	30
				Copper	Ecological	2245
				Lead	Occupational	460
	28	Elbow Tailings Pile	Recreational/ Ecological	Antimony	Ecological	56
				Arsenic	Recreational	274
				Copper	Ecological	2245
				Lead	Ecological	559
				Selenium	Ecological	38

Group Title	Area of Concern	Area of Concern Description	Applicable Receptors	COC / COEC[a]	Receptor for Cleanup Level[b, c, d, e]	Cleanup Level (mg/kg)
	23	Lower Chaparral Gulch	Recreational/ Ecological	Antimony	Ecological	56
				Arsenic	Recreational	274
				Copper	Ecological	2245
				Lead	Ecological	559
				Selenium	Ecological	38
Pyrometal-lurgical and South Smelter Plateau [h, i]	25	South Smelter Plateau	Occupational/ Ecological	Antimony	Ecological	56
				Arsenic	Occupational	618
				Cadmium	Ecological	30
				Copper	Ecological	2245
				Dioxins/ Furans[g]	Ecological	0.000052
				Lead	Occupational	460
	29	Agua Fria Tailings Pile	Occupational/ Ecological	Arsenic	Occupational	618
				Lead	Ecological	559
	24	Dross/ Pyrometallurgical Operations Area	Occupational/ Ecological	Arsenic	Occupational	618
				Cadmium	Ecological	30
				Copper	Ecological	2245
				Dioxins/ Furans[g]	Ecological	0.000052
				Lead	Occupational	460
East of Agua Fria River	31	East of River	Residential/ Occupational	Arsenic	Residential	79✦
				Lead	Residential	200

Notes:

✦ See Section 8.1: Cleanup Levels under the heading *Specific Discussion Regarding Arsenic Cleanup Levels in Areas with Residential Land Use.* The cleanup level for arsenic on the east side of the Agua Fria River in residential areas is based on a HI of 1 for child residents. The BTV, which is based on a 95-95 Upper Tolerance Limit, is 99 mg/kg for residential areas east of the river. Because the BTV exceeds the risk-based cleanup level of 79 mg/kg, EPA has chosen 79 mg/kg as the cleanup level but will also perform statistical evaluations to ensure that cleanup does not occur below background.

a) COCs/COECs differ for each of the areas of concern (including residential properties), although arsenic and lead are common COCs for all soil/waste areas. Although several COCs were originally identified as human health COCs under a hypothetical residential exposure scenario in areas of the former mine and smelter, they are not considered COCs under the RAFLU in any of the areas of concern evaluated. For updated RAFLU, see Figure 4.
b) Residential cleanup levels, except for the lead cleanup level, are based on the lower of ELCR of 1×10^{-6} or a HQ of 1, unless otherwise noted as a background concentration.
c) Occupational cleanup levels, except for lead, are based on the lower of ELCR of 1×10^{-4} or a HQ of 1. Occupational cleanup levels are also protective of construction workers.
d) Recreational cleanup levels, except for lead, are based on the lower of ELCR of 1×10^{-5} or a HQ of 1.
e) Ecological-based cleanup levels are based on lowest LOAEL HQ = 5.
f) The exposure pathway to the Galena Gulch sediments is identical to that of exposure to soil in other areas of the Site because the soils in the gulch are dry over most of the year; therefore, soil is the appropriate medium of concern.
g) Dioxins/furans were identified as COCs only in AOCs 24 and 25, which have potential future occupational and recreational land use and ecological habitat, but no potential residential land use.
h) Maximum detected CrVI soil concentration (18 mg/kg in soil sample from the South Smelter Plateau) is lower than the occupational cleanup level. Therefore, CrVI is not included as a final COC.
i) BaPe exposure point concentration (EPC) (based on maximum detections of carcinogenic PAHs in soil samples from the historical Dross/Pyrometallurgical Operations Area) is 0.84 mg/kg, which is associated with a risk of 3×10^{-6} and is at the lower end of the EPA risk range. The BaPe EPC (based on maximum detections) is orders of magnitude lower than the occupational cleanup level. Therefore, BaPe is not included as a final COC.

<table>
<tr><th>Group Title</th><th>Area of Concern</th><th>Area of Concern Description</th><th>Applicable Receptors</th><th>COC / COEC[a]</th><th>Receptor for Cleanup Level[b, c, d, e]</th><th>Cleanup Level (mg/kg)</th></tr>
<tr><td colspan="7">BaPe = benzo(a)pyrene equivalent
BTV = background threshold value
COC = chemical of concern
COEC = chemical of ecological concern
CrVI = hexavalent chromium
ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient
LOAEL = Lowest Observed Adverse Effect Level
mg/kg = milligrams per kilogram
MTP = mine tailings pile
PAH = polycyclic aromatic hydrocarbon
RAFLU = reasonably anticipated future land use
RI = remedial investigation

Source: FS, Table 2-3 with modifications for revised cleanup levels for arsenic and lead.</td></tr>
</table>

Table 8: Surface Water Cleanup Levels for Protection of Aquatic Organisms

COC	Cleanup Level[a] (µg/L)	Source
Aluminum (total)	893 (Agua Fria River) 87 (Lower Chaparral Gulch)	Site-specific calculator[b]
Barium	111	Background[c]
Beryllium	5.3	AAC A&Ww chronic
Cadmium	1.6	NRWQC-CCC; AAC A&Ww chronic
Cobalt	23	Tier II value
Copper (dissolved)	6.1 (Agua Fria River) 115 (Lower Chaparral Gulch)	Site-specific calculator[d]
Cyanide	5.6	Background[e]
Iron	1,000	NRWQC-CCC; AAC A&Ww chronic
Manganese	120	Tier II value
Mercury	0.01	AAC A&Ww chronic
Selenium	2	AAC A&Ww chronic
Vanadium	20	Tier II value
Zinc	118	NRWQC-CCC

Notes:

a) Cleanup levels apply to the Agua Fria River (AOC 30) and the Lower Chaparral Gulch (AOC 23). Surface water cleanup levels were selected as the lower concentration from the aquatic and wildlife (warm water) standard chronic value for metals in AAC R18-11-104 Appendix A and National Recommended Water Quality Criteria - Criterion Continuous Concentrations (NRWQC-CCC; EPA 2019), or background for the Agua Fria River if background was higher than ecological protection values. If no concentration was contained in these requirements, then the Tier II value based on Suter and Tsao (1996) was selected.

b) Aluminum water quality criteria concentration is based on the aluminum-criteria calculator-v20, an Excel application that allows users to calculate criteria values under various water chemistry scenarios. Input data are pH, hardness, and concentration of dissolved organic carbon (EPA 2021). See also FS Appendix C-7.

c) Background levels of barium are higher than the Tier II value of 4 µg/L.

d) Values are based on the Biotic Ligand Model EPA (2015), a metal bioavailability model that uses receiving water body characteristics and monitoring data to develop site-specific water quality criteria. Input data for the Biotic Ligand Model include temperature, pH, dissolved organic carbon, major cations, major anions, alkalinity, and sulfide. See also FS Appendix C-7.

e) Background levels of cyanide are higher than the NRWQC-CCC of 5.2 µg/L.

A&Ww = aquatic and wildlife (warm water) standard
AAC = Arizona Administrative Code
CCC = Criterion Continuous Concentration
NRWQC = National Recommended Water Quality Criteria
Tier II = Tier II values are secondary values based on Suter and Tsao (1996). A higher level of uncertainty and conservatism is associated with the Tier II Values, because the Tier II values were established with fewer data than are required for the NRWQC and are generally expected to be lower than NRWQC.
µg/L = micrograms per liter

References:
EPA. 2015. Copper Biotic Ligand Model. Available online at: https://www.epa.gov/wqs-tech/copper-biotic-ligand-model
EPA. 2019. National Recommended Water Quality Criteria. Office of Science and Technology. Available online at: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table
EPA. 2021. Aquatic Life Criteria – Aluminum. Available online at: https://www.epa.gov/wqc/aquatic-life-criteriaaluminum
Suter, G.W., II and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 Revision. ES/ER/TM-96/R2. Health Sciences Research

Table 9: Comparison of Alternatives

Alternative 1 is not shown because it would not be protective of human health and environment		**Alternative 2: On-Site Consolidation/ Containment at One Repository at the Mine Tailings Pile**	**Alternative 3A: On-Site Consolidation/ Containment at Two Repositories with Chaparral Gulch Waste to the Mine Tailings Pile**	**Alternative 3B: On-Site Consolidation/ Containment at Two Repositories with Waste Remaining East and West of the Highway**	**Alternative 4: Removal and Off-Site Disposal**
Would it be protective of human health and the environment?		Yes – provided the repository is maintained	Yes – provided repositories are maintained	Yes – provided repositories are maintained	Yes
What is the cost?		Capital: $70.7 M O&M: $2.0 M Total: $72.7 M +$15 M for residential cleanup	Capital: $72.7 M O&M: $2.5 M Total: $75.2 M +$15 M for residential cleanup	Capital: $69.6 O&M: $2.5 M Total: $72.1 M +$15 M for residential cleanup	Capital: $567 M O&M: $1.1 M Total: $568 M +$15 M for residential cleanup
Time	Hauling Wastes on Roads	At least 81 weeks (1 yr. & 7 mo.)	At least 46 weeks (11 months)	At least 37 weeks (9 months)	487 weeks (9 yr. & 4 mo.)
	Complete Cleanup	2.1 years	1.4 years	1.2 years	9.9 years
Short Term Impacts: Wastes moved across the highway in the short term **Traffic congestion, community disruption…**		Yes 1.1 million loose cubic yards[a] waste (55,000 truckloads) moved across Highway 69 (Soil still would be hauled in to build the covers)	Yes 560,000 loose cubic yards[a] waste (28,000 truckloads) moved across Highway 69 (Soil still would be hauled in to build the covers)	No Wastes will not be moved across Highway 69 – least disruptive option (Soil still would be hauled in to build the covers)	Yes 6.6 million loose cubic yards[a] of waste hauled on Highway 69 and other roads
Will it be permanent and effective over the long term?		Yes – RAOs would be met indefinitely provided repository is maintained	Yes – RAOs would be met indefinitely provided repositories are maintained	Yes – RAOs would be met indefinitely provided repositories are maintained	Yes
Can it be implemented? **How hard would it be to do it?**		Yes One repository is somewhat easier to build and maintain than two repositories	Yes Two repositories are somewhat more difficult to build and maintain than one repository	Yes Two repositories are somewhat more difficult to build and maintain than one repository	Possible, but problematic. Very difficult to do – finding a facility; huge quantity of waste on-road for 10 years
Can it meet other applicable and relevant laws and environmental requirements?		Yes	Yes	Yes	Yes

Alternative 1 is not shown because it would not be protective of human health and environment	**Alternative 2: On-Site Consolidation/ Containment at One Repository at the Mine Tailings Pile**	**Alternative 3A: On-Site Consolidation/ Containment at Two Repositories with Chaparral Gulch Waste to the Mine Tailings Pile**	**Alternative 3B: On-Site Consolidation/ Containment at Two Repositories with Waste Remaining East and West of the Highway**	**Alternative 4: Removal and Off-Site Disposal**
Would it reduce the ability of wastes to move and reduce their volume?	Yes	Yes	Yes	Yes
Notes: a) Loose cubic yards refers to the volume of material after it has been excavated from the ground and loaded on trucks. This is greater than the volume of material before it is excavated. M = million mo. = months yr. = years				

Table 10: Costs for the Selected Remedy, Alternative 3B: On-Site Consolidation and Containment at Two Repositories with Waste Remaining East and West of Highway

Cost Item	Cost
Capital Costs	
West of Highway	
Excavation, Hauling Grading and Compaction - Wastes and Tailings Outside MTP (includes Dust Control and Traffic Control)	$1,713,372
Excavation - MTP Slope Reduction[a]	$3,115,750
Repositories and Capping	$11,190,000
Restoration	$3,670,000
East of Highway	
Excavation, Hauling, Grading, and Compaction	$15,150,000
Repositories and Capping	$3,780,000
Restoration	$4,270,000
Subtotal Construction Costs =	**$42,890,000**
Mobilization, Insurance, Bonding	$4,290,000
Institutional Controls	$150,000
Subtotal Costs =	**$47,330,000**
Project Management Remedial	$2,370,000
Design	$2,840,000
Construction Management	$2,840,000
Construction Contingencies	$14,200,000
Total Capital Costs =	**$69,580,000**
Operation and Maintenance (O&M) Costs	
Annual Site Inspections Site	$4,000
Groundwater Monitoring	$25,000
Annual Site Maintenance **Subtotal**	$120,000
Annual O&M Costs	**$149,000**
Annual O&M Contingencies	$45,000
Total Annual O&M Cost	**$194,000**
Present Worth of Annual O&M Costs Based on 30 Year Life @ 7%	**$2,410,000**
Periodic Five-Year Reviews	$50,000
Present Worth of Periodic Costs Based on 30 Year Life @ 7%	**$108,000**
Total Present Worth	**$72,100,000**

Notes:
a. Decreasing amounts of waste disposed allows for more cutting of existing slopes and construction of a repository with gentler slopes

Table 11: Federal Chemical-Specific ARARs

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
SOIL				
There are no federal chemical-specific ARARs for soil.				
SURFACE WATER				
Clean Water Act § 304 Criteria				
Surface water standards for aluminum, cadmium, copper, cyanide, iron and zinc for the protection of aquatic receptors.	Surface water	Clean Water Act § 304 criteria (national recommended water quality criteria)	Relevant and appropriate	CERCLA § 121(d)(2)(A) requires remedial actions attain water quality criteria established under Clean Water Act § 304 when relevant and appropriate under the circumstances. The Clean Water Act § 304 criteria for aluminum, cadmium, copper, cyanide, iron and zinc are relevant and appropriate for the Site. Risk to aquatic receptors in the Agua Fria River was identified from these chemicals; and criteria for these chemicals have been established under Clean Water Act § 304. The criteria are used as the basis for the surface water remediation goals.

Notes:
§ - Section
ARAR - Applicable or relevant and appropriate requirement
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act

Table 12: State Chemical-Specific ARARs

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
		SOIL		
Enabling legislation for the establishment of soil remediation standards	Applies to parties conducting soil remediation pursuant to a program administered by ADEQ	ARS § 49-152(A)-(B)	Relevant and appropriate	These statutory provisions allow for the establishment of predetermined soil remediation standards and methods for calculating site-specific standards.
Soil shall be remediated to either: background concentrations, pre-determined remediation standards, or site-specific remediation standards.	Soil remediation conducted pursuant to a program administered by ADEQ	AAC R18-7-203	Relevant and appropriate	These standards are considered to be relevant and appropriate for the Site for COCs identified for human receptors. Appendix A pre-determined standards must be used if site characterization was not completed before May 2007 and/or risk assessment was not completed before May 2010.
A person may elect to remediate to a background concentration and establish the background concentration according to certain factors.	Soil background is calculated	AAC R18-7-204 (A) & (B)	To be considered	Provision: "(A) A person may elect to remediate to a background concentration for a contaminant. (B) A person who conducts a remediation to a background concentration for a contaminant shall establish the background concentration using all of the following factors: 1. Site-specific historical information concerning land use. 2. Site-specific sampling of soils unaffected by a release, but having characteristics similar to those of the soils affected by the release. 3. Statistical analysis of background concentrations using the 95th percentile upper confidence limit." This requirement is to be considered. It is noted that the basis for the statistical analysis in (B)(3) is a procedural provision.
A person may elect to remediate to residential or non-residential pre-determined remediation standards.	Soil remediation conducted pursuant to a program administered by ADEQ	AAC R18-7-205 ARS §49-151 through 159 AAC Title 18, Chapter 7, Sections 201 through 207	Relevant and appropriate	"The owner of a property may elect to remediate the property to meet a site specific residential or nonresidential risk-based remediation standard or a predetermined residential or nonresidential risk-based remediation standard. The property is suitable for unrestricted use if it has been remediated without the use of engineering or institutional controls to meet either 1) the predetermined residential risk-based remediation standard identified in A.A.C. R18-7-205, or 2) a site-specific risk- based hazard index equal to or less than one or a risk of carcinogenic health effects that is less than or equal to the range of risk levels set forth in 40 CFR 300.430(e)(2)(i)(A)(2), based on residential exposure."

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
A person may elect to remediate to residential or non-residential site-specific remediation standards derived from a site-specific human health risk assessment. The remediation standard must be based on either: (1) a deterministic methodology; (2) a probabilistic methodology; or (3) an alternative methodology.	Soil remediation conducted pursuant to a program administered by ADEQ	AAC R18-7-206	Relevant and appropriate	These standards are considered to be relevant and appropriate for the Site. EPA determined the site-specific standards are more relevant and appropriate for the Site.
SURFACE WATER AND GROUNDWATER				
State of Arizona Water and Aquifer Quality Standards				
Beneficial uses of the Agua Fria River and Galena Gulch	Surface water	AAC R18-11-104(B) and Appendix B	Applicable	The beneficial uses of the Agua Fria River at and near the Site are aquatic and warm water wildlife; human health full body contact; domestic water source; fish consumption; and agricultural irrigation and livestock watering. The beneficial uses of Galena Gulch are aquatic and ephemeral wildlife, human health partial body contact recreation, and agricultural livestock watering.
Water quality standards for surface water that is not listed in Appendix B but is a tributary to a listed surface water	Surface water not listed in Appendix B	AAC R18-11-105	Applicable	Chaparral Gulch is not listed in Appendix B. It is a tributary to the Agua Fria River so, pursuant to AAC R18-11-105, the beneficial uses are aquatic and warm water wildlife, full-body contact, and fish consumption.
Surface water standards for beryllium, mercury, and selenium for the protection of aquatic receptors	Surface water	AAC R18-11-104 Appendix A	Applicable	Risk to aquatic receptors in the Agua Fria River was identified from these chemicals. The numeric water quality standards for exposure of aquatic receptors to beryllium and mercury in AAC R18-11-104 Appendix A are identified as ARARs because they are more stringent than criteria under CWA § 304. Also, AAC R18-11-104 Appendix A contains a promulgation for selenium and there is no comparable promulgation in CWA § 304. These standards are used as the basis for the surface water remediation goals.

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Aquifer Water Quality Standards: Discharges to groundwater shall not pose a threat to human health and shall not exceed certain specified standards. Specified uses of groundwater in the State and numerical standards shall be attained.	Applies to discharges of contaminants to drinking water sources	ARS § 49-223 AAC Title 18, Chapter 11, Sections 104 through 105, 401 through 408, and Appendix A and B	Applicable	ARS 49-223 provides for adoption of drinking water aquifer water quality standards based on the protection of human health. R18-11-104: "Designated Uses. B: Designated uses of a surface water may include full-body contact, partial-body contact, domestic water source, fish consumption, aquatic and wildlife (cold water), aquatic and wildlife (warm water), aquatic and wildlife (ephemeral), aquatic and wildlife (effluent-dependent water), agricultural irrigation, and agricultural livestock watering. The designated uses for specific surface waters are listed in Appendix B of this Article." R18-11-405: Narrative Aquifer Water Quality Standards: "A. A discharge shall not cause a pollutant to be present in an aquifer classified for a drinking water protected use in a concentration which endangers human health. B. A discharge shall not cause or contribute to a violation of a water quality standard established for navigable water of the state. C. A discharge shall not cause a pollutant to be present in an aquifer which impairs existing or reasonably foreseeable uses of water in an aquifer." R18-11-406. Numeric Aquifer Water Quality Standards: Drinking Water Protected Use. "A. The aquifer water quality standards in this Section apply to aquifers that are classified for drinking water protected use. R18-11-407. Aquifer Water Quality Standards in Reclassified Aquifers. B. All aquifers in the state are classified for drinking water protected use except for aquifers which are reclassified to a nondrinking water protected use pursuant to A.R.S. § 49-224 and A.A.C. R18-11-503."

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Groundwater Protection Limits: Discharges shall not impair specified screening levels for protection of groundwater.	Discharges to groundwater	AAC Title 18, Chapter 11, Section 405; A Screening Method to Determine Soil Concentrations Protective of Groundwater Quality (ADEQ, June 1996)	To be considered	AAC R18-11-405: "A. A discharge shall not cause a pollutant to be present in an aquifer classified for a drinking water protected use in a concentration which endangers human health. B. A discharge shall not cause or contribute to a violation of a water quality standard established for a navigable water of the state. C. A discharge shall not cause a pollutant to be present in an aquifer which impairs existing or reasonably foreseeable uses of water in an aquifer. ADEQ (1992) developed screening levels to determine residual soil concentrations protective of groundwater."

Notes:
§ - Section
AAC - Arizona Administrative Code
ADEQ - Arizona Department of Environmental Quality
ARS - Arizona Revised Statutes
COC - Chemical of concern
CWA - Clean Water Act
EPA - U.S. Environmental Protection Agency
R - Rule

Table 13: Federal Location-Specific ARARs

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
WETLAND AND FLOODPLAIN RESOURCES				
Clean Water Act				
Discharge of dredge or fill material into waters of the U.S., including adjacent wetlands, is prohibited without a permit.	Waters of the U.S.	Clean Water Act § 404	Applicable	There are three surface water features on the Site: Agua Fria River, Chaparral Gulch (and adjacent wetlands), and Galena Gulch. Excavation of waste will occur in Chaparral Gulch and adjacent wetlands and Galena Gulch. Chaparral Gulch and adjacent wetlands may be Waters of the U.S. and need to be delineated. If Chaparral Gulch and adjacent wetlands are Waters of the U.S., then requirements controlling the discharge of dredge and fill at Clean Water Act § 404 would be followed. The substantive provisions of Nationwide Permit 38 will be used as guidelines for complying with Clean Water Act § 404. Pursuant to CERCLA § 121(e), a permit is not required for portions of the remedial action entirely on site. The excavation in Chaparral Gulch and adjacent wetlands would be on site, so a notice of intent to discharge pursuant to Nationwide Permit 38 would not be completed. The selected remedy includes removal of the tailing dam. Guidance from the U.S. Army Corps of Engineers (USACE) indicates that losses due to removal of obsolete dams may not require compensatory mitigation if those actions result in net increases in aquatic resource functions (USACE 2018).
Executive Orders				
Federal agencies must minimize the destruction, loss, or degradation of wetlands and avoid support of new construction in wetlands if a practicable alternative exists.	Waters of the U.S.	Executive Order 11990	To be considered	Executive Orders are not promulgated, and so do not meet the requirements to be ARARs. They are evaluated as to-be-considered (TBC) criteria and are binding on the federal government. Wetlands have been identified on the Site. The wetlands will be delineated to determine if they are jurisdictional. If the wetlands are jurisdictional and if a discharge of

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
				dredge or fill material would occur, Clean Water Act § 404 is an ARAR.
Federal agencies must avoid, to the extent possible, adverse effects associated with development and modification of a floodplain.	Floodplain	Executive Order 11988	To be considered	Executive Orders are not promulgated, and so do not meet the requirements to be ARARs. They are evaluated as TBC criteria and are binding on the federal government. The selected remedy will include the excavation of waste in floodplains. If the excavation is determined to adversely affect the floodplains, actions will be taken to minimize the adverse effects.
BIOLOGICAL RESOURCES				
It is illegal to take, capture, or kill any migratory bird or the parts, nests or eggs of any migratory bird.	Presence of migratory birds	16 U.S.C. § 703 et seq.	Applicable	Migratory birds are present on the Site. Potential risk to birds was identified at various locations in the Site. RAOs, numerical goals, and the selected remedy are protective of birds. In addition, remedial actions will avoid taking migratory birds during implementation.
Entities must comply with protections for fish, wildlife, and plants that are listed as threatened or endangered, including notice and mitigation requirements.	Presence of endangered species	16 U.S.C. § 1531 and 50 C.F.R. 402.	Applicable	Endangered species have not been identified at the Site during the biological survey and ecological risk assessment. However, should such species be identified during the remedial action, the remedy will comply with the substantive requirements, including notice and mitigation requirements, for protection of the species.
HISTORICAL RESOURCES				
Federal agencies must take historic properties into account when undertaking projects.	Historic property	54 U.S.C. § 306108 et seq. 36 C.F.R. Part 800	Applicable	Features eligible for inclusion on the National Register were identified on the Iron King Mine property and the Humboldt Smelter property. Remedial activities are not expected to affect most of the features; however, remedial activities may affect two of the historic features – the historic residential neighborhood (locus 4) and the artifact scatter (locus 6) at the Humboldt Smelter property. EPA will work with the SHPO to determine the effect, if any, of the remedial actions on these features and if necessary, identify appropriate actions to minimize or avoid impact to these two loci.

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Historical and archaeological data must be recovered and preserved if it is within an area where actions may cause irreparable loss or destruction.	Alteration of terrain	54 U.S.C. §§ 312502, 312503, and 312507	Applicable	Features eligible for inclusion on the National Register were identified on the Iron King Mine property and the Humboldt Smelter property. Therefore, data of archaeological or historical significance may be present. Remedial activities are not expected to affect most of the features; however, remedial activities may affect two of the historic features: the historic residential neighborhood (locus 4) and the artifact scatter (locus 6). EPA will work with the SHPO to determine if the remedial activities will cause an irreparable loss of data associated with these two loci.

Notes:
§ - Section
ARAR - Applicable or relevant and appropriate requirement
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R. - Code of Federal Regulations
EPA - Environmental Protection Agency
SHPO - State Historic Preservation Office
U.S. - United States
U.S.C. - United States Code

Table 14: State Location-Specific ARARs

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
		BIOLOGICAL RESOURCES		
It is illegal to take or injure any bird or harass any bird on its nest, or remove the nests or eggs of any bird, except as authorized under certain circumstances.	Presence of birds	ARS § 17-236(A)	Applicable	"It is unlawful to take or injure any bird or harass any bird upon its nest, or remove the nests or eggs of any bird, except as may occur in normal horticultural and agricultural practices and except as authorized by commission order." Pursuant to CERCLA § 121(e), a permit (or obtaining of permission) is not required for portions of the remedial action entirely on site. This state statute is broader in scope than the federal Migratory Bird Treaty Act in that is applies to birds not protected by the Migratory Bird Treaty Act. Precautions will be taken to avoid taking birds.
Requirements and prohibitions for the collection and salvage of protected plants	Presence of native protected plants on site	ARS § 3-906, AAC Chapter 3 Article 11 Appendix A	Relevant and appropriate	ARS 3-906(A): "Except as provided in this chapter a person shall not take, transport or possess any protected native plant taken from the original growing site in this state without possessing a valid permit." Pursuant to CERCLA § 121(e), a permit is not required for portions of the remedial action entirely on site. This law requires a notice to the Department of Agriculture for any removal or transplant of native plants as incorporated into AAC Chapter 3 Article 11 Appendix A the Arizona Protected Native Plants by Category. The notice provision shall be the followed as the ARAR.
		ARCHAEOLOGICAL DISCOVERIES		
Excavation on a burial ground is prohibited without a permit. A person who finds human remains is required to notify the director of the Arizona state museum, who will give notice to individuals with direct kinship, other interested groups and the SHPO. Agreement between all interested groups on the disposition of the remains will be sought.	Presence of human remains	ARS § 41-844	Applicable	A non-Native American burial site has been identified on the Iron King Mine property as F19 within locus 4. EPA will notify the director of the Arizona state museum, who will initiate the process of agreement among interested groups. Pursuant to CERCLA § 121(e), a permit is not required for portions of the remedial action entirely on site.

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Standards, Requirements, and Notification Requirements upon discovery of archeological, historical, or paleontological artifacts on lands owned or controlled by the state of Arizona	Conducting of any survey, excavation, construction or other like activity on any lands owned or controlled by this state, by any public agency or institution of the state, or by any county or municipal corporation within the state	ARS § 41-841(A) - 844 (A), -865 (A)	Applicable	ARS 41-841(A): “On lands owned or controlled by this state or any agency of this state a person shall not knowingly excavate in or upon any historic or prehistoric ruin, burial ground, archaeological or vertebrate paleontological site, or site including fossilized footprints, inscriptions made by human agency or any other archaeological, paleontological or historical feature.” ARS 41-844(A). “A person in charge of any survey, excavation, construction or other like activity on any lands owned or controlled by this state, by any public agency or institution of the state, or by any county or municipal corporation within the state shall report promptly to the director of the Arizona state museum the existence of any archaeological, paleontological or historical site or object that is at least fifty years old and that is discovered in the course of such survey, excavation, construction or other like activity and, in consultation with the director, shall immediately take all reasonable steps to secure and maintain its preservation.” ARS 41-865(A): “A person shall not intentionally disturb human remains or funerary objects on lands, then lands owned or controlled by this state, any agency or institution of this state or any county or municipal corporations within this state, without obtaining the written permission of the director of the Arizona state museum. “Pursuant to CERCLA § 121(e), a permit (or obtaining of permission) is not required for portions of the remedial action entirely on site.” ARS 41-865(A) shall only apply to the extent it may require giving notice to the director of the Arizona museum.
A person shall not intentionally disturb human remains without permission of the director of the Arizona state museum.	Presence of human remains	ARS § 41-865	Applicable	A non-Native American burial site has been identified on the Iron King Mine property as F19 within locus 4. EPA will notify the director of the Arizona state museum, who will initiate the process of agreement on the disposition of the remains.

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Other State Location-Specific Requirements				
The owner of a property must record a restrictive covenant called a Declaration of Environmental Use Restriction (DEUR) for residential property under specified conditions and restrict the use of the property.	Establishment of engineered or institutional control; or concentrations exceeding residential standards remain on site after cleanup; for residential land	ARS § 49-152 (C) AAC R18-7-208	Applicable	ARS § 49-152 (C): "If the owner of a property has elected to use an engineered or institutional control to meet the standards prescribed in A.R.S. §49-152 (B) or if concentrations remain on the property exceeding applicable residential standards, the property owner must record a restrictive covenant labeled as a Declaration of Use Restriction pertaining to the area of the property necessary to protect human health and environment and restrict residential land use." AAC R18-7-208: "A property owner who elects to leave contamination on a property that exceeds the applicable residential standard for the property under R18-7-205 or R18-7-206, or elects to use an institutional control or an engineering control to meet the requirements of R18-7- 205, R18-7-206, or R18-7-207, shall record a DEUR pursuant to A.R.S. § 49-152 and comply with the related provisions of that statute and applicable rules."
Notice is required from a lessee, permittee or other person having a legal interest in state lands located in a floodplain to construct or make improvements or developments on the lands.	Floodplain(s) present on state lands within the Site	ARS § 37-323(A)	To be considered	ARS 37-323(A): "A lessee, permittee or other person having a legal interest in state lands located in a floodplain as defined in section 48-3601 other than a holder of a certificate of purchase shall not construct or make improvements or any other development upon the lands without obtaining the written permission of the department." EPA does not have nor does it acquire legal interest in state lands. This provision should be considered as a notice to provide to the state prior to response work in floodplains.

Notes:
§ - Section
AAC - Arizona Administrative Code
ARAR - Applicable or relevant and appropriate requirement
ARS - Arizona Revised Statutes
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
EPA - U.S. Environmental Protection Agency
F - Feature
SHPO - State Historic Preservation Office

Table 15: Federal Action-Specific ARARs

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Excavation				
Clean Air Act				
Reasonable precautions must be used to limit excessive amounts of particulate matter from becoming airborne during excavation in open areas, dry washes or riverbeds. Reasonable precautions include approved dust suppressant or adhesive soil stabilizer, paving, cover, continuous wetting, detouring, barring access and other acceptable means.	Excavation and construction of covers	AAC R18-2-604	Applicable	The selected remedy includes excavation of waste (tailings and mine waste) and soil. Precautions will be taken to prevent particulate matter from getting airborne during excavation.
Reasonable precautions must be taken to prevent excessive amount of particulate matter from becoming airborne during material handling. Reasonable precautions include spray bars, wetting agents, dust suppressants, covers and hoods.	Excavation and construction of covers	AAC R18-2-606	Applicable	The selected remedy includes handling contaminated materials. Precautions will be taken to prevent particulate matter from becoming airborne during these activities.
Organic and inorganic producing material may not be stacked, piled or stored without taking reasonable precautions to prevent excessive amounts of particulate matter from becoming airborne. Reasonable precautions include chemical stabilization, wetting or covering.	Stacking, piling or storing organic or inorganic dust producing material	AAC R18-2-607	Applicable	The selected remedy includes handling waste that contains inorganic chemicals. Precautions will be taken to prevent particulate matter from becoming airborne during handling.
Operations on mineral tailings piles are prohibited unless precautions are taken to prevent excessive amounts of particulate matter from becoming airborne. Precautions include wetting, chemical stabilization or revegetation.	Operations on mineral tailings piles	AAC R18-2-608	Applicable	The selected remedy includes the excavation or contouring of tailings piles. Precautions will be taken to prevent particulate matter from becoming airborne during operations on these piles.

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Solid Waste Management				
Alternative final cover designs may be used that include: (1) an infiltration layer that achieves an equivalent reduction in infiltration; and (2) an erosion layer that provides equivalent protection from wind and water erosion.	Closure of a municipal solid waste landfill	40 C.F.R. § 258.60(b)	Relevant and appropriate	The selected remedy includes construction of covers over solid waste in place or in other on-site solid waste repositories. These requirements are not applicable to these solid waste landfills; however, they are relevant and appropriate.
Post-closure care is required for 30 years to: (1) maintain the integrity and effectiveness of the final cover; (2) maintain and operate the leachate collection system (which may stop if leachate no longer poses a threat to human health and the environment); and (3) monitor groundwater.	Closure of a municipal solid waste landfill	40 C.F.R. § 258.61(a)	Relevant and appropriate	Post-closure care will be included for all solid waste management units or other on-site solid waste repositories.
The post-closure care period may be decreased if it is demonstrated that the reduced period is sufficient to protect human health and the environment or increased if necessary to protect human health and the environment.	Closure of a municipal solid waste landfill	40 C.F.R. § 258.61(b)	Relevant and appropriate	Post-closure care will be included for all solid waste management units or other on-site solid waste repositories.
Resource Conservation and Recovery Act				
Identification criteria for solid waste exhibiting hazardous waste toxicity characteristic.	Treatment of hazardous waste	Resource Conservation and Recovery Act; 40 C.F.R. § 261.24	Relevant and appropriate	If the dross at the smelter property is determined to be a hazardous waste under Subtitle C of RCRA, all dross waste at the former smelter with concentrations of metals exceeding the RCRA TCLP limits at the smelter property will be excavated and treated to stabilize the waste and remove the hazardous waste toxicity characteristic below the TCLP limits set forth at 40 C.F.R. § 261.24 under RCRA before they are disposed of in the waste repository. (See ROD Section 5.5.4 regarding the Bevill exemption for certain wastes at the Site). These standards are relevant and appropriate for the Site.

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Notes: § - Section AAC - Arizona Administrative Code ARAR - Applicable or relevant and appropriate requirement CAMU - Corrective action management unit CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act C.F.R. - Code of Federal Regulations TCLP - Toxicity Characteristics Leaching Procedure				

Table 16: State Action-Specific ARARs

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Excavation and Site Restoration				
Restoration of excavation areas requires grading and other topographic contouring suitable for post-mining land use and stable under static and dynamic conditions considering site-specific seismic conditions, good engineering practices and hazards to public safety if failure occurs.	Reclamation of a mine	AAC R11-2-602	Relevant and appropriate	These requirements are not applicable to the cleanup of a mine that stopped operations long ago. However, these are identified as relevant and appropriate requirements for the restoration of excavation areas (not for construction of repositories). The excavation areas will be backfilled and contoured to minimize erosion and to blend with surrounding topography.
Revegetation should be conducted during the most favorable period of the year for plant establishment. Soil stabilizing practices or irrigation measures, or both, may be used to establish vegetation. Provides a method for determining successful revegetation if the vegetation being used is different than the pre-existing conditions.	Reclamation of a mine	AAC R11-2-702	Relevant and appropriate	These requirements are not applicable to the cleanup of a mine that stopped operations long ago. However, these are identified as relevant and appropriate requirements for revegetation of excavation areas (not for construction of the repositories). The revegetation will be done at the favorable time for planting and will be inspected to determine if the revegetation is successful.
Solid Waste Landfill Covenants				
The owners of the real property and the director must execute and record a restrictive covenant that prohibits development, filling, grading, excavating, drilling, or mining in the solid waste landfill after closure.	Closure of a solid waste landfill	ARS § 49-771	Applicable	The selected remedy includes consolidation of solid waste in repositories at the Site. Restrictions will be included that prohibit these activities to maintain the integrity of the covers. EPA will work with the owner of the real property and the director of ADEQ to ensure that an appropriate covenant will be executed.
Hazardous Waste and Materials Transport and Disposal				
Hazardous waste must be transported in a manner so as to protect human health and the environment.	Hazardous Materials requiring transport is generated by the remedial action	AAC Title 17, Chapter 5, Section 209	To be considered	As relevant to the transportation of hazardous materials, AAC R17- 5-209 incorporates by reference, as amended, relevant parts of the Federal Hazardous Materials Regulations (49 C.F.R. - Transportation, Subtitle B - Other Regulations Relating to Transportation, Chapter I - Pipeline and Hazardous Materials Safety Administration, Department of Transportation)

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Hazardous waste must be properly managed, treated, stored, transported, and disposed of.	Hazardous Waste generated by the remedial action	ARS §§ 49-901 through 49-973	Applicable	ADEQ has promulgated rules that establish criteria and standards for the characteristics, identification, listing, generation, transportation, treatment, storage, and disposal of hazardous waste within Arizona. ADEQ's hazardous waste management program is equivalent to and consistent with the federal hazardous waste regulations, which are adopted by reference.
Dust Control / Clean Air Requirements				
Parties involved in remedial activities should implement voluntary Best Management Practices to reduce or prevent PM10 particulate emissions as soon as practicable before and during a day that is forecast to be at high risk of dust generation.	Remedial activities that can result in generation of particulate emissions	ARS §§ 49-401 through 516	To be considered	Best management practices for regulated activities before and during a day that is forecast to be at high risk of dust generation and at moderate risk of dust generation. "Best management practices" means techniques that are verified by scientific research and that on a case-by-case basis are practical, economically feasible and effective in reducing PM10 particulate emissions from a regulated activity. "Dust-generating operation" is defined as disturbed surface areas, including those of open areas or vacant lots that are not defined as agricultural land and are not used for agricultural purposes or any other area or activity capable of generating fugitive dust, including the following: (a) Land clearing, maintenance and land cleanup using mechanized equipment. (b) Earthmoving. (d) Excavating. (g) Bulk material handling, including hauling, transporting, stacking, loading and unloading operations. (h) Storage or transporting operations, including storage piles. (i) Operation of outdoor equipment. (j) Operation of motorized machinery. (k) Establishing or using staging areas, parking areas, material storage areas or access routes. (l) Establishing or using unpaved haul or access roads.

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Other State Action-Specific Requirements				
Pollutant Discharge Elimination System: Specified types of discharges associated with construction activities are required to receive authorization by ADEQ.	Discharges associated with construction activities, that will disturb one or more acres of land, or will disturb less than one acre, but are part of a common plan of development that will ultimately disturb one acre	ARS § 49, Chapter 2, Article 3.1 AAC Title 18, Chapter 9, Article 9, and Chapter 11, Article 1 ARS Title 49 Chapter 2, Article 3.1 et seq. (non WOTUS). ARS § 49-255.04 AZPDES Construction General Permit AZG2020-001 CGP (substantive requirements only)	To be considered	This includes those substantive surface water controls that would be applicable under General permit, AZG2020-001 CGP, which would authorize, under the Arizona Pollutant Discharge Elimination System (AZPDES) program, stormwater discharges of pollutants associated with construction activity to all waters on the protected surface water list, including discharges to waters of the U.S. (WOTUS) and non-WOTUS protected surface waters. Substantive provisions consider stormwater discharges associated with “construction activities” that will disturb one or more acres of land, or will disturb less than one acre, but is part of a common plan of development that will ultimately disturb one acre or more (see 40 C.F.R. 122.26(b)(15)(ii)). All discharges should be controlled from the “commencement of construction activities” until “final stabilization.” While this is to TBC and not an ARAR, it is noted that pursuant to CERCLA § 121(e), permits (and by extension, permissions and authorizations) are not required for portions of the remedial action entirely on site.
Policy: Investigation-Derived Wastes (IDW) must be managed according to various described types and classifications of IDW.	IDW generated by remedial action.	ADEQ Investigation Derived-Wastes (IDW) Policy. August 9, 2005, Rev. No. 1.	To be considered	Management and disposal options will depend on whether the materials derived from investigative activities are solid waste, hazardous waste, or another type of waste, and the final disposition of IDW, whether on site or off site.

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions
Mining unit reclamation requires erosion control, stability, grading, and prohibition of restriction of surface drainages.	Reconfiguration of current or former mining units	AAC R11-2-602 Erosion Control and Topographic Contouring Standards	Relevant and appropriate	"Mining units shall be reclaimed to a stable condition for erosion and seismic activity. B. Grading and other topographic contouring methods shall be conducted, as necessary to establish final land forms which are: 1. Suitable for the post-mining land use objective in the approved reclamation plan 2. Stable under static and dynamic conditions as certified by qualified engineer C. Site-Specific grading, revegetation or other proposed erosion-control measures shall be conducted as necessary to address erosion so that permanent piles of mine development rock, overburden, and tailings shall not restrict surface drainages in a manner that contributes to excessive erosion or which compromises the stability of the reclaimed facility."
Mining unit reclamation shall meet specified revegetation standards.	Reconfiguration of current or former mining units	AAC R11-2-702 Revegetation Standards	Relevant and appropriate	"A. Where surface disturbances result in compaction of the soil, ripping, disking, or other means shall be used in areas to be revegetated to reduce compassion and to establish a suitable root zone in preparation for planting. B. Revegetation shall be conducted to establish plant species that will support the approved post-mining land use. The establishment of vegetation species density or diversity which is different that pre-existing conditions or on adjacent lands shall constitute successful reclamation C. Planting shall be conducted during the most favorable period of the year for plant establishment. D. Soil stabilizing practices or irrigation measures or both may be used to establish vegetation. E. This Section only applies if vegetation or revegetation measures are included in the approved reclamation plan."

Requirement	Prerequisite	Citation	ARAR Status	Comments and Key Provisions

Notes:
§ - Section
AAC - Arizona Administrative Code
ARAR - Applicable or relevant and appropriate requirement
ARS - Arizona Revised Statutes
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
TBC - To be considered

FIGURES

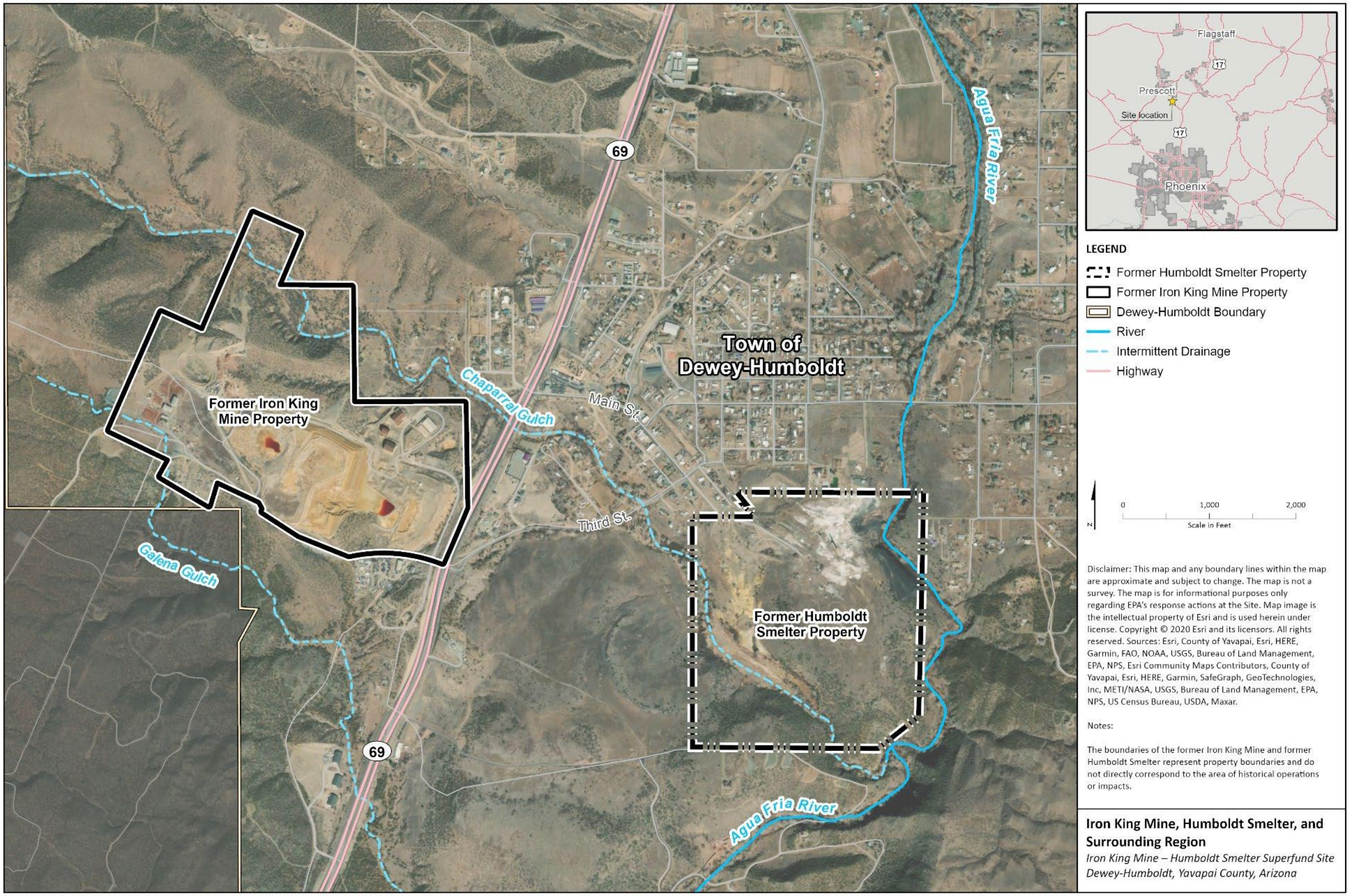


Figure 1: Site Location

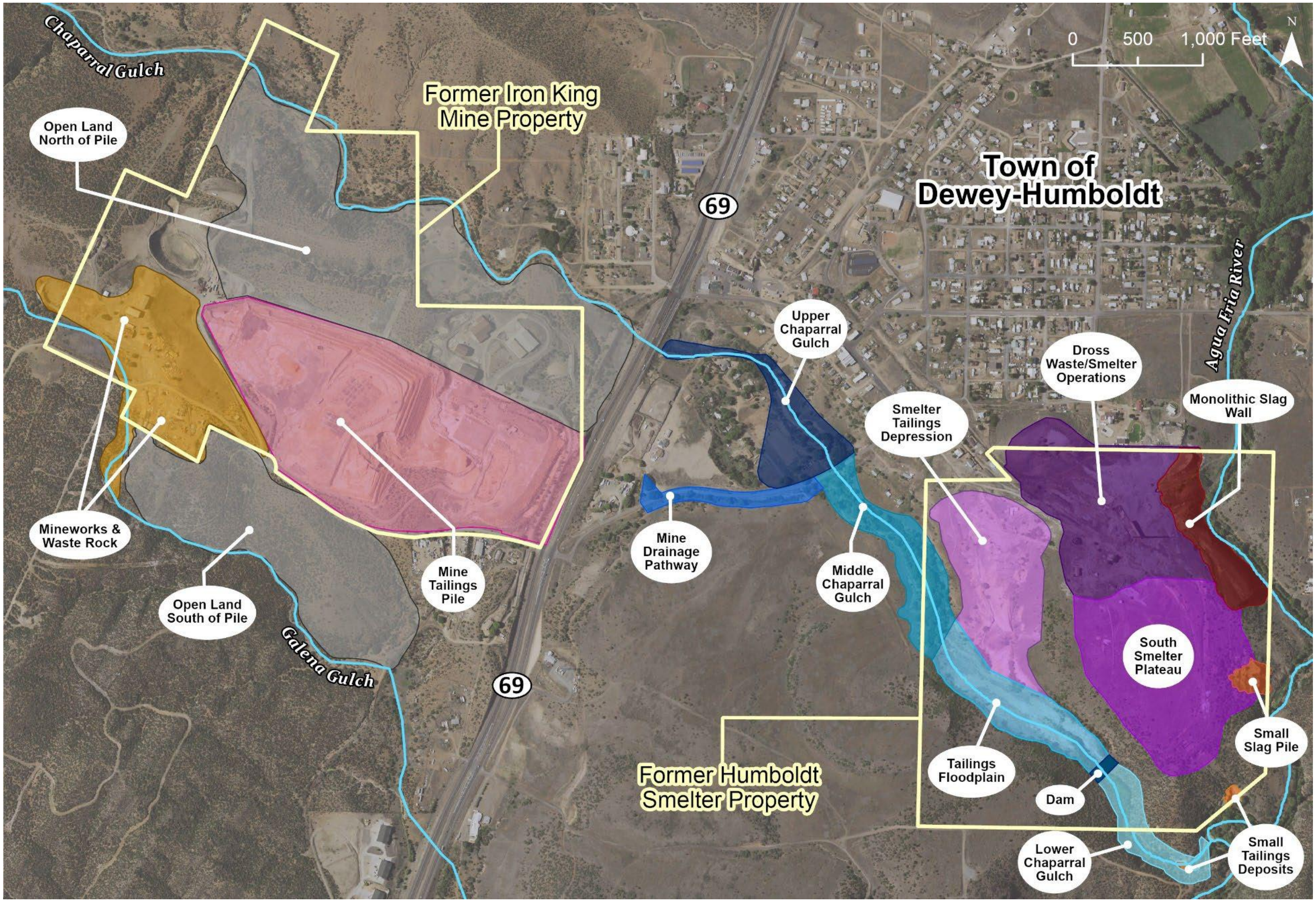


Figure 2: Major Site Areas of Concern

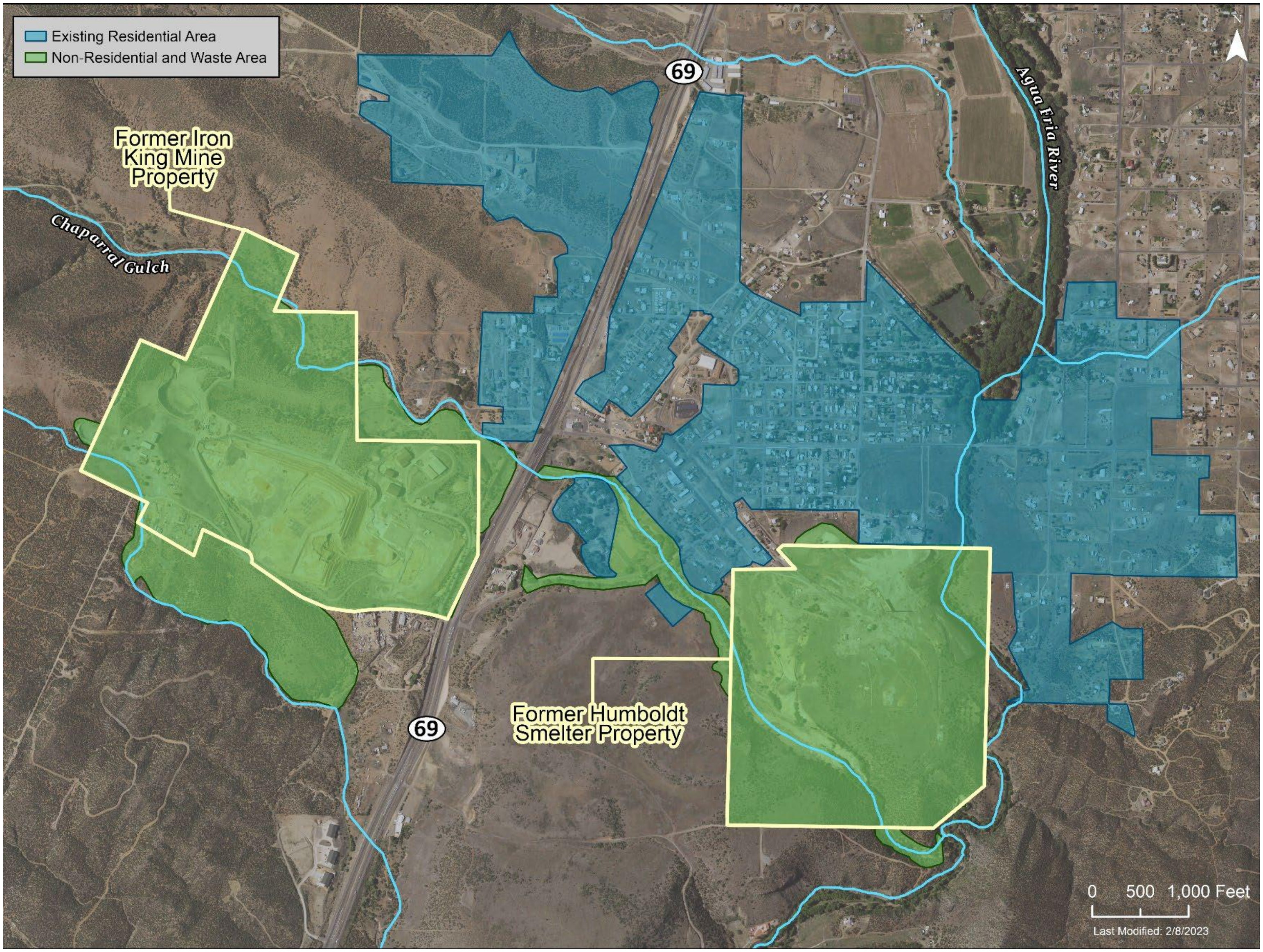


Figure 3: Existing Residential and Non-Residential Areas

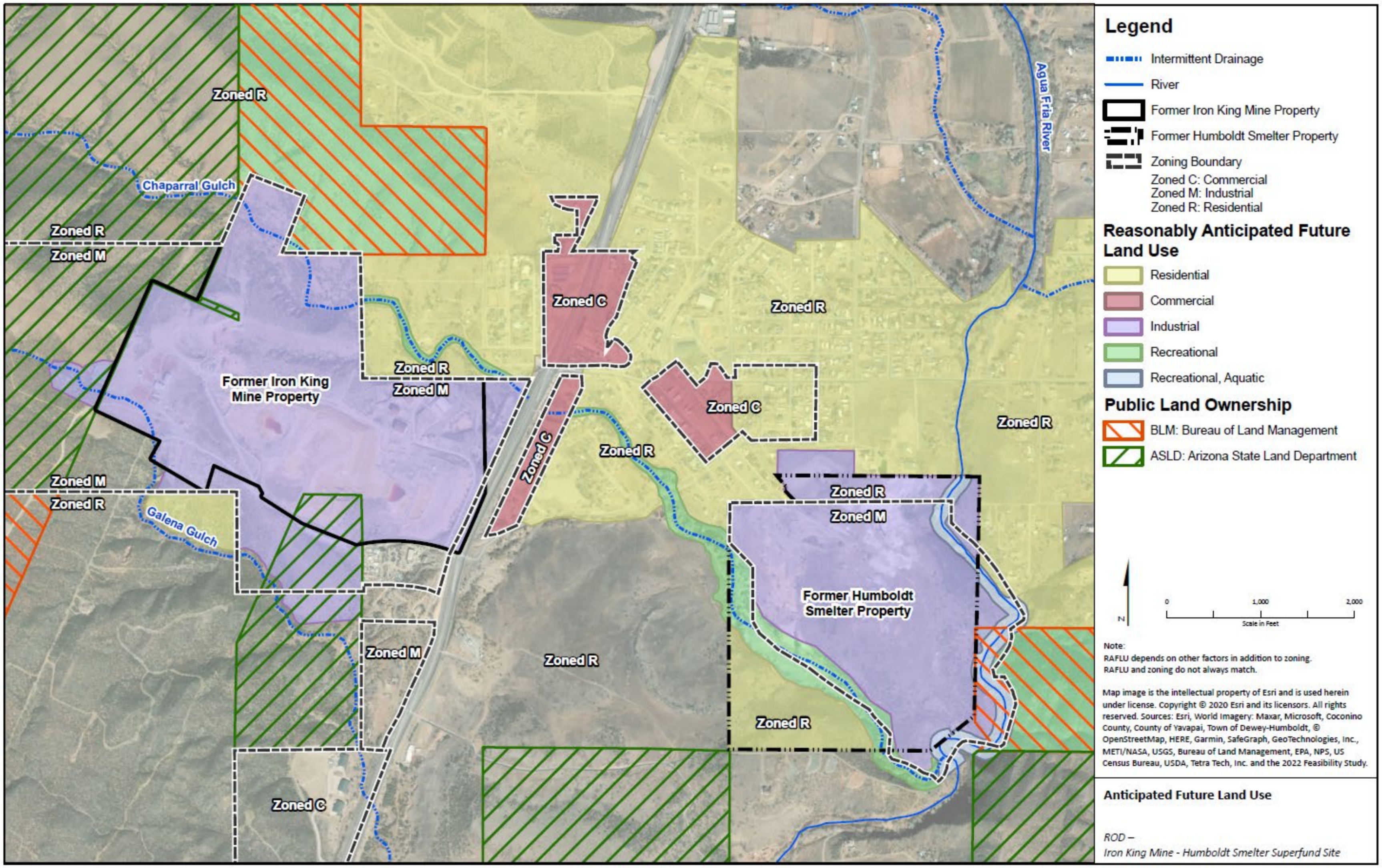


Figure 4: Anticipated Future Land Use and Zoning

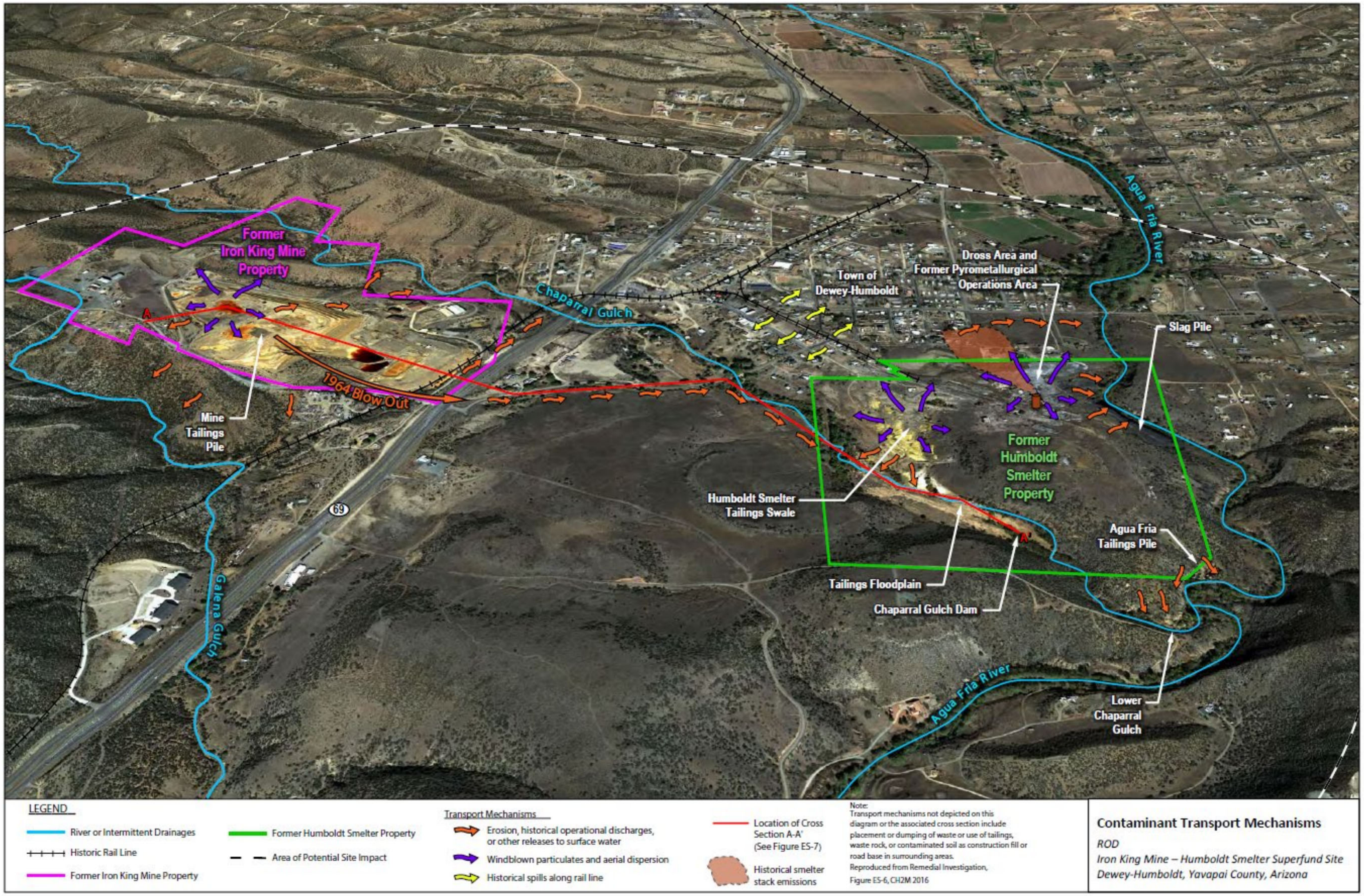
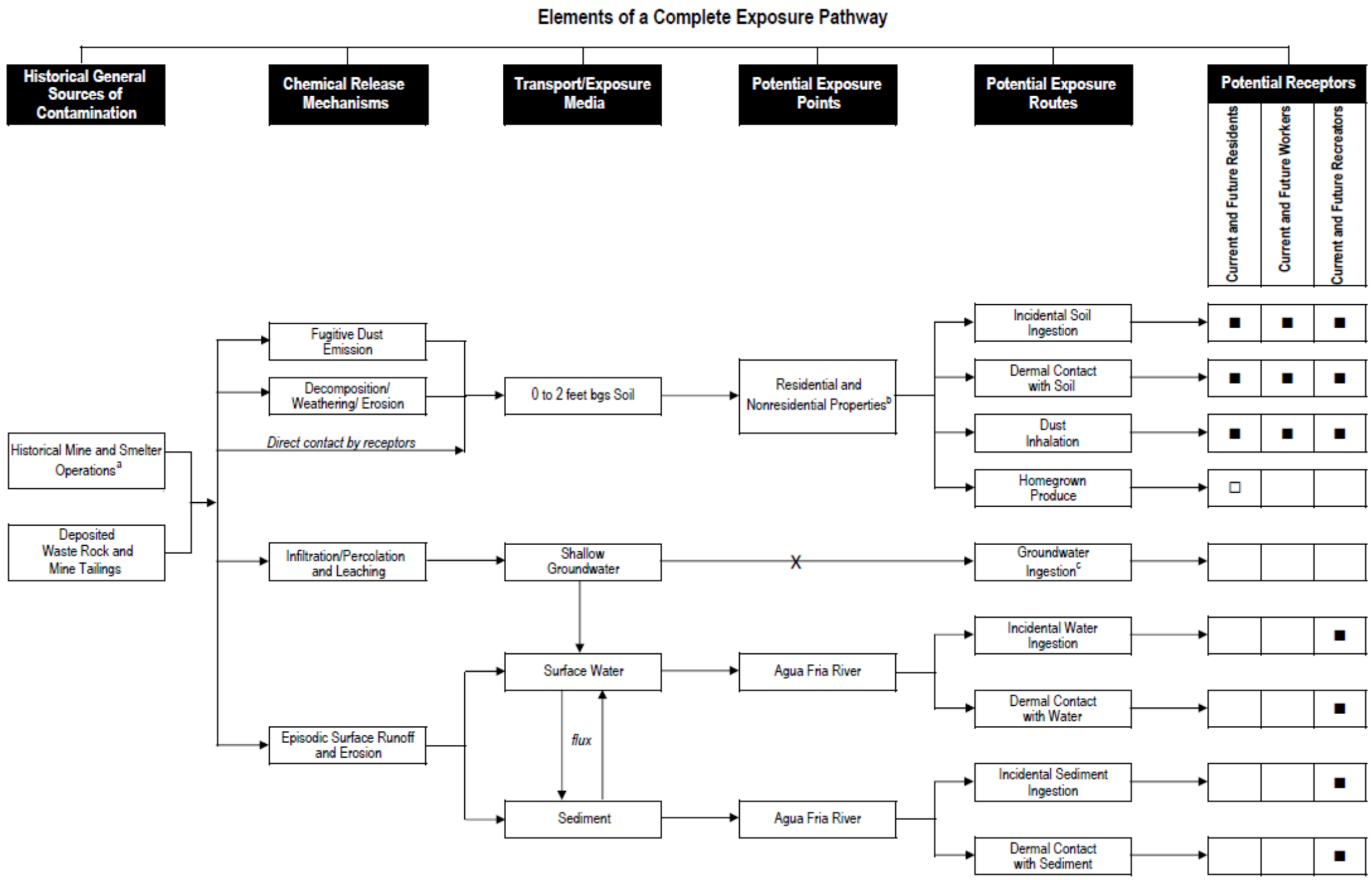


Figure 5: Contaminant Transport Mechanisms



Notes:

■ = Potentially complete pathway quantitatively evaluated in the Baseline Human Health Risk Assessment

☐ = Minor pathway quantitatively evaluated in the Baseline Human Health Risk Assessment

Blank = Incomplete pathway

a. Includes tailings, ash, slag, building debris, and other sources associated with historical mining and smelter operations.

b. Residential exposure scenario is evaluated for all exposure areas; worker and recreator exposure scenarios are evaluated for all non-residential exposure areas.

c. Groundwater data were not evaluated as part of the human health risk assessment because (1) site-related impacts to groundwater appear to be confined to the former Iron King Mine and Humboldt Smelter properties and the area between them, and (2) regional groundwater quality includes naturally elevated arsenic, and local domestic water quality may be affected by septic systems and other non-mine related activity.

Conceptual Site Model for Potential Human Exposures

ROD

Iron King Mine – Humboldt Smelter Superfund Site

Dewey-Humboldt, Yavapai County, Arizona

REPRODUCED FROM IRON KING HUMBOLDT SMELTER REMEDIAL INVESTIGATION, APPENDIX B, FIGURE 9-1. EPA 2016.

Figure 6: Conceptual Site Model for Potential Human Exposures

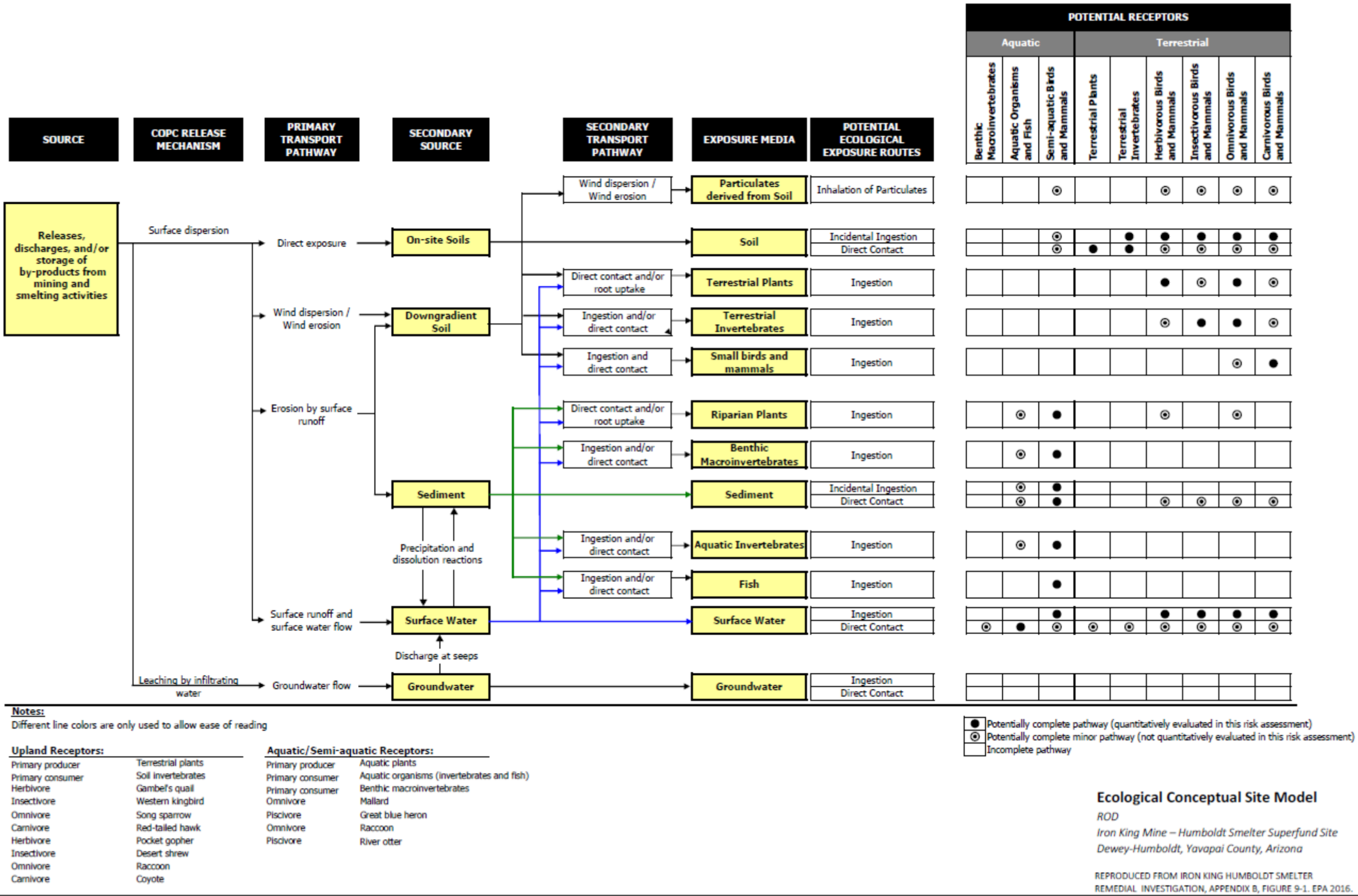
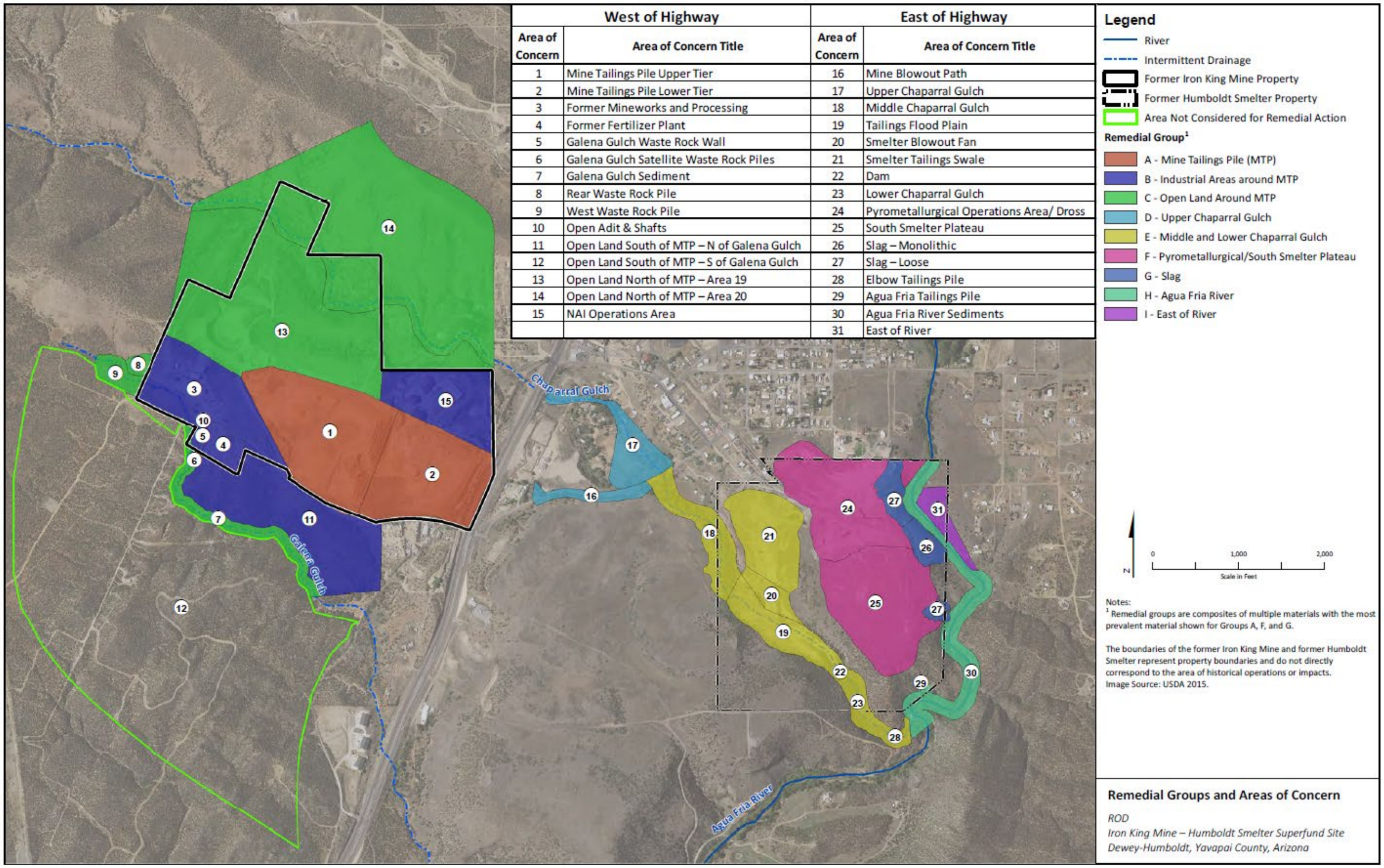


Figure 7: Ecological Conceptual Site Model



West of Highway		East of Highway	
Area of Concern	Area of Concern Title	Area of Concern	Area of Concern Title
1	Mine Tailings Pile Upper Tier	16	Mine Blowout Path
2	Mine Tailings Pile Lower Tier	17	Upper Chaparral Gulch
3	Former Mineworks and Processing	18	Middle Chaparral Gulch
4	Former Fertilizer Plant	19	Tailings Flood Plain
5	Galena Gulch Waste Rock Wall	20	Smelter Blowout Fan
6	Galena Gulch Satellite Waste Rock Piles	21	Smelter Tailings Swale
7	Galena Gulch Sediment	22	Dam
8	Rear Waste Rock Pile	23	Lower Chaparral Gulch
9	West Waste Rock Pile	24	Pyrometallurgical Operations Area/ Dross
10	Open Adit & Shafts	25	South Smelter Plateau
11	Open Land South of MTP – N of Galena Gulch	26	Slag – Monolithic
12	Open Land South of MTP – S of Galena Gulch	27	Slag – Loose
13	Open Land North of MTP – Area 19	28	Elbow Tailings Pile
14	Open Land North of MTP – Area 20	29	Agua Fria Tailings Pile
15	NAI Operations Area	30	Agua Fria River Sediments
		31	East of River

Figure 8: Non-Residential Waste-Bearing Areas of Concern

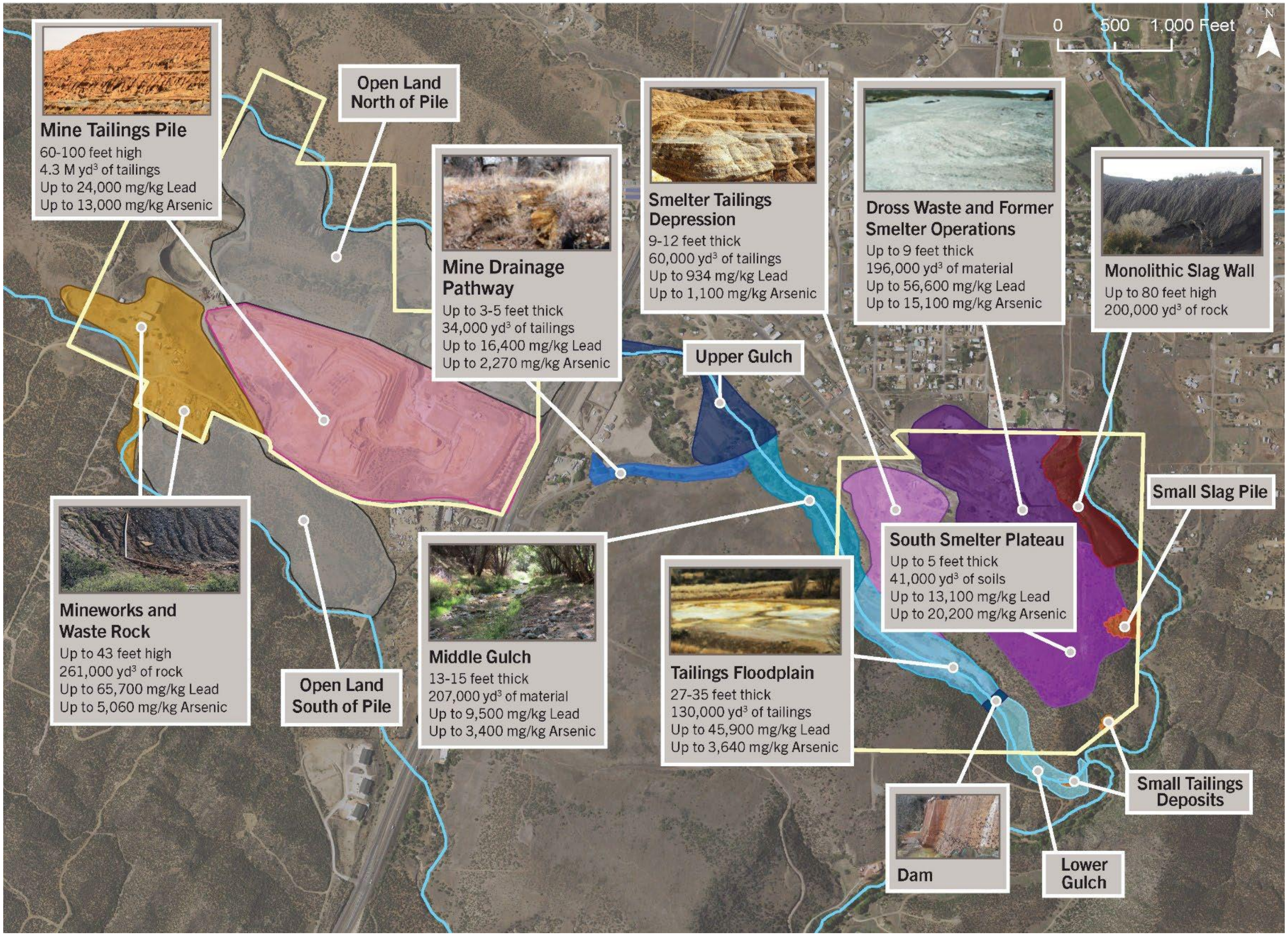


Figure 9: Contamination Levels in Major Site Areas of Concern

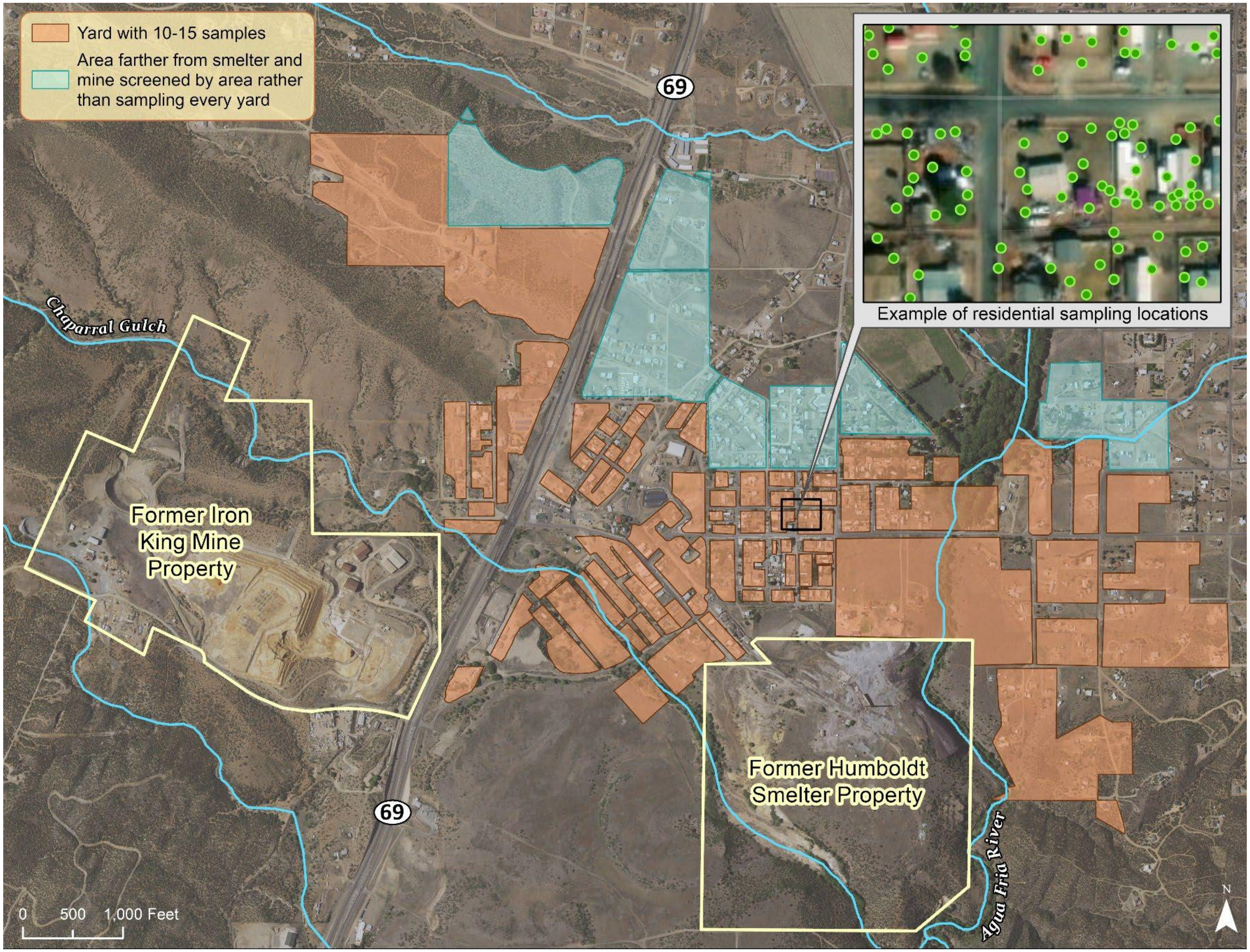


Figure 10: Residential Areas Sampled

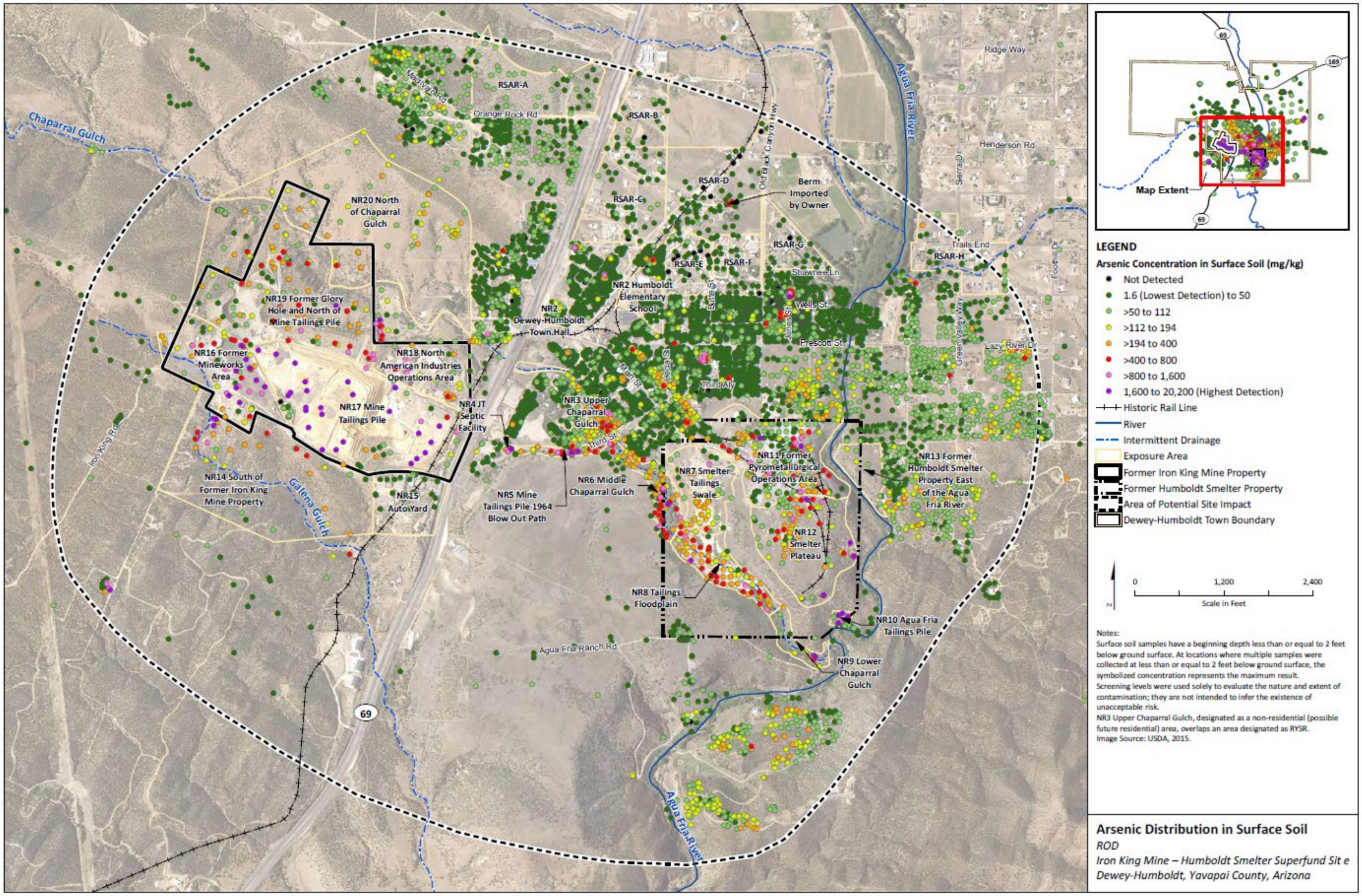


Figure 11: Arsenic Distribution in Surface Soil

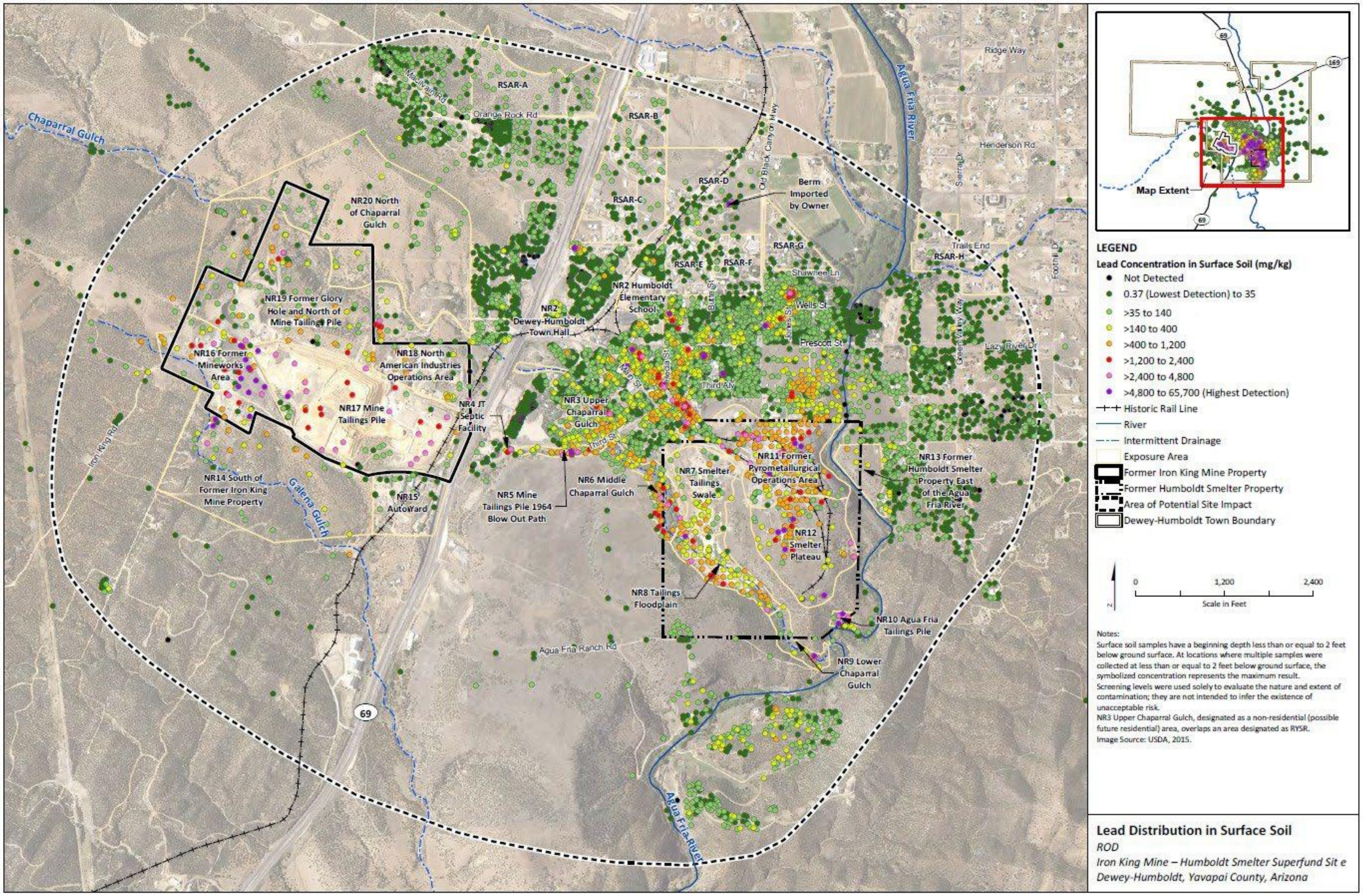


Figure 12: Lead Distribution in Surface Soil

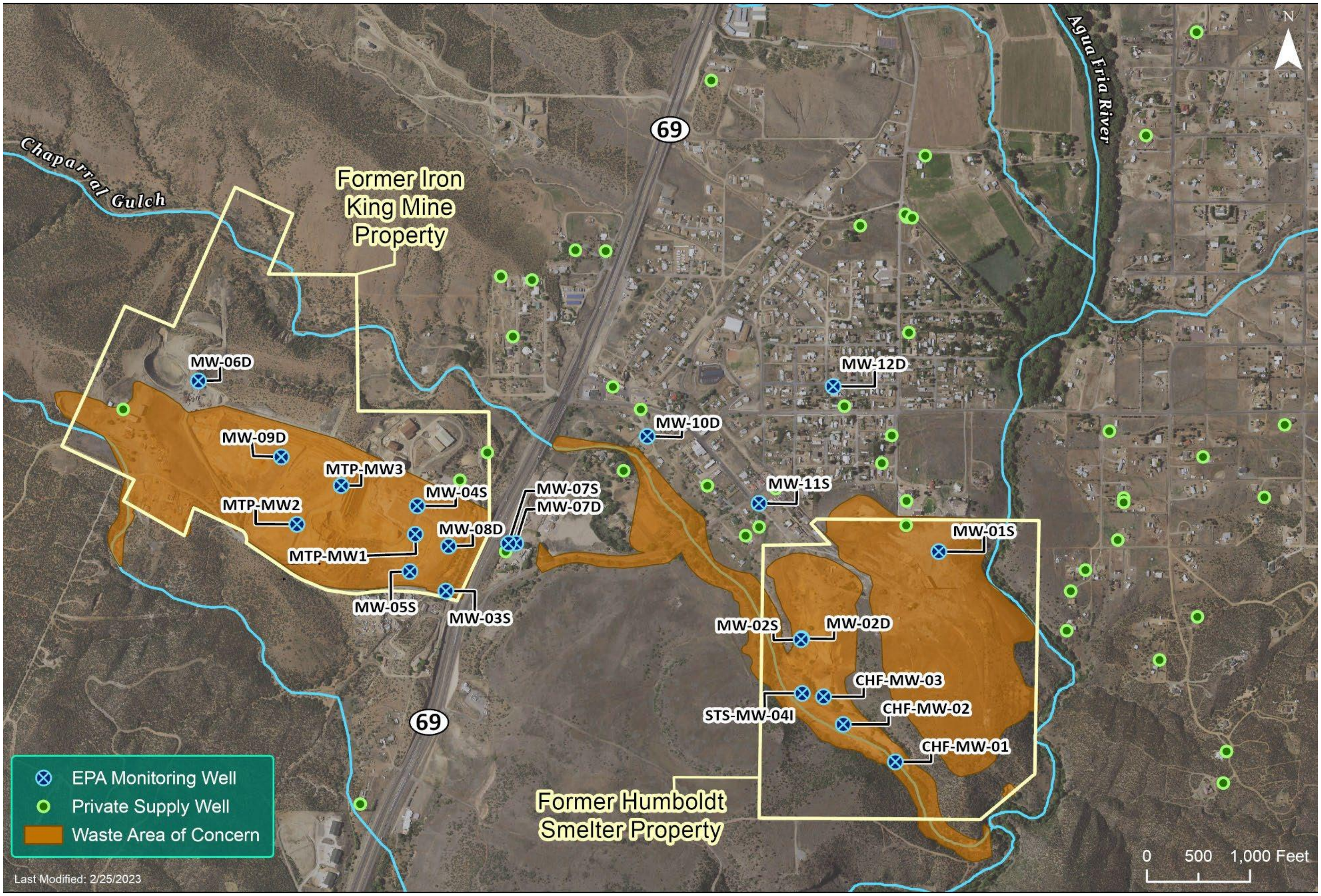


Figure 13: Monitoring and Supply Wells Sampled

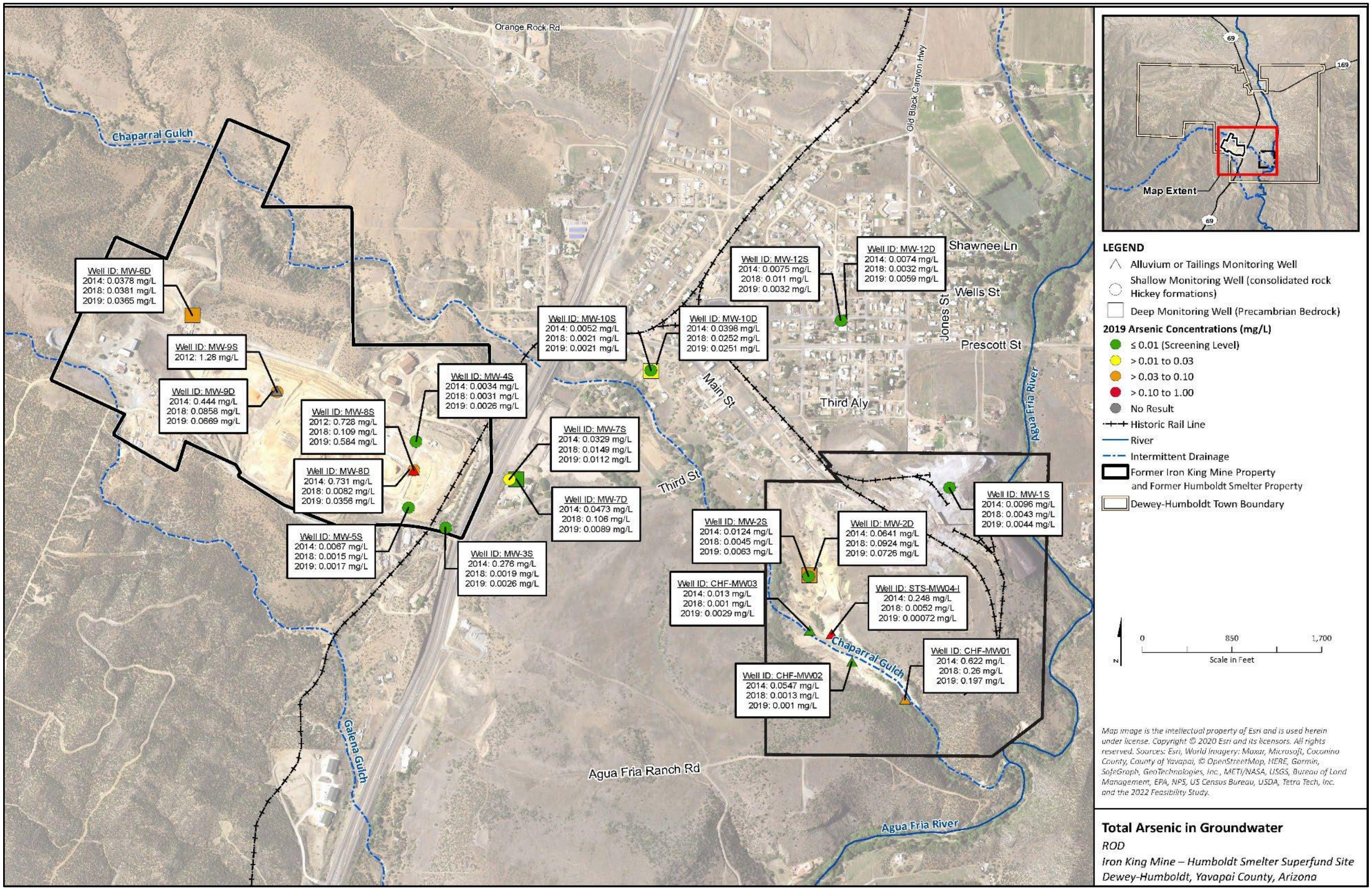


Figure 14: Total Arsenic in Groundwater

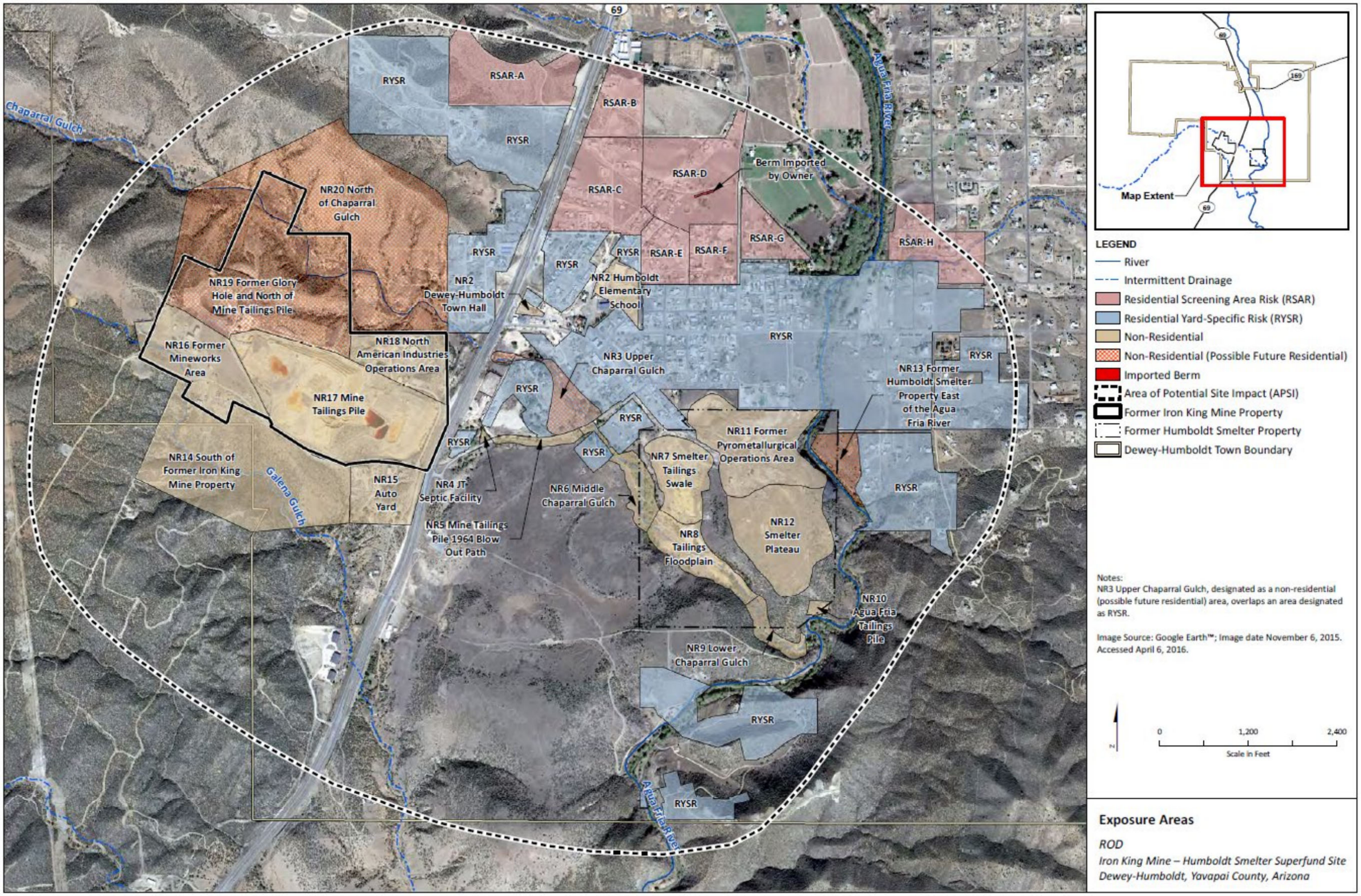


Figure 15: Human Health Risk Management Areas

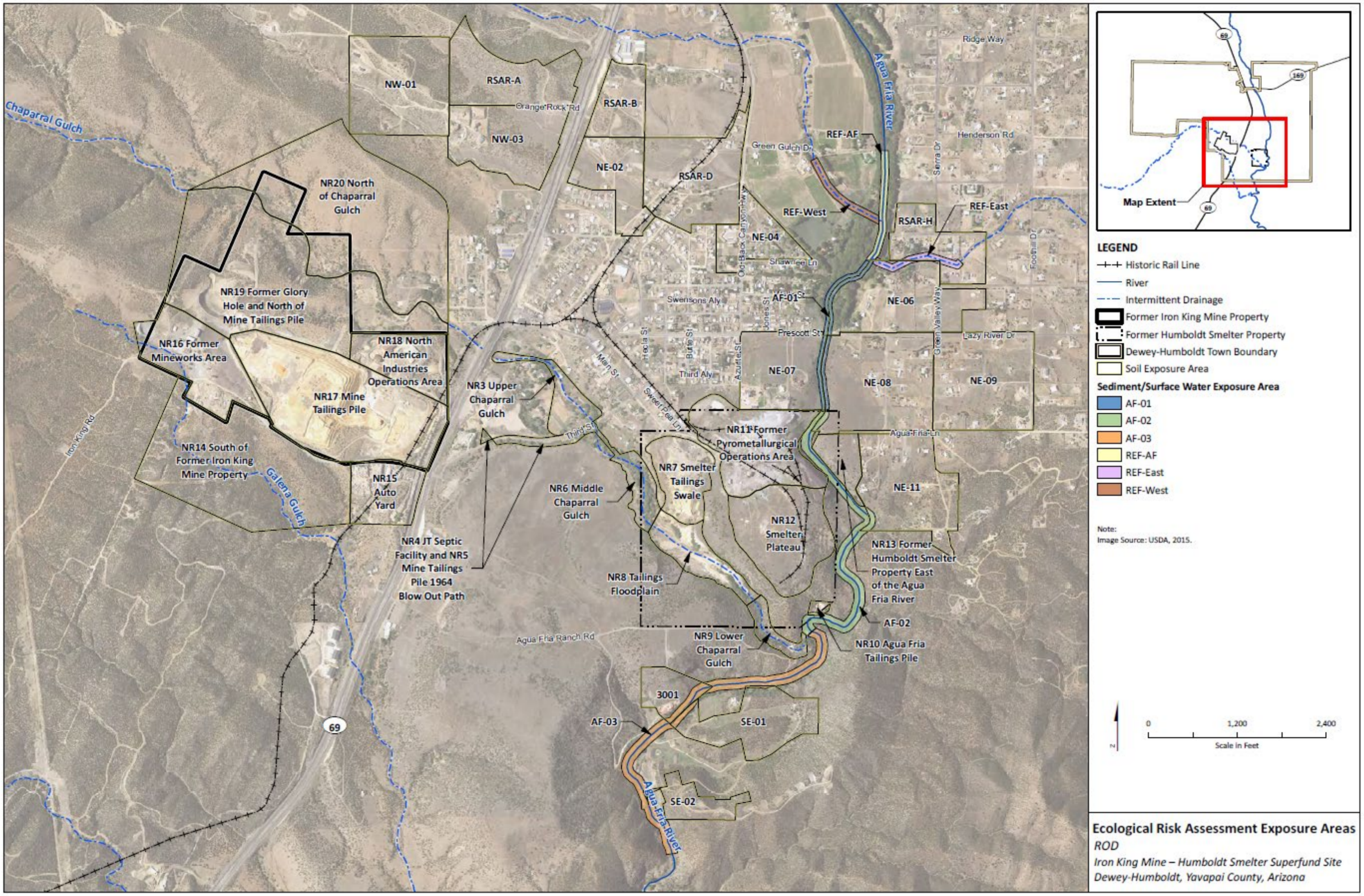


Figure 16: Ecological Risk Assessment Exposure Areas

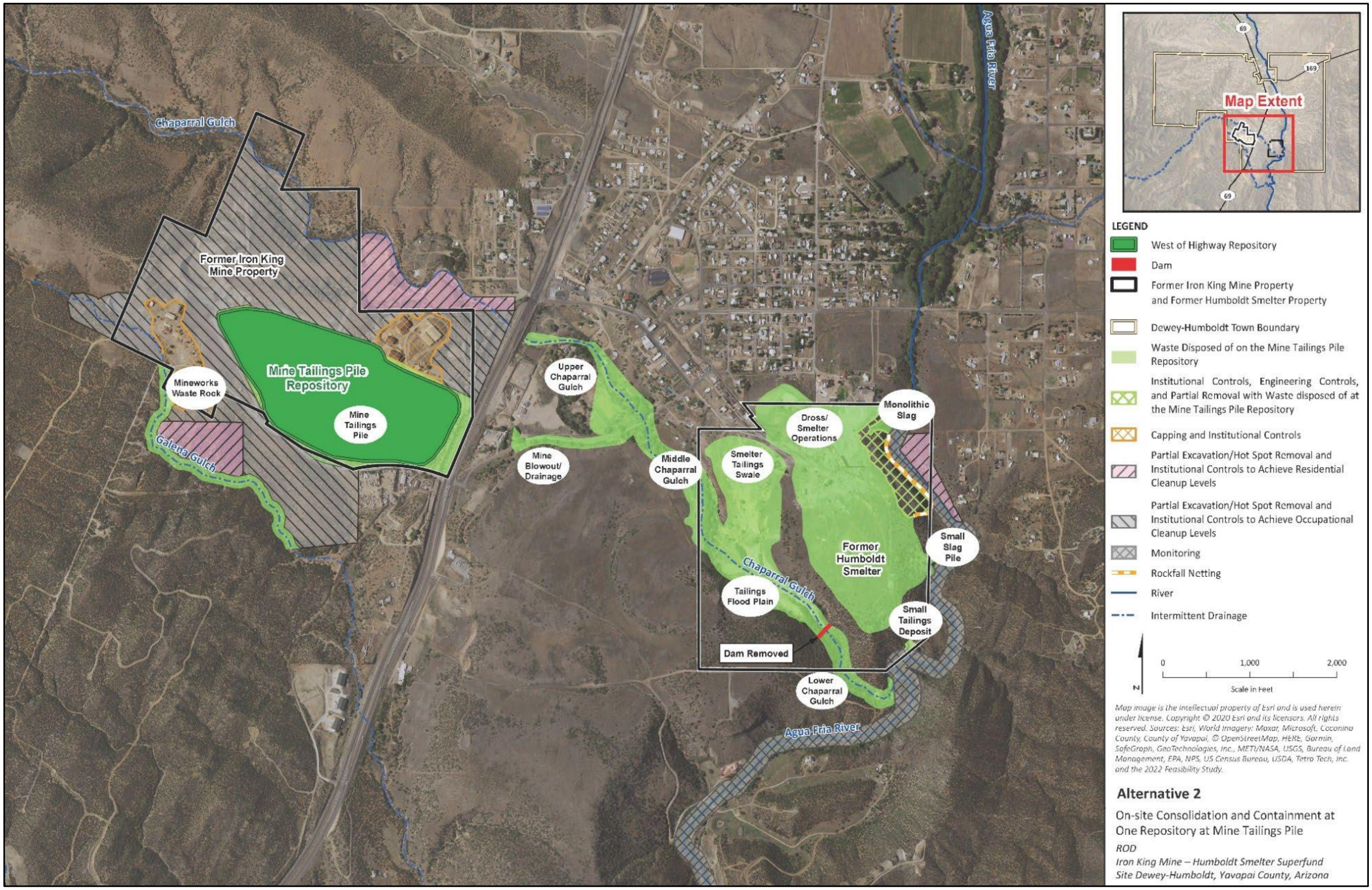


Figure 17: Alternative 2 Waste Movement and Repository Location

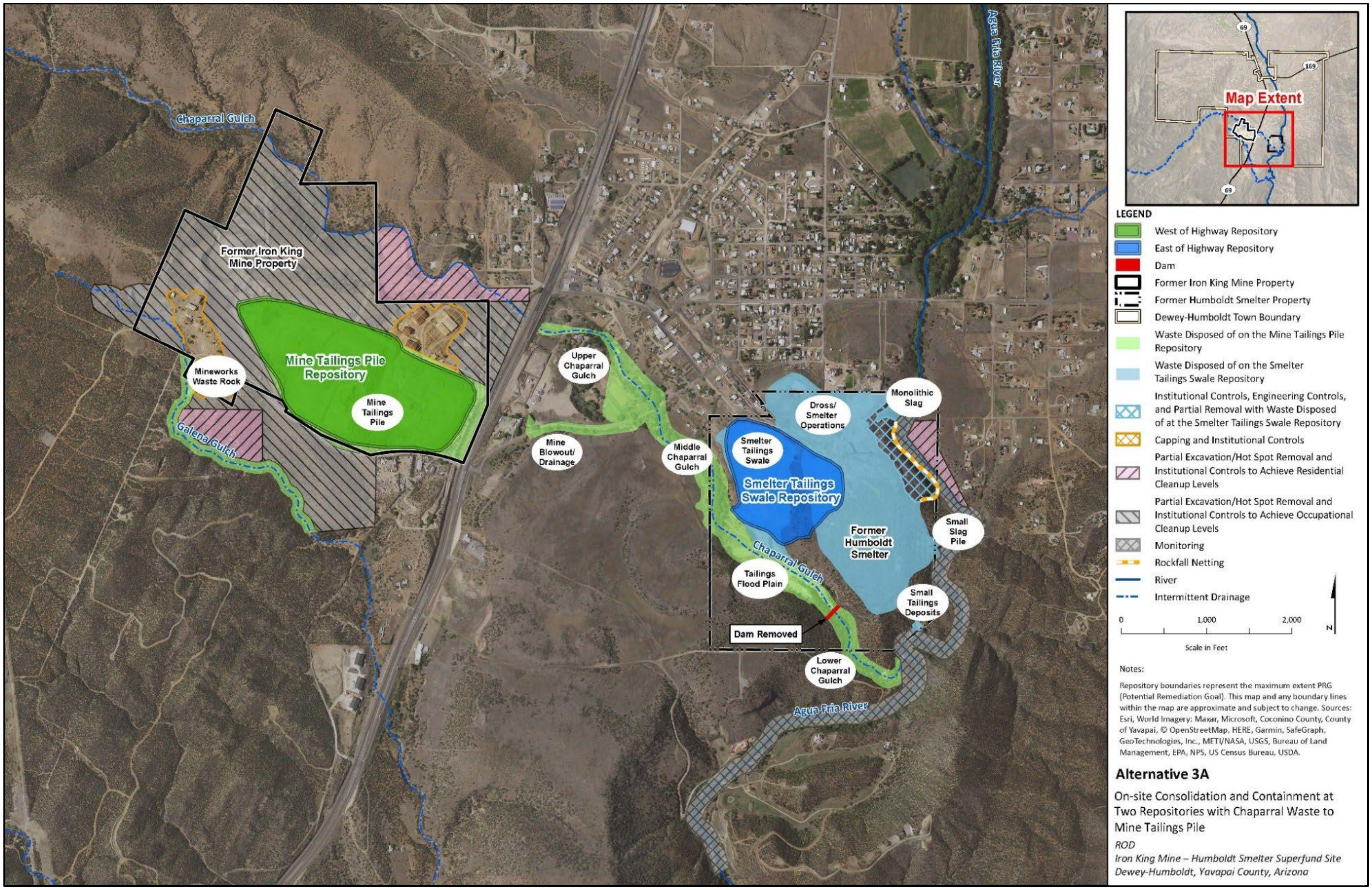


Figure 18: Alternative 3A Waste Movement and Repository Location

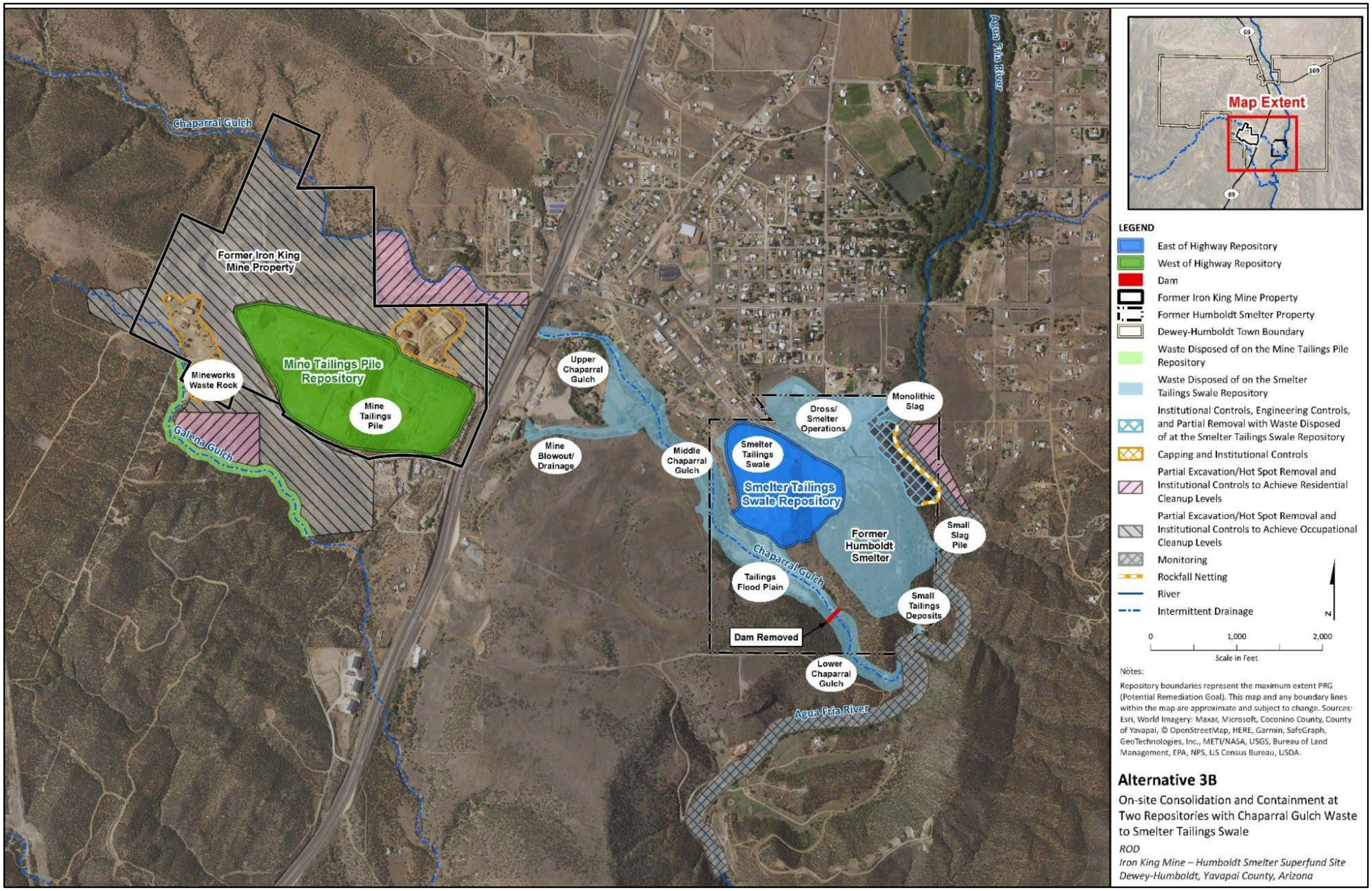


Figure 19: Alternative 3B Waste Movement and Repository Location

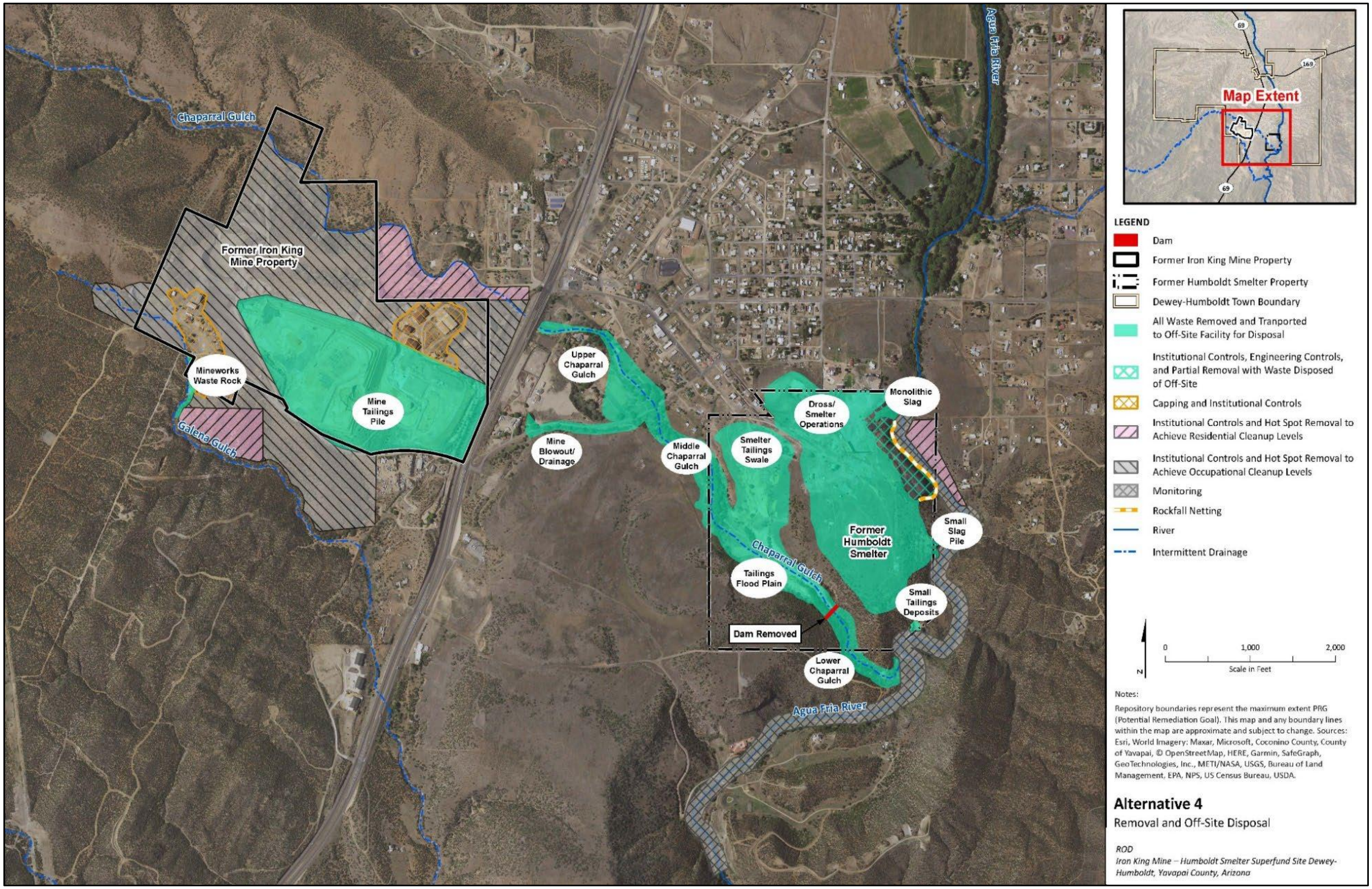


Figure 20: Alternative 4 Waste Movement and Off-Site Disposal

Figure 21: Former Mine Property Before and After

Figure 22: Former Smelter Property Before and After

APPENDIX A

COMMENT AND RESPONSE INDEX

COMMENT AND RESPONSE INDEX

As noted in Part 3 of this ROD, the Responsiveness Summary for the Site has been prepared in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Contingency Plan (NCP), 40 Code of Federal Regulations (C.F.R.) § 300.430(f). The Responsiveness Summary documents, for the public record, EPA's responses to comments received on the Proposed Plan during the public comment period.

EPA made the Site's Proposed Plan available to the public in March 2023. The Proposed Plan and other site documents can be found in the Site's Administrative Record file, which is available online at www.epa.gov/superfund/ironkingmine.

EPA published a notice of the availability of the Proposed Plan and other site documents in the *Prescott Courier* and *Arizona Republic* on March 1, 2023. A public comment period for the Proposed Plan was held from March 15, 2023, to May 13, 2023. In addition, EPA held a public meeting on March 29, 2023, to present the Proposed Plan to the community.

EPA received 38 comments from the general public during the Proposed Plan public comment period and 67 pages of comments from the Town of Dewey-Humboldt government.

This Comment and Response Index includes the comments and EPA's responses to the comments, which are divided into four categories:

- Summary of Public Comments and Lead Agency Responses.
- EPA Responses to Letter from Town Council to Jeffrey Dhont (EPA, dated May 13, 2023, regarding "Town of Dewey-Humboldt's Comments on the U.S. Environmental Protection Agency's Proposed Remedial Action Plan, dated March 1, 2023, for the Iron King Mine-Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona."
- EPA Responses to "Town of Dewey-Humboldt Comment Package: Technical Memorandum: Specific Comments on EPA's Remedy Selection Process, The Iron King Mine-Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona, May 13, 2023."
- EPA Responses to "Town of Dewey-Humboldt Comment Package: Technical Memorandum: Technical Review & Findings, USEPA Feasibility Study, IKMHS Superfund Site, May 28, 2023."

A. SUMMARY OF PUBLIC COMMENTS AND LEAD AGENCY RESPONSES

Verbal Comments Provided at the March 29, 2023, Public Hearing

A.1. Comment:
So, this is a how question. I understand that we're talking about the remedial design and everything, but whenever we're talking about individual properties, how deep is the mitigation going to happen? Because mitigation was only done at 1 foot, and the barrier is showing on my entire property. So, therefore, my entire property is yet re-contaminated.

EPA Response:
For residential surface soil cleanups, EPA typically will excavate to a depth necessary to remove contamination but not exceeding 2 feet below ground surface. We will test the soil at the bottom of the excavation and install a warning barrier if contamination above cleanup levels is still found below 2 feet. Clean soil is then placed on top of that barrier, so the warning barrier should not be showing on your property. As part of our upcoming supplemental cleanup of residential yards, we will plan to return to your property, resample to ensure it is not contaminated, and make sure the barrier does not protrude. If needed, additional excavation and depositing of clean soil will be performed.

A.2. Comment:

a. My comments are focused around the proverbial time and money. As we all know, the federal government does not have a good reputation for keeping on budget and time, and so one question is -- or I guess a comment is -- what kind of timeframe would we be looking at -- it's been 20 years now -- from now to when the project will actually begin and dirt will start moving? And also, once it starts moving, what kind of guarantee does the community have that the project will complete if something were to happen, like maybe all of our money gets sent to Ukraine or something?

EPA Response:
EPA understands that it seems to be a very long time for cleanup. We must follow a legally required process to ensure sites are thoroughly and adequately cleaned up. The Site was listed on the National Priorities List in 2008. Since then, EPA has performed extensive investigations, assessed cleanup options, and conducted three cleanup actions addressing residential yards. The ideas that need to be addressed before "dirt starts moving" are as follows:

(1) Completion of this document, the Record of Decision (ROD), to document the Agency's selection of appropriate cleanup remedy for the Site.

(2) Obtaining funding, including potentially from the federal Bipartisan Infrastructure Law. (The next step of the process is contingent upon funding being obtained.)

(3) Designing the cleanup.

EPA estimates that these items will take an estimated 12-18 months. Once these milestones have been achieved, the remedial action and construction ("dirt moving") can commence.

b. So, would the project be guaranteed and completed no matter what?

EPA Response:
Part of the funding process is to estimate and secure funding for the full cleanup. There can never be 100% guarantees, however, EPA understands the importance of finishing the project once it starts and ensuring adequacy of funding to complete the action.

c. The time estimates for the different options, one to two years, does that include weather delays? Because as you know if you were here all day, this is a windy place. And wind, you would think, would stop the project. I don't know how you could possibly mitigate dust control when you have 20 knot winds and, also, when you have two, three or four inches of rain falling per hour and the ensuing mud mess that would happen after that kind of weather.

EPA Response:
The construction contractor will be required to prepare a work plan, which will include the work and associated schedule. That work plan will include realistic time frames to complete actions including anticipated weather conditions as well as some time for unanticipated events. The work plan will include "Temporary Environmental Controls" while doing the excavation work. These include following approved stormwater and drainage plans, dust control plans, traffic controls and hauling routes, mud track-out controls, etc. Construction stormwater plans routinely account for runoff capture, sediment controls, and erosion controls. The temporary weather conditions that can occur in Dewey-Humboldt, including high winds and monsoon rains, can be addressed through appropriate planning and controls.

As examples, the size of exposed wastes can be kept relatively small and be covered and secured if high winds or rains are expected. In such cases, work would temporarily stop until conditions clear. To avoid drainage flows from heavy rains flooding the excavation, the design could include temporarily rerouting the stream bed. Control methods can include the application of polymers to the soil, silt fences, wattles, coir rolls, detention basins, ditches, etc. The polymers allow waste to be exposed but be less mobile under wind and storm events because it forms a crust on the soil. Very large tarps, large wind breaks, battens, cover soil, and wetting can also be used.

d. But I more strongly agree with the fact that it should have, certainly, a liner underneath. I don't know how you could possibly consider doing that without a liner. That just doesn't make sense at all.

EPA Response:
Water falling on and moving through the mine waste is the primary way wastes could migrate or impact site soils and/or groundwater. The engineered cover on top of the repository will be designed to prevent water infiltration into the waste. As part of the remedy, waste would be dewatered prior to placement and compacted in the repository. The soil would dry further during placement and compaction. The engineered cover on the top of the repository would prevent future infiltration of water into the waste. Tailings piles have been effectively capped at many Superfund sites across the country without a liner underneath. Infiltration modeling of the repositories indicates that no precipitation would reach the bottom of the waste after the repositories are capped. In addition, not installing a liner reduces the risk of the sliding of the waste.

Under the preferred Alternative 3B, the mine tailings pile itself would become a repository. It would be nearly impossible to move the 4.3 million cubic yards of tailings to the side in order to install a liner and then put it back, and it would not likely result in an overall benefit at the Site.

e. Also, I strongly agree with the option of putting all of the mess on one side of the highway, particularly the west side…[if] it moves the project across the highway, would it not be less economically, and certainly less of a social impact, to bore a tunnel under 69, put a cheap culvert in -- you know, a 12-, 16-foot wide, wide enough for one-way traffic for the trucks to be able to go underneath the highway and not impact traffic at all?

EPA Response:
This comment supports the cleanup Alternative 2, where all waste material is moved to the mine tailings pile west of Highway 69, with no repository on the east side of Highway 69. As described in the FS (Table 5-1), Alternative 2 would involve moving 890,000 cubic yards or over a million tons of waste across Highway 69. Alternative 3B involves no transportation of waste across Highway 69. The comment suggests hauling waste under Highway 69, rather than on the highway.

In response to comments in support of Alternative 2 and transportation of waste not on Highway 69, EPA evaluated transportation options and consulted with the Arizona Department of Transportation (ADOT). Options evaluated included: a dedicated (temporary) one-way construction bridge, a low-clearance one-way tunnel made of precast concrete box culvert under the highway, and a closed conveyor system.

The time frame for implementation of Alternative 2 was already the longest of any of the alternatives evaluated by EPA in the FS except Alternative 4. Implementation of the options for moving waste either under or above Highway 69 would increase the design, planning, and construction time significantly, adding more than two years of additional related work to design, permit, and construct an alternative method for transportation.

ADOT disfavored the option of constructing a temporary bridge. This option would require construction of ramps, constriction of traffic flow down to two lanes on Highway 69 during construction, and potential detouring of traffic from the highway for extended periods of time.

The tunnel option also proved impractical. A tunnel could not be constructed across the highway from Main Street because it lies in the Chaparral Gulch and is subject to large amounts of storm water discharge. Instead, a tunnel could in principle be constructed either through an existing culvert near the north end of the JT Septic facility, or south of the JT Septic facility near the junction of Third Street and Highway 69. A tunnel through the existing culvert would emerge on the west side of the highway very close to the toe of the mine tailings pile and thereby interfere with the required regrading of this area during reconfiguration of the mine tailings pile as a repository. By contrast, a tunnel along Third Street would emerge at Iron King Road on the west side of the highway.

However, either of these tunnel options would send thousands of trucks up Iron King Road for more than a year. This would greatly restrict or eliminate access to or on Iron King Road to any non-construction traffic for the duration of the cleanup. Constriction of the highway to two lanes and/or highway detours would be required during the tunnel construction.

Additionally, dust suppression would be more difficult with Alternative 2 than Alternative 3B, because Alternative 2 would require moving waste on dirt roads for much greater distances.

EPA also considered an option that would involve erecting a closed mechanical conveyor system to move waste across Highway 69 as part of Alternative 2. A conveyor system is estimated to require up to two years to design, procure and fabricate, construct, and test prior to full scale operation. With a conveyor, waste would be moved by loaders from where it is excavated on the east side of the highway and transferred to trucks, which would then take wastes to the conveyor (also on the east side) and empty their loads into the conveyor. At the other end of the conveyor on the west side of the highway, waste would have to be loaded back into trucks to be taken to the repository. This double handling of wastes would increase the time and cost of the cleanup and reduce its efficiency. This option also creates additional fugitive dust and thus requires additional mitigation.

EPA did not consider a conveyor system constructed over Highway 69 due to design, permitting, and construction difficulties as well as the risk of waste material falling onto the highway. A conveyor utilizing an existing, abandoned culvert near the JT's Septic property was considered. The conveyor would exit right next to the front toe of the mine tailings pile, resulting in the same issues that would occur with a truck tunnel at that location. Finally, another conveyor option would involve boring a conveyor tunnel under Highway 69 near the Third Street highway crossing. However, *additional time for design and permitting would be required to install the large-diameter pipe under Highway 69.*

In summary, EPA believes that the significant disadvantages associated with a modified Alternative 2 with a bridge, tunnel or conveyor – i.e., longer duration and higher cost of construction, impacts to the travelling public, difficulty of dust suppression, and cutoff of access for local landowners and businesses on Iron King Road do not outweigh the benefits of constructing a second repository on the east side of Highway 69 with no waste having to cross the highway (Alternative 3B as proposed).

A.3. Comment:

I'm a Dewey-Humboldt resident. I think that this may have partially been addressed, but one of my questions -- you kept referring, Jeff, to the cap. Is that still yet to be decided? Okay. So once the cap is decided, who is it that maintains one or two repositories? Who's responsible for that maintenance? So, is DEQ -so they are requiring a regular report from someone? You know, I'm just understanding from some kind of engineering background that there should be some responsible reporting regularly -- monthly, whatever -- and who is actually looking this over. Which is sort of leading me to grasp and to say let's get the big picture out of the way. So, one of the things I am proposing for the big picture is it seems to me as though, sure, you're going to be spending quite a bit of detailed time getting trucks across the highway. But you have one repository -- frankly, which is a landfill -- to maintain. One landfill to maintain rather than leave one over on the Dewey-Humboldt side -- and I've lived here only eight years, but I know there are many people here who are really interested in the growth and the look of our Dewey-Humboldt downtown and believe it could be something special. What I would suggest, do not put a landfill in Dewey-Humboldt. Do the best you can, and I would like to specifically request that a picture be produced that would show it without any kind of repository there.

EPA Response:

Under the Superfund Law, called CERCLA, the State of Arizona will be responsible for long-term operation and maintenance of the repositories. Reports documenting the outcome of operation and maintenance will be produced by ADEQ at a frequency to be determined during the Remedial Design phase of the project. These reports will be available for public review.

Your comment suggests that you would rather not have a repository on the smelter side of the highway and only have one repository rather than two. If you are referring to hauling all the waste at the Site away off site, doing so would be cost- and time-prohibitive, as shown in the Proposed Plan for Alternative 4. If you are referring to putting all the waste from the smelter side of the freeway on the mine tailings pile, the concern continues to be moving huge quantities (890,000 cubic yards or over a million tons) of wastes over Highway 69. Please see *EPA Response to Comment A.2.e**.*

A.4. Comment:

I didn't realize until tonight when I got this program there's what's called a Bevill exemption. Basically, the extraction industry, anything generated in a mining extraction is exempt, and it's not the same as hazardous waste as we know it. The waste from mines and extraction is not considered hazardous waste like in other places. And this is what the EPA has to base their operation off. At any rate, what we have, the material's going to be placed, but there's not going to be a membrane underneath the cap. My concern as a scientist is you're going to have dry earth up here, wet ground down here. Everything has to move from a greater to a lesser concentration. I've been assured this is going to work. If we do it this way, I certainly hope it does. My comment is we're betting -- we're all in on -- this is -- we're not going to get an ion exchange between the spoils that we're placing on the ground. My question is would we be better off, if we're spending $75 million, to put a little bit more money into this game and put the membrane down and lessen the chance of leaks in the future? Thank you very much.

EPA Response:

Water falling on and infiltrating into the mine tailings waste is the primary way in which wastes could react with or impact site soils or groundwater. The proposed engineered cover on the top of the repository would prevent future infiltration of water into the waste. As part of the remedy, any saturated mine waste would be dewatered prior to placement in the repository. Infiltration modeling of the repositories indicate that no precipitation would reach the bottom of the waste after the repositories are capped. The soil would dry further during placement and compaction, which significantly decreases the potential for ion exchange. This has been done effectively at many sites throughout the U.S.

Regarding the use of a liner/membrane, see *EPA Response to Comment A.2.d**.*

A.5. Comment:

In 2008, I completed mapping and remediation work on the smelter site and EPA-funded work for the University of Arizona on the Iron King Mine site. My opinions are due, in part, to my working on both sites with heavy equipment and previous employment with the cities of Tucson and Scottsdale, which required working with federal agencies. Number one, I'm pleased to see the EPA is moving toward remediation. Thank you. This has been a long time coming, and you can tell there's some excitement here. So, to all of you from EPA, welcome. We'll have the Marriott up in a month or so. That being said, I sincerely appreciate the work that will lead to, really, actual remediation.

a. Reviewing the EPA's feasibility plan, I have these suggestions. Alternative 2 is best. One repository for contaminated materials is best for the community as it removes all contaminants and soil from the smelter site and leaves clean property and a blank slate for development, or not, for the town. And I believe the community deserves this. The smelter site contaminant volume is only 16% of the total contamination volume, factoring in the huge Iron King tailings site. Contractors have hauled material across 69 in the past in Prescott Valley. It is not rocket science to do this with a million cubic yards of contaminated waste and provide decontamination measures. It's 2023. We do this.

And this may be a contested point with the EPA, but we feel we're an intelligent people here. A rough cost estimate for the total export is $7 million and perhaps one to one-and-a-half years running two shifts. Subtract the cost of having to build and continuously monitor a separate waste pile using up valuable community property on the smelter site and allocate an attractive savings to removing completely the risk of children accessing the smelter waste pile. They have a way of doing that, we know. Then we move the cost of continuous monitoring for a separate site, and I believe that the cost-benefit calculations should fall nicely in place for Alternative 2…Having been unable to use this property for over a century, the town has been unable to develop the tax base and real estate to build a sewer plant. This lack of infrastructure presents a collateral and imminent environmental threat to the town's health. And not because the town was negligent. I suggest the town request EPA funding for this companion threat to the smelter problem. Also, residents have a threatened water supply that goes downward and lateral migration of contaminants moves closer to the aquifer. I would suggest improvements to the town's water supply also be considered.

EPA Response:
The location of the repository in the bowl-shaped depression at the smelter would not significantly interfere with development on the developable plateau compared to a repository on the top of the smelter plateau. For a more detailed and complete discussion about moving the waste on the east side of Highway 69 to the mine tailings pile, please see *EPA Response to Comment A.2.e*.

Finally, regarding potential EPA funding of a sewer plant in Dewey-Humboldt, EPA's authority under the Superfund law is limited to ensuring adequate protection of public health and the environment from the wastes that were generated by the mine and smelter many years ago. Grants or loans may be available through other EPA or other agency programs.

b. Having worked on the Iron King, I know that the tailing pile is essentially jelly with a three-foot crust. One dozer has already sunk in this mess. It would be informative to learn how EPA proposes -- and this is a question – Could we grade this pile to prevent liquid and diluted contaminants from seeping into the smelter? Continuing rainstorms of any intensity would seem likely to eventually provide penetrating water through any vegetation or cover that might be installed over the pile.

EPA Response:
It has not been found that the tailings pile is entirely gelatinous in nature. EPA has performed a geotechnical study of the tailings pile using borings extending through the waste from top to bottom. (FS Appendix D-2) EPA used a computer model to evaluate such factors as liquefaction, shear stress, and sliding potential of the tailings in the pile; these are related to pile stability. The data indicate that there is in fact moisture retained in the tailings pile, and it varies by location. On average, water saturation levels are about 60%. While saturation is not generally present, EPA has identified that there are thin, one-centimeter-thick layers throughout the tailings pile profile that are still saturated with water. Where tailings remain saturated, a

substance that could be characterized as "gelatinous" or a "slime" may be present. The jelly-like consistency at certain spots in the pile arises from the fine-grained texture of the tailings when they are saturated with water. The Site has been open to the elements, so it is expected that some layers, especially near the surface, may be saturated. Because the pressure of water between the particles in the tailings can spread out into the layers of the pile that do not have water, the potential for the tailings to collapse during regrading is mitigated. The hydraulic conductivity, or likelihood of "seeping" of the fine tailings material out of the pile is low.

Engineering approaches are available and will be considered in Remedial Design to address the conditions posed by the tailings pile. The pile can be graded to prevent liquid and diluted contaminants from seeping into the soil. EPA plans to regrade the main tailings pile into a repository. When the tailings are regraded, saturated material will have the opportunity to dry out.

The repositories will be engineered so that rainfall and surface water drainage do not penetrate/infiltrate the waste. The engineering process involves modeling the repository and surrounding area, including waste materials, slopes, drainage patterns, vegetation, and storm events and designing a system in which the repository will be designed so that infiltration is low enough to protect against slope failure and leaching of contaminants into the subsurface. The current potential for slope failure of the mine tailings pile in some areas of the pile is questionable so that slope failure is a possibility if a cleanup action is not undertaken.

A.6. Comment:

There is something in here -- I can't find it again -- talking about Bevill waste. Bevill waste apparently was something that was passed by our Congress 45 years ago that gave EPA -- that gave EPA the authority to not have to seal hazardous waste until they could decide whether or not that hazardous waste was hazardous waste. Forty-five years ago, they were tasked to figure that out, to answer that question. And you have decided in this plan not to seal this hazardous waste because of the -- because it's Bevill waste. The question I have is after 45 years, how many more years does EPA need to determine whether or not mine waste is hazardous?

EPA Response:

The comment is confusing the term "hazardous waste" with the notion of "hazardous" in general. This is understandable as this topic can be very confusing. There is a law, called the Resource Conservation and Recovery Act, or RCRA, that typically applies to active industrial facilities that generate, store, treat, or dispose of hazardous waste. It makes certain requirements for storing, containing, and cleaning up wastes that the law defines as "hazardous waste." In the Bevill exemption, Congress excluded certain mining materials, such as tailings, from being "RCRA hazardous wastes." This means that the requirements for RCRA hazardous wastes do not apply to these types of wastes. However, this does not mean that mine tailings at this site are not hazardous in general, or don't pose a health risk if people are exposed to them. The federal Superfund law was created to address contamination *from hazardous substances at inactive industrial sites like the Iron King Mine and Humboldt Smelter.*

In order to protect human health and the environment, EPA is proposing to excavate and move wastes to one of two repositories and cap them with a permanent cover. One of these repositories is the mine tailings pile itself. With this action, we would not be moving the existing 4 million cubic yards of existing tailings out of the pile, we would place additional wastes on it and regrade it. Therefore, this work does not involve placing down a liner underneath all of the waste. There will be engineered covers to seal the tailings off from direct exposure to people, blowing in wind, drainages and groundwater. The wastes are hazardous, and the repositories will be designed to contain wastes and prevent future exposure, but treating the waste as RCRA hazardous waste is not legally required.

A.7. Comment:

I've received complaints that -- well, not complaints, but concerns that once this mitigation process starts, it's 9 to 12 months it's going to take to complete the project. So, you're going to remove all the soil off the ground and expose all this toxic material. We need to make sure that we take steps to keep that consolidated and then, also, continuous tests in the area so we make sure that our water aquifer in our area is not being contaminated. So, we need to monitor the entire area by the remediation that's taking place. So that's one of my main concerns.

EPA Response:

After EPA selects a cleanup option in the record of decision (ROD), the cleanup will go through a design process in which detailed plans will be made to ensure that excavated material will not be released and will be monitored during the cleanup process.

The designers and builders of the repositories are required to apply what are known as "temporary environmental controls." These controls take into account staging, stockpiling, and other activities vulnerable to exposure to the environment. These controls effectively prevent or reduce the spread or exposure to contaminants.

We agree it is important to ensure that the aquifers are not being contaminated by work at the Site. Currently, the information we have does not indicate that metals contamination from the Site is contaminating water that is being used by people. EPA is proposing to address groundwater on an interim, not a final basis. We plan to continue to monitor existing groundwater monitoring wells and work with the State Water Resources Board to ensure that new wells are not drilled close to the waste. In the meantime, we are planning to install additional groundwater monitoring wells and then determine whether additional cleanup actions for groundwater are needed.

A.8. Comment:

I'm a concerned citizen in the valley. This raises points that the EPA needs to consider: any radon studies, where and what findings. And the radon studies are for fissures, voids, caves.

All that stuff. Because you have -- you have a sludge slurry that -- and I don't know what the volume is. I don't know what the composition is. But, you know, what's the pH? What's the density? Because if you -- if you guys breach that and that slurry goes, it's going to go right to the aquifer. The main hazardous chemicals in mining: Sodium cyanide, potassium cyanide, sulphuric acid, nitric acid. You know, these are strong, strong chelators. Okay? So -- I know what I'm talking about, and you guys need to consider this. Heavy metals: arsenic, mercury, lead … copper, beryllium, cadmium, hex chrom. Okay? So, this is serious. And if this stuff goes in the aquifer, we're screwed.

EPA Response:
EPA has stated that the Site does not contain radon levels that could harm human or ecological health. The volume of the mine tailings pile is 4.3 million cubic yards. Table 1 on page 11 of EPA's Proposed Plan summarizes waste volumes and contaminant levels. Table 7 of FS discusses pH and other lab results. The sediment pH is between 7.3-7.7 and on-site soil pH is between 2.7 and 7.6. Table 7 of FS discusses lab data and results. All potential chemicals of concern associated with former mining/smelter activities have been investigated. Table B-1 also has a list of the analytes that exceed cleanup goals as well as how those goals were derived.

The mine tailings pile has not been found to be entirely gelatinous in nature. EPA has performed a geotechnical study of the tailings pile using borings extending through the waste from top to bottom. (FS Appendix D-2). Please see *EPA Response to Comment A.5.b above* *for more details.*

EPA investigated groundwater as part of the RI using 26 monitoring wells installed in the Site area, and numerous domestic supply wells sampled in the vicinity of the Site. EPA tested groundwater and surface water for the main hazardous chemicals used in mining and the heavy metals you mention. The FS indicates that "other than sulfate, site-related groundwater impacts were not impacting any human or ecologic receptors" even as natural processes of oxidation and chelation may be occurring (Section 1.4). With installation of the repositories, groundwater would only be further protected from contaminants.

A.9. Comment:

a. I understand the EPA looked into this. Where we have water, it goes into the Agua Fria, this gets floated downstream. Everybody here understands the Agua Fria goes into Lake Pleasant, which then drops into an irrigation system at the Buckeye Water Irrigation District, which goes down to Arlington, which waters the crops of the food that we eat. Hopefully, there have been studies on that, the solids and what floats down the river from this headed that way, because that's more than just this little, itty-bitty town up here.

EPA Response:
Lake Pleasant is very far south of the Site. The Agua Fria has been sampled just upstream, side-stream, and downstream of the Site, and the water is suitable for

irrigation. EPA does not believe that contamination from the Site is affecting Lake Pleasant.

b. And in conjunction with the gentleman there saying put a culvert underneath the road to run trucks, you know, we have a manufacturer up here that does conveyor belts. We could conveyor that stuff. Cover it and have water misting systems on it to keep it damp to optimum moisture so you have no particulates in the air. I appreciate what the EPA has done, and I see your variables you have here for what you'd like to do, but it is still kind of really, extremely vague. We have a percentage of tonnage of what the trucks will take, and probably the rate of trucking, but it's vague enough to where there wasn't enough in there for me to understand, like, for containment.

EPA Response:
Please see EPA Response to Comment A.2.e. Please also note that there is an extensive and much more detailed evaluation of the trucking volumes, truck trips, and many other factors related to what would be required to move the waste material in the FS in Sections 3 and 4.

A.10. Comment:
I will agree that having one repository up on Iron King is the best for our community. I will reiterate what [another commenter] said about the 3-foot crust and the jelly-like consistency. To the best of my knowledge, there hasn't been any testing to what that matter actually consists of. In one report that I read by EPA, they estimated that if that pile had a breach, that that jelly-like consistency could cover up to a mile of town. I would suggest extensive testing on the stability of that pile before any material crosses over.

Like [another commenter] had stated, if there is an option to put a tunnel under 69, that would alleviate the majority of the problems with the traffic. I would suggest that in this proposed plan that maps are given to our town on contaminated property so as building permits and grading permits are being issued, if any, in the contaminated areas, we are well aware of that. Our town has taken on many liabilities by not having maps or consistent information when submitting permits.

EPA Response:
Regarding the concept of having one repository and the concept of a tunnel, please see EPA Response to Comment A.2.e.

Regarding the consistency of the tailings pile and the approach to the stability of the mine tailings pile, please see EPA Response to Comment A.5.b.

The remedial design will contain maps of the work conducted and any remaining contamination. Maps will be available for the town. If additional stability testing is necessary, it can be conducted during the Remedial Design phase of the project.

A.11. Comment:
I agree that it needs to be put in one spot, and preferably over at the Iron King away from houses where the industry is. And the tunnel going under the road, it's better to do it that

way. And I hope you really aren't going to drag this out for another two years, because this seems a lot like five years ago when I came to the meeting. And it is frustrating for those of us that have lived here for years.

EPA Response:
Please see [EPA Response to Comment A.2.e](#).

A.12. Comment:
I live within a hundred feet of the smelter site, and I have for 40 -- more -- 50 years. I went right to this school, one through eighth grades, and then I was raised, before I got married, right down on the Iron King farm site where old Fort Woolsey is. What people don't realize is we had a tunnel under the road in the '50s and '60s to haul concentrates to the railroad. That was either caved in, filled in, whatever, when Highway 69 was in -- widened to four-lane. I've seen it when that dust and dirt blows off of the smelter site, and the tailings, until you can't see a hundred foot down the road. But what I can tell you is in past years, with the vegetation that you can see right here on this picture that's growing up, it has subsided that dust a lot. I'm going to agree with the old timers that I was raised with that do not disturb it. Not -- not do nothing but cap it where it is. Don't dig. Don't – don't disturb it. It's settled. A lot of it's settled. And you need to just cap it, seal it and everything, and then haul dirt over it. And that way you would only have the expenditure of finding new dirt to haul -- or to cover, instead of disturbing the tailings of two different sites and then trying to cover them, also. You would also have a lot less truck traffic, and roads and everything else would not be torn up.

EPA Response:
This comment appears to support the No Action Alternative or Alternative 3B. The mine tailings pile is not stable enough to cap it without regrading and using engineered materials to make it stable and prevent infiltration of rainwater into the waste. Both repositories will receive waste from other excavations at the Site. EPA will work to ensure dust suppression is effective and once capped the repositories will be vegetated for stability and erosion protection.

A.13. Comment:
There's been an awful lot of questions about chemical -- or items other than arsenic and lead, and I was just thinking it might help everyone here to know of all these other materials that might be out here and whether or not they have been searched for and what the results may be. That seems to be an elephant in the room that hasn't been addressed yet.

EPA Response:
The Site has been investigated for a wide variety of metals other than arsenic and lead. Section 7.0 of the RI includes a full discussion of the nature and extent of contamination at the Site. For example, thousands of soil samples were analyzed for a standard suite of metals including aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc. Samples have also been analyzed at the smelter

for polycyclic aromatic hydrocarbons and dioxins/furans. Groundwater has also been sampled for nitrate, chloride, sulfate, and total dissolved solids.

Because arsenic and lead account for the vast majority of the potential health risks associated with the Site, the remedy focuses on addressing these two metals.

A.14. Comment:

EPA, beryllium is one of those issues, and I know because it was found in my daughter's blood and she was diagnosed with beryllium sensitivity. I know of other kids that lived on the same street as us, Jones Street, who have extremely high levels of beryllium. This has never been looked into by EPA. When the data was requested of them, they specifically told me in an email that it was left out of the RI report; the contractor didn't think the levels were high enough to include. And I think that's kind of the explanation we've got tonight. If you research and know anything about beryllium, there is no safe level. Zero. You can be exposed to the slightest amount and have a reaction. It's similar to developing an allergic reaction to peanuts. If you're exposed to the slightest amount, you can continue to have that reaction. So, this has been a concern. It's been part of the meetings I've held with the community. It needs to be researched and looked into.

EPA Response:

Beryllium was not left out of EPA's investigation, nor from the RI Report. EPA has collected more than 1,900 soil and waste samples and tested them for beryllium, in addition to other heavy metals. We considered beryllium in our risk assessment but found that the levels were so low – i.e., health risks more than 100 times smaller than the Risk Screening Levels – that we screened beryllium from further review except at the smelter property itself. Even there, the risks were determined to be low. All beryllium data are in the Site-wide RI database.

Specifically, beryllium was not detected in any lab results from samples collected for surface water or groundwater. Beryllium results in sediment were between 0.18 milligrams per kilogram (mg/kg) and 0.15 mg/kg. Beryllium results in soils were between 0.35 mg/kg and 0.14 mg/kg. All results remain below EPA's levels of concern for this substance.

Beryllium was one of several contaminants studied in a University of Arizona Study of the Dewey-Humboldt community. A very low-risk safe screening level for beryllium in soils and dust is 16 mg/kg. In the University of Arizona study, beryllium in yard soils averaged 0.49 mg/kg. This was less than the average concentration of beryllium in soils across the U.S. – 0.63 mg/kg. During the study, indoor vacuum dust was collected from homes. The concentration of beryllium was 0.25 mg/kg, 65 times lower than the screening level.

We are aware that beryllium sensitization is a real condition that affects certain individuals. However, EPA does not perform studies of health effects attributable to previous exposure of persons to chemicals at issue, including potential site contaminants. This is addressed by health agencies such as the Arizona Department of

Health and Yavapai County Department of Health. EPA's focus is to clean up where necessary to address possible future exposure to site contaminants. Because Site-related beryllium, at levels as low as they may be, is collocated with the arsenic and lead and other metals in other wastes at the Site, we believe that beryllium will be addressed by addressing the soil and waste contamination as we have planned in the selected remedy.

A.15. Comment:

A couple of days ago, I was at a friend's house that's on the east side of the mine. It's probably about a half a mile from the free(way) -- from 69. And they have a stream. And we've had a lot of rain. We've had a lot of runoff. And like I explained, we have a lot of oxidizers. We have a lot of chelators. And you know what I -- and the stream's running. And what concerned me, it was murky. It was cloudy. So that's a huge, huge concern. The aquifer, our water supply, our contamination level, you guys should be looking at this like no tomorrow. So, I mean, that is just one thing that I saw two days ago. Maybe three days ago. But murkiness in a stream isn't good. And it's right off of the mine. So, the stream goes underneath the freeway off the -- off the west side, goes underneath the freeway, and travels eastward. And that's what I witnessed.

EPA Response:

It is not clear where your friend's house is located, which may affect the nature of the response to your comment. If it is a half mile from the highway, it is most likely also east of the river, and no mine-related wastes affecting runoff water quality are present there. Either way, it should not be assumed that Site contamination is the cause of the cloudy water you observed. It is common that runoff produces what is called turbidity, or the murkiness you speak of, especially after heavy rains. Sediment and other fine particles get swept up with the moving water and mix with it. The sediment and fine particles may contain organic matter such as clays, detritus, animal residues, etc.

A.16. Comment:

I'm going to follow up on the water issue. So, U of A had a research student who did a project for us called Voices Unheard, where she interviewed a lot of people in our community. It was based off the mining history, the Mexican history of the mine. She interviewed an Iron King Mine owner, Kuhles. You can go on YouTube, look up Voices Unheard and watch his interview. He speaks of water racing through the mine shafts at Iron King with such force he hired a company to come out and put an isotope in the water to try to track where it went to harvest that energy. It was moving at such speed that they were unable to track it. And he describes this -- now, correct me if I'm wrong. Underneath this, there's, like, 150 miles of mineshafts. If you have water visibly to the naked eye that you can look in the mineshaft and see racing through, common sense is going to tell you it's got an entrance and it's got an exit. It's going somewhere. And it has never been looked into. And I've addressed this with EPA. I have brought it up at every meeting there is. Again, watch the video for yourself. And it is an issue. Our groundwater is an issue, and it needs to be looked at.

EPA Response:
A mineshaft can receive and transmit groundwater to other locations within the mineworks. There, the water may be reabsorbed into the soil and become groundwater again. At the Iron King Mine, the mine shafts are generally upgradient of the town and are distant from any private or municipal drinking water wells. Please refer to Figure 1-15 of the FS for a graphic depiction. Wells are not screened to the depth of the mine works. Please note that the underground mine features do not contain concentrated mining-related waste but instead exposed naturally occurring soil and unprocessed ores that the groundwater has always passed through.

A.17. Comment:
…a follow up to (other) comments why beryllium is not looked at, there's a lot of evidence showing that beryllium is one of the things that they're dumping from the sky on a regular basis. So, if there's some deep, dark federal agency dumping it in the sky, of course, they wouldn't want another federal agency looking into where it's going. And that could also be why groundwater is not being looked at extensively as part of the planning. I don't know how you could possibly plan such a big project without looking into the effects of the groundwater first. That's just insanity, in my opinion. And I think -- I think that covers my thoughts at the moment.

EPA Response:
Please see EPA Response to Comment A.14 regarding beryllium.

As discussed in EPA's Proposed Plan, groundwater at the Site has been thoroughly investigated in EPA's remedial investigation. Groundwater analysis below and near the mine tailings pile indicates that groundwater impacts are limited to the immediate vicinity of the pile, parts of the Chaparral Gulch, and the smelter property. The ROD selects an interim cleanup action for groundwater at the Site that will be protective of human health and the environment in the short term. This action will restrict groundwater use near the affected areas. Additional monitoring wells will be installed, and more groundwater sampling will take place. Final groundwater remedial actions will be addressed in a later remedy selection, as necessary, after re-evaluation of groundwater following the excavation and disposal of mine and smelter wastes and contaminated soils. The interim response action for groundwater will be consistent with the final action selected for the Site.

A.18. Comment:
I guess the mine was different phases - different industry phases for many, many years. And correct me if I'm wrong. I might be wrong, but I heard that this mine used to recover World War II planes. And that's a concern because we all know that World War II planes, their radar and a lot of stuff had isotopes. I think you need to do a study on isotopes.

EPA Response:
To our knowledge, the mine does not have a history of recovering World War II planes. Appendix B of the RI contains an extensive history and cultural resource

inventory of the Site. There is no mention of radium dials, faceplates, or other aviation-related artifacts.

Please see Table 7 of the FS for laboratory results regarding radioisotopes. During the FS investigation, radioisotope data was collected from surface water and monitoring wells and isotope ratios computed for oxygen and hydrogen isotopes ($^{18}O/^{16}O$ and $^{2}H/^{1}H$). Deuterium isotopes for groundwater and surface water have also been investigated. Based on available data, radioisotopes do not pose a risk to human health or ecological health at the Site.

Written Comments Submitted at the March 29, 2023, Public Hearing

A.19. Comment:

Your plan contains a method to cover on top and sides of tailings but how do you cover or contain underneath the tailings sites to prevent any seepage or drainage below the pile of contaminated site?

EPA Response:

EPA does not anticipate seepage or drainage below the pile because the repositories will be designed to prevent it. See EPA Response to Comment A.2.d for a more complete discussion.

A.20. Comment:

Why can't all the waste be removed to Montana?

EPA Response:

This scenario is essentially Alternative No. 4 – hauling all waste at the Site to a permitted off-site facility. This was evaluated by EPA at length in the FS. As discussed in EPA's Proposed Plan, Alternative 4 would cost half a billion dollars and take 10 years to implement; these estimates were based on the assumption that the waste would be trucked to a facility in the Phoenix area. Hauling all the waste at the Site to Montana would likely require several billions of dollars. This alternative is cost- and time-prohibitive. It would also cause extreme congestion and disruption on Highway 69 and beyond for over a decade. Alternatives 2, 3A and 3B provide equal protection of health and permanence for far less cost and time.

A.21. Comment:

A plot seems to be in the works to manipulate this process such that a sewer plant gets built at the smelter site.

EPA Response:

Under the Superfund program, EPA does not select or pay for future land uses of sites. We do seek to understand interests that the community may have for future land uses and evaluate whether various alternatives would be consistent with those uses. EPA has had no discussions or involvement with any entity regarding building a sewer plant at the smelter site.

A.22. Comment:

I have grave concerns that John Hughes may be "handling" negotiations with EPA. Hughes was endorsed in his mayor campaign by Karen Fann - sister of a co-owner of the smelter - Michael W. Fann. He is a "member" of Greenfield's Enterprises, LLC. I request that all negotiations be in writing and subject to public records law.

EPA Response:

EPA does not negotiate the selection of cleanup remedies and is not doing so with Mayor Hughes. We do interact with Mr. Hughes in his capacity as mayor, but his comments and input, those of the town, and those of all the public are treated equally.

A.23. Comment:

So, this is a feasibility study, we know what's in the ground but have vague options. With 0% plans. Looking for resolution. This needs to happen again. After you choose 3B.

EPA Response:

EPA will develop specific Remedial Design documents that describe in detail how the remedy will be applied after the Record of Decision is signed.

Oral Comment Received by Telephone During the Public Comment Period (March 15 to May 13, 2023)

A.24. Comment:

Hello… I live in Dewey-Humboldt… I would like to comment that I think that if we could just let nature clean it up by itself, put seed on it so that it doesn't move and let nature in its time – it may take 20 or 40 years I have no idea, but we don't need any more residential developments – we're getting stuffed with people and we don't have water for that. I do think we'd be better off letting nature take care of it. We don't need to build on it. I think that building trees, things like that where it's just nature and see what happen. Moving dirt to another place is a terrible waste of energy, money and I think we need to pay attention to what happens when you take dirt to another place. $72 million. No, no, no that is a terrible waste of money when we can let nature take its course. In time it will be cleaned by nature. But I don't want it moved from place to place. If there is something I can do I would be delighted, but I think we should just leave the land so it can take care of itself. Everything seems to take care of itself eventually. (We shouldn't be putting it) somewhere else until we know what other kinds of things could happen. You're welcome to call me if you like…but I would support just leaving it in and making it a grassland. Thank you and goodbye and good luck with the project.

EPA Response:

Contamination levels will sometimes be reduced under natural conditions in a process called "natural attenuation." When it exists, it can be a useful tool instead of spending a lot of money on another remedy. For example, at some (not all) sites, bacteria may break down certain kinds of organic chemicals in groundwater slowly degrading over time.

In the case of the Iron King Mine and Humboldt Smelter Superfund Site, we have inorganic contaminants – mostly metals. These do not naturally attenuate and are persistent through time. Since mining and smelting operations began years ago, wastes have been left to the elements which spread the contamination down waterways, in the air, etc. Doing nothing (also considered under Alternative 1) would pose a significant threat to public health and the environment due to continued exposure of human and ecological receptors to the hazardous substances. Nature will, unfortunately, not be able to reduce these effects.

Written Comments Received During the Public Comment Period (March 15 to May 13, 2023)

A.25. Comment:
Hello, I'd like to ask that all cleanup activities use renewable diesel and employ a non-idling strategy to reduce local emissions.

EPA Response:
Thank you for this suggestion. EPA will consider this during the Remedial Design of the cleanup.

A.26. Comment:
Seemingly, all EPA RCRA regulations apply to generators and owners/operators of potential and actual hazardous waste. Related to the Iron King Mine – Humboldt Smelter Superfund Site, since the EPA is not and was not the waste generator, property owner, or operator of the mine or smelter properties, what published government intervention guidelines, standards, and regulations are they following and have they had congressional oversight and approval?

EPA Response:
You have asked about the government regulations regarding RCRA. The Resource Conservation and Recovery Act, or RCRA, imposes certain requirements on active industrial facilities for generating, storing, transporting, and cleaning up wastes that the law itself defines as "hazardous waste."

You have also asked about government statutes related to the Superfund program. EPA is managing the Site under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act, also known as CERCLA or Superfund. CERCLA was enacted by the US Congress in 1980 to respond to releases of hazardous substances, pollutants, and contaminants (including waste) at abandoned or inactive industrial sites. The law was amended in the Superfund Amendments and Reauthorization Act (SARA) in 1986. EPA was delegated the authority via the US Congress and the President to respond to most CERCLA sites and is the lead agency for this Site. CERCLA contains standards that all remedies must attain (for example, upon completion of the remedy, the site must be protective of human health and the environment. The National Contingency Plan (NCP) is the regulations that accompany CERCLA. It is used by EPA to provide a specific road map for responding *to releases of contamination at a CERCLA site all the way from investigation and characterization of a site, through alternatives analysis, then into remedy selection. EPA has followed CERCLA and the NCP in its activities at this Site.*

The CERCLA process includes evaluation of the human and environmental health risks posed by a Site, setting Site-specific cleanup standards and goals, public involvement requirements, and numerous other requirements and guidelines. CERCLA also has a myriad of guidance documents addressing its execution. In addition, part of the CERCLA process includes identifying federal and more stringent state requirements that indicate how a remedy will be conducted (called ARARs). EPA identified several Federal and State of Arizona requirements that will be complied with during the implementation of the remedy.

A.27. Comment:

The orange mine tailings within the Iron King Mine – Humboldt Smelter Superfund Site are reported to be in a potentially dangerous, gelatinous state. Rumor control suggests that at least one and possibly two large Caterpillar bulldozers have sunk into the tailing residue. What will be done to solidify that mass prior to covering it? What studies have been done to determine why the Iron King Mine tailings remain in a gelatinous state and has the subsurface been studied to determine if underground water sources are contributing to the gelatinous condition?

EPA Response:

Please see EPA Response to Comment A.5.b for a discussion of the nature of the tailings in the mine tailings pile. Please note that the FS included geotechnical soil analyses from many borings through the mine tailings pile. (Appendix D-2).

Underground water sources, except from the infiltration mentioned previously, do not contribute to the saturation of these materials. In fact, groundwater is almost entirely found below the bottom surface of the pile. Please see Figure 1-15 of the FS for a depiction of the relationship of groundwater to the mine tailings pile.

A.28. Comment:

Are subsurface streams under the Iron King Mine Tailings potentially contaminating the Prescott Aquifer?

EPA Response:

Groundwater analysis below and near the mine tailings pile shows that groundwater impacts are limited to the very shallow groundwater in the immediate vicinity of the pile, the Chaparral Gulch, and the smelter. There is no threat to the deeper aquifer water. After the pile is stabilized and capped, groundwater will be monitored for the long term to ensure that the contamination in the shallow groundwater subsides. Note that EPA's cleanup actions for groundwater are interim in nature. Final groundwater cleanup will be decided upon in a future remedy decision.

A.29. Comment:
What hazardous chemical reactions are or are likely to occur within the Iron King Mine – Humboldt Smelter Superfund Site waste and how are they being mitigated?

EPA Response:
A study was conducted to evaluate any chemical reactions and whether they would be hazardous. The study is included in Appendix D-3 of the FS, "Iron King Mine – Humboldt Smelter Site Geochemical Technical Memorandum." Many scientific topics are addressed in the technical memorandum, including chemical reactions known as "acid rock drainage" that is present at some sites. At some sites, acid in precipitation moves through the waste in the presence of air and causes metals to become dissolved in water. The technical memorandum concludes that acid rock drainage chemical reactions do occur at the Site. However, the buffering capacity of the tailings at the Site and in soils neutralizes acid so that arsenic and other metals have not dissolved and migrated to the extent they have at other sites. The geochemical processes at each area of concern are unique. The cleanup of these areas prevents and reduces them. A full description of different scenarios is found in Table 6 of Appendix D-3 of the FS.

The proposed Alternative 3B would stop water from infiltrating into tailings and other wastes and thereby stop the formation of acid rock drainage.

A.30. Comment:
Are the Iron King Mine Tailings in danger of collapsing and, if so, what is being done to prevent that catastrophe?

EPA Response:
Please see EPA Response to Comment A.5.b. That response provides information on how the mine tailings pile will be handled to prevent collapse. Under current conditions, there is some risk of failure for the mine tailings pile. Over time, the piles have been benched and some stormwater controls have been put in place to minimize ponding and stormwater collecting on the pile. At present, nothing is being done to stabilize the pile. The remedy will address this concern by drying saturated materials, stabilizing and capping the tailings.

A.31. Comment:
The EPA has defined the Iron King Mine and Humboldt Smelter residue to be Bevill-exempt mine waste. The Bevill Amendment only addresses and therefore seemingly applies to generators and owners/operators of potential and actual hazardous waste. As the EPA is not and was not the waste generator, property owner, or operator of the mine or smelter properties, how does the Bevill Amendment apply, and shouldn't our government be held to a higher and probably the highest level of safety?

EPA Response:
See EPA Response to Comment A.6. In the Bevill exemption, Congress excluded certain mining materials, such as tailings, from being "RCRA hazardous wastes." This means that the specific requirements of the law called the Resource,

Conservation and Recovery Act (RCRA) do not apply to these types of wastes. However, this does not mean that mine tailings at this site are not hazardous in a general sense, or do not pose a health risk if people are exposed to them. It does not mean it does not need to be cleaned up to protect the community. This is why EPA is cleaning up the Site under the Superfund program that is designed to address threats posed by abandoned industrial facilities such as the mine and the smelter.

A.32. Comment:
It appears that for the Iron King Mine – Humboldt Smelter Superfund Site, the EPA has focused on only arsenic and lead contamination. When will the EPA study the Iron King Mine – Humboldt Smelter Superfund Site for all probable hazardous materials and chemicals and provide those findings?

EPA Response:
Please see EPA Response to Comment A.13.

A.33. Comment:
Within surface and subsurface waterways adjacent to the Iron King Mine – Humboldt Smelter Superfund Site, what hazardous materials have been searched for and what are the results?

EPA Response:
The full list of analytes that were tested, including results of said tests are available in Appendix G of the RI, and evaluated in Section 7 of the RI. Risks related to all chemicals were evaluated in Section 9 of the RI.

A.34. Comment:
The EPA's concern for moving material across Highway 69 is unnecessary. As others have noted, a tunnel under Highway 69 could be used to transport the Humboldt Smelter waste using either trucks or conveyors. Otherwise, do as ADOT is doing on the much more extensive material movement for the expansion of Interstate 17 and simply use trucks to transport material over the roadway. Two large, nearby repositories that will forever remain in a limited use status due to their undersurface hazardous waste is illogical. All waste should be consolidated at one site.

EPA Response:
Please see EPA Response to Comment A.2.e.

A.35. Comment:
If underground streams are not (1) drawing hazardous material from the Iron King tailings and depositing those wastes into either an above or below-surface waterway, or (2) eroding the underside of the tailings, potentially resulting in a collapse of the tailings, or (3) keeping the tailings in a gelatinous state, then all Humboldt Smelter waste should be added to the Iron King tailings. If any of the above conditions do exist, there will need to be a plan 6 which would encapsulate the waste on all six sides.

EPA Response:
There are not currently "underground streams" flowing into the tailings. The design of the Remedial Action (cleanup action) will prevent surface and subsurface flows from disturbing the tailings. Please see responses above regarding moving the tailings across the highway (Alternative 2) in *EPA Response to Comment A.2.e*.

A.36. Comment:
One rumor is saying that in 16 years the EPA has expended roughly $100,000,000 in studying the Iron King Mine – Humboldt Smelter Superfund Site. If that is anywhere near the cost to date, and three large binders and the incredibly poor public hearing at the Humboldt Elementary School on March 29th are the cumulative results, folks at many levels should no longer be allowed to be paid by this or any similar project and a waste, fraud, or abuse investigation should be immediately initiated.

EPA Response:
The rumor is not correct. Nonetheless, very significant monetary and other resources have been spent to address the Superfund Site in this community. The Site is large and complex. A huge amount of sampling and investigation was required, and options had to be fully studied. Three separate cleanup actions were performed in residential areas at the Site to protect human health. It is generally very costly to address contamination sites, but EPA is encouraged that we have been able to provide this community with the actions that have already been conducted.

A.37. Comment:
First thing I would do is make a 4-9" cut with a PR-450/1000 or a Wirtgen Profiler. Asphalt/Concrete molding machine. Last time I was on this site I was preparing the storage building for demo. The owner sold it out from under my [illegible]. I want to see some documents on what you want to do: to store your soil. (Oh, the mine caught fire: so the owner filled it with sand to put out the fire.) And he burned my junk yard CAT 225 and its magnetic pickup hardware too.

EPA Response:
Your comments are noted, thank you. Documents regarding soil storage, if storage is needed, will be generated during the next (design) phase of the project, which include bases of design, design drawings, specifications, and construction work plans.

A.38. Comment:
I have lived around Humboldt most of my life… In my opinion there are only two options:

1) Let the owners of the property produce fertilizer. Extract the harmful elements while producing an excellent fertilizer product that rice-producing agriculturists and farmers begged for, here in the USA and other countries.

2) If the powers that be deem the above option 1 is not an option, then leave the Iron King Mine Alone! Contain it, cap it, and let the community get on with peaceful and productive lives. Do not stir it up! Please! Thank you for your consideration.

EPA Response:
The reprocessing of mine and smelter related materials into fertilizer and other recoverable metals was evaluated in the FS in Section 4.1.1.1 "Why a Commercial Reprocessing Process Option Was Not Used in Alternatives." One of the main problems with producing fertilizer or further recovering metals from the waste is the scale and time frame required to process it. The Site would pose the same human health risks and hazards to the community for decades while the commercial reprocessing takes place. Each commercial process also involves its own waste stream which could be problematic. EPA's selected remedy is designed to address contamination at this Site and its impact to the community and the environment.

B. EPA RESPONSES TO LETTER FROM TOWN COUNCIL TO JEFFREY DHONT (EPA) DATED MAY 13, 2023, REGARDING "TOWN OF DEWEY-HUMBOLDT'S COMMENTS ON THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S PROPOSED REMEDIAL ACTION PLAN, DATED MARCH 1, 2023, FOR THE IRON KING MINE-HUMBOLDT SMELTER SUPERFUND SITE, DEWEY-HUMBOLDT, ARIZONA"

B.1. Comment, Letter Section B

The Town Supports Adoption of Remedial Alternative 3B.

EPA Response:

EPA appreciates the Town's support for EPA's selection of Remedial Alternative 3B at the Site. EPA believes that the Remedial Alternative 3B best fulfills the remedy selection criteria set forth in the NCP with least potential disruption to the residents and businesses of the Town and nearby areas.

B.2. Comment, Letter Section C

The Town Urges Immediate and More Substantive Attention to the Development and Implementation of Institutional Controls.

a. Letter Sections C.1 and C.2

EPA's contemplated institutional controls ("ICs") for the Site are inadequately developed.

EPA Response:

EPA agrees with the Town that "[a]dding ICs on as an afterthought without carefully thinking about their objectives, how the ICs fit into the overall remedy and whether the ICs can be realistically implemented in a reliable and enforceable manner, could jeopardize the effectiveness of the entire remedy." Throughout this process, EPA has considered current land uses at the Town and how that could impact or be impacted by future remediation efforts.

Accordingly, EPA issued a Reuse Assessment for the former smelter property in June 2020 after detailed consultations with the Town Council in September 2018 and 2020 and a community workshop in May 2019. The Town Master Plan identified the smelter property as part of the Town's open space amenities and excluded future residential or commercial development. The 2020 Reuse Assessment identified likely ICs such restrictions on public access to the slag area on the steep banks of Agua Fria River and permitted land use such as mixed commercial and light industrial use in northern portions of the smelter property and recreational use or park for reclaimed areas on top of the smelter tailings swale. EPA did not conduct a reuse assessment for the mine property in 2020 due to its distance from the town and a lesser probability of reuse due to hazards (i.e., mine shafts and a large tailings pile.)

While EPA's Proposed Plan focused heavily on engineering controls (ECs) contemplated by various remedial alternatives, the Agency also identified ICs intended to work in concert with ECs to protect public health and the environment:

The following institutional controls are anticipated:

- *If Alternative . . . 3B [EPA's preferred remedy] is selected, land use would be restricted, physical controls would be applied, and excavation would be prohibited on the waste repository and the immediate area surrounding it that is necessary for its protection and maintenance.*
- *If Alternative . . . 3B is selected, land use would be restricted, physical controls would be applied, and excavation would be prohibited on the waste repository at the smelter property and the immediate area surround it that is necessary for its protection and maintenance.*
- *Zoning and/or land use restrictions would be applied to prevent development of capped and covered areas which could damage the caps.*
- *Zoning and/or land use restrictions would be applied to prevent exposures in open areas north and south of the tailings pile if waste or contaminated soils above cleanup levels is left in place.*
- *The installation of drinking water wells would be prohibited at the mine tailings pile, at the smelter property, and near and below the Chaparral Gulch, as there is shallow groundwater contamination under the wastes in these locations.*
- *Land use would be prohibited on the remaining stabilized monolithic slag to prohibit construction and prevent persons from falling off the slag or into crevasses.*
- *In existing residential areas and areas for which the RAFLU is residential, landowners with warning barrier left on their parcel after cleanup will receive instructions from EPA on how to handle warning barrier if excavating. Also, the town government will receive instructions and a map of all parcels with warning barrier for use in permitting processes.*

EPA recognizes that there is much work to be done to flesh out and implement these ICs and looks forward to working with the Town and State of Arizona during the Remedial Design process, which is when EPA will evaluate and determine appropriate ICs for the Site.

b. Letter Sections C.3.a and C.3.b
More substantive attention to the development and implementation of ICs is needed prior to the remedial design.

EPA Response:
As stated above, EPA is committed to working with the Town and the State of Arizona to develop and implement ICs as part of its Remedial Design process upon the issuance of this ROD.

c. Letter Section C.3.c
The town has pressing needs currently for one or more IC ordinances.

EPA Response:
EPA will focus on ICs that protect the long-term integrity and effectiveness of waste repositories and other remediation measures, and prevent any harmful exposure to chemicals of concern. In response to the concern expressed by the Town about soil management, excavation, and construction issues associated with Superfund wastes, EPA recognizes that the residential cleanup component of the selected remedy (and past removals) raise these concerns and has proposed warning barriers and notification of the Town as an IC. EPA will discuss with the Town additional potential ICs such as Declaration of Environmental Restrictions under Arizona law and other mechanisms to address these concerns during the Remedial Design and Remedial Action phases.

d. Letter Section C.3.d
Remedy construction will require landowner commitment to both ECs and ICs.

EPA Response:
EPA does not anticipate any transfer of ownership of properties at the mine and smelter in order to implement the selected remedy. Property owners will be included in the process of determination of ECs and ICs, as appropriate. EPA will consult with the Town and the State of Arizona regarding this issue during the Remedial Design phase upon issuance of the ROD.

e. Letter Section C.4
The town recommends preparation and adoption of an Institutional Controls Implementation and Assurance Plan ("ICIAP").

EPA Response:
Following the issuance of this ROD, EPA will consult with the Town and the State of Arizona regarding any use of ICIAP or potential funding mechanisms for ICs. EPA's guidance on ICIAPs contemplates that such plans are finalized at the conclusion of the Remedial Design phase:

"It generally is recommended that the ICIAP be developed prior to, or at the same time as, the design of the engineered response (e.g., Remedial Design phase of

CERCLA . . .) and finalized with design completion. This approach should allow time for the site managers and site attorneys to complete detailed discussions with parties that are responsible for implementing, maintaining, and enforcing ICs and any other relevant stakeholders."

See https://www.epa.gov/sites/default/files/documents/iciap_guidance_final_-_12.04.2012.pdf.

Regarding the Town's comments about potential use of EPA's Brownfields program grants for IC implementation, EPA notes that it does not award such grants for any sites that are on the NPL, as is this Site.

See https://www.epa.gov/sites/default/files/2018-10/documents/web-content-info-on-site-eligibility.pdf.

f. Letter Section C.5

The Town reuse/revitalization options for the remediated mine and smelter properties needs to be factored into IC development and implementation.

EPA Response:
EPA looks forward to working with the Town and the State of Arizona in developing and implementing ICs that appropriately consider the Town's re-assessment of current and future land uses at the sites, including enhancement of commercial and/or recreational amenities for the Town and its residents.

C. EPA RESPONSES TO TOWN OF DEWEY-HUMBOLDT COMMENT PACKAGE: TECHNICAL MEMORANDUM: SPECIFIC COMMENTS ON EPA'S REMEDY SELECTION PROCESS, THE IRON KING MINE-HUMBOLDT SMELTER SUPERFUND SITE, DEWEY-HUMBOLDT, ARIZONA, MAY 13, 2023

C.1. Comment:

The Town understands that, by the conclusion of fiscal year 2023, $2.0 billion of the BIL's original $3.5 billion Superfund-related appropriation will have been spent at or committed to other Superfund sites. The Town therefore is concerned that by the time EPA Region 9 has a "construction-ready" remedy at the IKM-HS Superfund Site, all or nearly all BIL Superfund-related monies will have been spent at or committed to other Superfund sites. Please advise the Town whether potential unavailability of BIL Superfund-related monies for the final remedy at the IKM-HS Superfund Site may result in EPA Region 9, and the Town, having a "construction-ready" remedy that cannot be constructed.

EPA Response:

The Bipartisan Infrastructure Law (BIL) provides a fixed amount of funding that can be used for Superfund cleanup nationwide. There is a specific process for obtaining funding for BIL funds for Remedial Action. There are Superfund sites throughout the country that have received or have applied to receive the funding because they are at the Remedial Action phase. EPA is dedicating additional resources to move expeditiously to complete this Record of Decision (ROD) and respond to the general public comments and extensive comments from the Town, which will allow us to move forward with seeking funding under BIL. However, we cannot guarantee that sufficient BIL funding will remain available. More information will be available after the ROD is completed.

C.2. Comment:

Please advise whether EPA Region 9 anticipates such Superfund excise taxes being available to fund the final remedy at the IKM-HS Superfund Site, or what other funding options exist or might exist to ensure that the Superfund process in the Town can continue to closure.

EPA Response:

We are not in a position now to evaluate whether excise taxes will be available for the Site.

C.3. Comment:

…the Town is concerned that EPA Region 9's acceleration of the remedy selection process at the IKM-HS Superfund Site may result in an inadequately and deficiently designed final remedy, all in the interest of securing BIL monies that may not be available by the time EPA Region 9 has a "construction-ready" remedy at the site.

EPA Response:

EPA has dedicated additional resources to move through this process in a timely and comprehensive manner. The concern about design is noted; please note that we need *to complete the ROD and response to comments before we can begin the Remedial Design to which the comment refers.*

C.4. Comment:

A test of EPA Region 9's commitment to develop a fully protective final remedy will be in EPA Region 9's readiness and willingness to meet and work with the Town prior to final remedy decision and design to develop and implement a robust "institutional controls" program by the Town, as requested in the Town's May 13, 2023, comment letter to EPA.

EPA Response:

See EPA Responses to Comments received from the Town on its letter sent with its comment packet on the Proposed Plan. EPA Region 9 will meet and work with the Town on matters related to institutional controls, however this will not occur prior to the ROD and start of Remedial Design, as that is the appropriate time in the process to discuss institutional controls.

C.5. Comment:

The Town agrees that the determination of an appropriate Background Threshold Value ("***BTV***") that adequately addresses A.A.C. R18-7-204 as an ARAR is an appropriate approach regarding Arsenic contamination at the IKM-HS Superfund Site. The Town understands that there are three (3) keynote requirements under the State regulation that bear attention. First, an adequate historical assessment of the property in terms of the background conditions considered to represent a suitable baseline must be established. The Town believes that this has been adequately addressed by EPA. Second, the baseline study must adequately identify "site- specific" and compile an appropriate, corresponding dataset. Third, the background standard must be calculated using an appropriate statistical analysis, such as the 95% Upper Confidence Limit ("***UCL***").

The Town requests that EPA provide a summary of how these individual requirements for the adopted ARAR were addressed by EPA in assigning a remediation standard based on a calculated BTV for arsenic.

EPA Response:

EPA Response to Comment C.6 *provides information pertinent to this comment in relation to derivation of background value for arsenic.*

Please note that EPA has determined in the ROD that AAC R18-7-204 is not an ARAR, but rather a To-Be-Considered criterion.

The comment refers to the Arizona state statute governing soil remediation levels, however it does not appropriately characterize this statutory information. This statute provides a remediation standard for arsenic (10 mg/kg), which is not a risk-based standard. Instead, due to the prevalent background levels of arsenic in many areas of the state, parties responsible for cleanup ("remediating parties") are given a choice among three options of soil cleanup levels which can be simplified as follows: 1) cleanup to 10 mg/kg, which is not risk based but is based on a very conservative *estimate of a state-wide background; 2) perform a background study and cleanup to background levels, or 3) perform a site-specific risk assessment and cleanup to a risk-based level (or to background, if background is higher). This approach is not typical for the State remediation standards for other contaminants.*

AAC R18-7-203(A) states:

A person [defined in AAC R18-7-201(30)] subject to this Article shall remediate soil so that any concentration of contaminants remaining in the soil after remediation is less than or equal to one of the following:

The background remediation standards prescribed in R18-7-204.
The pre-determined remediation standards prescribed in R18-7-205.
The site-specific remediation standards prescribed in R18-7-206.

The remediating party may choose which option for remediation of soil will be utilized and bears the burden of justifying the work conducted should background or a site-specific standard be chosen for remediation under the second and third methods. Normally, ADEQ's purview is to determine whether the remediating party conducted the remediation according to the remediation standard chosen after cleanup has been completed. EPA has performed both an appropriate site-specific risk assessment and determined site-specific risk-based levels for the Site.

Regarding background, as is discussed in *EPA Response to Comment C.6* *next, since the Proposed Plan was issued, EPA has now reevaluated the background levels at the Site and derived two background values: one for east and one for west of the Agua Fria River. This site-specific evaluation is based on over 500 data points collected in areas spatially distributed in areas out to about 2 miles from the Site, using a highly sophisticated statistical approach. The ROD now contains revised cleanup levels for residential soils, compared to those levels derived for the Proposed Plan. These are: 48 mg/kg arsenic east of the river, and 99 mg/kg arsenic west of the river.*

AAC R18-7-204(B)(Background Remediation Standards) states:

A person who conducts a remediation to a background concentration for a contaminant shall establish the background concentration using all of the following factors:

Site-specific historical information concerning land use.

Site-specific sampling of soils unaffected by a release but having characteristics similar to those of the soils affected by the release.

Statistical analysis of background concentration using the 95th percentile upper confidence limit.

It should be noted that in this ROD EPA has found that AAC R18-7-204(B) is a To-Be-Considered requirement, and not an ARAR as the comment implies.

Nonetheless, EPA believes it has met the conditions specified. The RI, FS, and Proposed Plan thoroughly review historical information regarding land use. The background assessment uses site-specific samples with characteristics similar to soils affected by the release, and EPA based its BTVs on the 95% tolerance limit of the 95th percentile, which is a typical way of calculating a BTV.

It is noted that ROD Section 8.1, under the heading Specific Discussion Regarding Arsenic Cleanup Levels in Areas with Residential Land Use and with regard to residential areas east of the river, EPA has not based the cleanup standard for the east side of the river on the BTV (99 mg/kg) but on a concentration corresponding to a hazard index of 1 for child residents (79 mg/kg). As cleanup below background is not practicable and is prohibited, statistical tests will be used to confirm that properties identified for cleanup are not below background.

It is noted that the comment misquotes AAC R18-7-204.B.3. It does not say "the 95% upper confidence limit" but rather "the 95th percentile upper confidence limit," which here is a UTL with the confidence coefficient unspecified.

According to ADEQ, the above rule is not intended to prescribe detailed methods for conducting a background study shall be conducted but merely provides a guideline for evaluating a background data set to derive a background concentration.

See also EPA Response to Comment D.20.

C.6. Comment:

The Humboldt residential community is located on relatively flat ground west and, to a lesser degree, east of the Aqua Fria River. These two (2) residential areas may warrant differing remedial standards for arsenic, but the main body of the community, including the Town of Humboldt proper, is clearly situated on a flat of Balon Soil that is characterized, based on EPA's background arsenic dataset, at a BTV that is substantially less than the 92 mg/kg proposed.

…The Town believes that Dr. Speyer has demonstrated that residential properties on Balon Soil, but separated by the Agua Fria River, also show statistically different background attributes that should be reflected in assigning remediation standards.

EPA Response:

Comments received during the public comment period, including this comment, have raised concerns that previous background evaluations performed for the Site in the RI (RI Appendix E) and FS (FS Appendix C-6) were too high because they derived a single BTV of arsenic in surface soils across the areas surrounding the Site. Comments stressed that background sampling results on the east side of the river are higher and belong to a separate background population than those on the west side, *which elevated the value of the resulting BTV. The comments recommended that EPA perform a reexamination and derivation of the arsenic BTV for surface soils giving more attention to how background may differ in different areas.*

Since the Proposed Plan was issued, EPA has performed a new and sophisticated statistical analysis of surface soil background levels that reexamined surface soil background values for arsenic that was included in Appendix C-6 of the FS. A separate technical memorandum regarding arsenic soil background values is attached to the ROD as Appendix C.

Based on conclusions from this study, EPA has modified the single BTV of 92 mg/kg arsenic in the Proposed Plan to two background values: 48 mg/kg west of the river and 99 mg/kg east of the river. In turn, the residential soil cleanup levels in the ROD have been modified accordingly. However, it is noted that ROD Section 8.1, under the heading Specific Discussion Regarding Arsenic Cleanup Levels in Areas with Residential Land Use and with regard to residential areas east of the river, EPA has not based the cleanup standard for the east side of the river on the BTV (99 mg/kg) but on a concentration corresponding to a hazard index of 1 for child residents (79 mg/kg). As cleanup below background is not practicable and is prohibited, statistical tests will be used to confirm that properties identified for cleanup are not below background.

Multiple statistical models and approaches, and spatial weightings were employed. The data used in the analyses were re-examined and expanded, and modified data populations and groupings were used. Results from background samples on individual as well as grouped soil types were calculated and reviewed. Chemical signatures of other metals constituents were reviewed to evaluate whether the differences in background values east and west of the river were due to geologic differences.

It was determined that dividing the Site background data population into subpopulations from areas east and west of the Agua Fria River was the most appropriate and health -protective way of evaluating the data. This was superior for many reasons compared to dividing the data based solely on soil types. Statistical chemical signatures from various metals east of the river and other lines of evidence were evaluated to determine that higher background values of arsenic east of the river were due to differences in the underlying geology rather than aerial deposition of dust from the smelter property or the mine. See Appendix C for a more technical discussion.

Given the differing levels of heavy metal COCs in the different background soil types, and especially on the east side of the Agua Fria River versus the west side, EPA supports the use of two Site BTVs, primarily for the east side of the Agua Fria River versus the west side, but also secondarily for soil type on the conditions that the soil types (differentiated by location east or west of the river) are sufficiently different and have enough data to make the computation feasible.

The comment's reference to using only Balon soils is discussed in much more detail in EPA Response to Comment D.20.

C.7. Comment:
The Town believes that the BTV for Arsenic requires revision based on site-specific criteria as dictated and required by the state ARARs (as referenced). The numerical difference between the BTV remedial standard provided in the FS report and reiterated in the PRAP (92 mg/kg) and the BTV that is indicated by the concentration of Arsenic in Balon Soils only (< 45 mg/kg) is an order of magnitude less and, as such, represents a significant and unacceptable increase in the additive lifetime cancer risk associated with soils that are intended to be left on residential properties following completion of the remedy.

EPA Response:
This concern is understood. See EPA Response to Comment C.6 regarding EPA's re-evaluation of the background threshold values and the selection of cleanup values for arsenic in residential soils.

EPA agrees that there is a significant difference between the background data from east versus west of the river. Therefore, EPA's revised background evaluation (See EPA Response to Comment C.6) rectifies this problem by calculating different BTVs east and west of the river. In actuality, the Balon and Lonti soils are very similar. EPA has run the BTV calculations with and without data points from the Lonti soils with very similar results. EPA believes that the primary difference between the background data distributions of the Balon and Lonti soils is that the Lonti soil is on the east side of the River and the Balon soil is mostly (not entirely), on the west side of the river. The differences in the data are not due to differences in the soil unit mappings.

See EPA Response to Comment D.20 for more complete examples and details.

C.8. Comment:
EPA has, historically, been notified that Beryllium (Be)-sensitive receptors, including children, live within the boundaries of the IKM-HS Superfund Site. These potential receptors qualify as a "sensitive population" that pertains to the characterization of the site and affirmatively supports the analysis of potential remedial action alternatives. EPA is required to address this "sensitive population" in the development of its remedial alternatives and assigning removal and remedial standards. The Town requests that EPA advise how it intends to accommodate the foregoing requirement.

EPA Response:
Please see EPA Response to Comment A.14 regarding beryllium.

C.9. Comment:
A recent scientific article, based on research conducted by University of Arizona scientists, indicates that soil and groundwater conditions in residential areas of the IKM-HS Superfund Site have substantially contributed to the concentration of systemic Arsenic in child residents (i.e., toenail and urinary arsenic). This paper was published at about the same time that the RI

was released by EPA. There is no discrete acknowledgement of this study or the implications of its findings by EPA or its contractors. Moreover, there is no comprehensive effort to assess the distribution of conditions throughout the residential area of the IKM-HS Superfund Site that might correspond to the circumstances documented by this scholarship. [Loh et al., 2016. Multimedia Exposures to Arsenic and Lead for Children near an Inactive Mine Tailings and Smelter Site. Environmental Research v. 146:331-339]

EPA Response:
EPA has reviewed the referenced study. The conclusion stated in the comment, however, does not comport entirely with the certainty of the attributive conclusions in the document. EPA believes there is more complexity to the findings than this comment suggests. That said, we find the study informative and do not rule out that there has been human exposure to site contaminants in the past. This is in part why EPA is proposing a cleanup. The following are important points regarding the study in relation to EPA's work. First, EPA was unable to correlate the locations/distribution of biological samples (e.g., toenail, and dust samples in homes studied) with EPA's own contaminant distribution data because of privacy matters as the study authors were unable to share this information with us. Second, EPA does not perform and evaluate studies of past exposures to contaminants and their potential relationship to observed health effects. These kinds of studies and investigations are performed by public health agencies such as the Agency for Toxic Substances Control (ATSDR) and ADOH. EPA focuses on potential current and future health risks from exposure to the Site-related contaminants.

C.10. Comment:
The current PRAP [referring to EPA's Proposed Plan] provides adequate treatment of remedial alternatives but gives very little attention to the most sensitive subset of the residential population, namely children. Considerations of (i) airborne dust from unpaved roads, (ii) historical building foundations and building pads constructed with waste rock and tailings, (iii) distribution of carcinogenic (e.g., arsenic) and acutely toxic (e.g., lead) metal pollutants in subsurface soils within the tilling depth of household gardens and the root depth of vegetable garden produce need to be made in the remedy design phase, particularly in connection with institutional controls.

EPA Response:
EPA disagrees that little attention has been provided to children as sensitive receptors. EPA's risk assessments incorporate highly conservative assumptions in order to be protective of children. We have not found that dust from unpaved roads is likely to be significantly contaminated from historical activities of the mine and smelter.

Based on past input from Town residents, EPA acknowledges that tailings may have been used as fill or as base in the past. While this is difficult to address directly because there is no information available as to where this may have occurred, sampling has been and will be conducted around the Site and on residential properties to determine where concentrations of contaminants exceed levels of concern. If *concentrations of concern are identified, EPA will take an appropriate response action consistent with its authority under the Superfund program.*

C.11. Comment:

The Town requests that EPA provide a focus report that details specific provisions that are included in the final remedy that addresses protective measures that were consulted in establishing the remedial standards for each metal pollutant that has been documented to exceed the respective pre-determined regulatory standard, or proxy allowable under applicable ARARs (e.g., BTV for arsenic and site-specific risk assessment for lead). The Town expects that the adequate completion of remedial and removal activities conducted on residential properties is appropriately confirmed by soil sample analysis.

EPA Response:

This comment is confusing and contains many undefined and unclear terms. It is unclear what is being requested. EPA has completed a detailed FS and a supplemental Technical Memorandum (FS Appendix C-6). The FS Section 2.4 and Appendix B and the Technical Memorandum describe how background concentrations and preliminary remediation goals were developed. The ROD includes a Technical Memorandum, "Refined Background Threshold Value (BTV) Calculations for Arsenic at the Iron King-Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona." as discussed in *EPA Response to Comment C.6*.

C.12. Comment:

Previous Removal Actions conducted by EPA in residential areas were based on remedial standards that vary between 48 mg/kg, 38 mg/kg, 144 mg/kg, 112 mg/kg, and 92 mg/kg. This disparity has created a host of challenges for the Town and creates inconsistency between interim removal actions and the final remedial action.

EPA Response:

Three removal actions have been conducted involving excavation of residential soil, so it is not clear why the comment cites five cleanup values. While in the past the BTV for arsenic has been 112 mg/kg, this was not a cleanup value during the removal actions. It is true that the cleanup values differed during the removal actions. Among the three actions, cleanup levels varied from 23 mg/kg (applicable to only four properties in 2007) to 144 mg/kg for arsenic; and from 400 mg/kg to 513 mg/kg for lead. While the cleanup levels themselves were not all the same, the net result was that all properties for which the action was performed were cleaned up such that exposure point concentrations did not exceed 144 mg/kg arsenic and 400 mg/kg lead at the end of the cleanup. For example, while the 2011 removal action had a lead cleanup value of 513 mg/kg, no yards were excluded because they had an exposure point concentration between 400 and 513 mg/kg.

The disparity referred to in the comment is not as consequential as the comment implies. Removal actions are designed to address imminent and substantial endangerment and often are performed before the final risk assessment evaluations that are part of the remedial (as opposed to removal) action decision. As part of the Remedial Action, EPA plans to return to properties to ensure that cleanup now meets *the revised performance standards. It is not clear how the difference in the removal cleanup levels from past actions creates a "host of challenges" for the Town, nor how EPA's revised final cleanup standards does so.*

C.13. Comment:
CH2M-Hill's (2016) calculated BTV (112, mg/Kg) and Tetra Tech's (2022) BTV (92 mg/Kg) are based on too broad a dataset that combines Arsenic concentration data from multiple terranes and entirely unrelated areas.

EPA Response:
See *EPA Response to Comment C.6.*

C.14. Comment:
EPA should … identify areas other than contaminant source areas as AOCs that will be addressed in the Record of Decision ("***ROD***"). We think that these additional AOCs may be referred to as RAOCs so that the integrity of the FS and PRAP are not affected. The Town recommends that AOCs, including RAOCs, be identified within the boundaries of the IKM-HS Superfund Site. These should be segregated according to soil type and, accordingly, appropriate, and pertinent remediation and removal standards should be assigned.

EPA Response:
EPA agrees that residential areas are an AOC. While this is explicit in the Proposed Plan (the proposal includes a cleanup action in those areas), the 31 AOCs identified in the FS did not include residential areas. EPA does not believe that residential areas need to be grouped into multiple AOCs, however. All will be addressed in the Remedial Action to meet the appropriate cleanup standards.

C.15. Comment:
The Town has been made aware of confirmation sample results that were collected by Weston Solutions following the 2017 removal action that was conducted on 31 residential properties in the Superfund Site. Soil samples collected at the base of excavations reported concentrations of arsenic at depths of up to two (2) feet below ground surface that exceeded 750 mg/kg. These recent excavations pursuant to a removal action identified a target concentration of 144 mg/kg for arsenic.

EPA Response:
The comment does not identify which particular samples/locations have reportedly deeper contamination, which makes it more difficult for us to respond. EPA is aware of several properties in the former rail alignment leading into the smelter, parallel to Main Street, where it is believed that contaminated soils were mixed to depths of many feet, either/or when the railway was constructed or when it was taken out, and high levels of contamination remain up to several feet below ground surface. The 2017 soil Removal Action addressed residential contact with elevated arsenic containing surface soils and therefore EPA was not able to remove all deep contaminated soils in this area. This Removal Action included the placement of two feet of clean soil over a

fabric barrier to eliminate contact with deeper contaminated soils that remained in place.

C.16. Comment:

The Town believes that Dr. Speyer's analysis of the background Arsenic data indicates that remedial standards applied by EPA in removal actions conducted in 2010 and 2011/2012 are more appropriate and address more directly the difference between background conditions and contaminated conditions in those areas…The Town requests that residential properties be remediated to standards that more closely correspond to these earlier removal actions and believe that sufficient data exist to support this request.

EPA Response:

As is detailed in EPA Response to Comment C.6., EPA has revised the BTVs for arsenic in residential soils in the ROD. The residential cleanup values were also adjusted as discussed in that Response to Comment.

Removal Actions are designed to address imminent and substantial endangerment and may or may not use cleanup values that are the same as those selected in the final ROD. Please note that the revised cleanup standards selected in the ROD are more protective of health than those used during the 2011/2012 Removal Action.

C.17. Comment:

The Town observes that different residential properties have been historically remediated to differing cleanup criteria. Some of these properties are adjacent to each other and some are adjacent to properties that have elevated concentrations of arsenic that have not been remediated. A patchwork of parcels that are either cleaned or not cleaned according to different criteria, handicaps future Town planning and adversely affects the Town's ability to administer equal standards regarding health risk and support a uniform perception of property value.

The Town therefore requests that EPA include provisions in the ROD that ensure that residential property tracts, such as are located in, associated with, and surrounding the Town of Humboldt proper (cf. RAOC), are cleaned to a confirmed, comparable remedial standard.

EPA Response:

See EPA Response to Comment C.12.

C.18. Comment:

The Town questions EPA's calculation of a legitimate BTV based on the BTV values presented in the RI and FS and the definition of the 95% UCL, which is required by regulation, to be used to determine an appropriate BTV. BTV calculations applied to address A.A.C. R18-7-204.B.3, which requires that the BTV be calculated using the 95% Upper Confidence Limit (UCL).

EPA Response:

Please see EPA Response to Comment C.6.

C.19. Comment:

The BTV calculations applied by CH2M-Hill and Tetra Tech incorporate data that should be eliminated from the dataset as outliers…The Town requests that EPA explain, specifically, why four (4) outlier values were not eliminated in addition to the so-called "extreme" outliers, from the BTV calculation. The Town recommends that EPA eliminate these additional four (4) values as conflicted under the terms of EPA guidance documents and as responsive to standard data quality objectives.

EPA Response:

EPA Response to Comment C.6 and attachment to this ROD for discussion on revised BTV calculations, which determined a modified outlier analysis.

EPA followed guidance for identification of outliers (USEPA. 2006. Data Quality Assessment: Statistical Methods for Practitioners. EPA QA/G-9S. EPA/240/B-06/003. February) and evaluation of outliers (USEPA. 2006. Data Quality Assessment: Statistical Methods for Practitioners. EPA QA/G-9S. EPA/240/B-06/003. February; and USEPA. 2015. ProUCL Version 5.1 Technical Guide. Prepared by A. Singh and A.K. Singh. Office of Research and Development. EPA/600/R-07/041. October). EPA also identified extreme outliers by data visualization and comparative analysis of the highest measurements. Once outliers were identified, EPA performed a formal test of these possible outliers. The outlier assessment was done using an extended version of Rosner's multiple outlier block test at the 1% significance level following guidance (USEPA. 2009. Unified Guidance: Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities. EPA/530/R-09/007. March.).

C.20. Comment:

Certain soil types recognized by EPA, for which data are incorporated into the EPA BTV calculations, do not occur within the boundaries of the IKM-HS Superfund Site, as defined by EPA. Further, certain outlier values remaining in the complete RI and FS dataset, for example, correspond to the Lonti Soil type. These values are not relevant to the IKM-HS Superfund Site and, therefore, should be removed altogether by EPA from the analysis of BTVs.

EPA Response:

EPA believes that there is a significant difference between the background data from east versus west of the river, and that it is therefore not appropriate to calculate a single BTV for the undivided dataset. EPA's revised background evaluation (See EPA Response to Comment C.6) rectifies this problem by calculating different BTVs for east and west of the river. (We note for the following discussion that while Lonti soil occurs only east of the River, Balon soil occurs both east and west of the river. We further note that residents are living east of the river on Lonti soil).

Beyond this, we disagree both that Lonti soil data should be removed from the background dataset and that Lonti soil is not "site-specific" as has been contended in other comments.

The comment places too much importance and emphasis on the U.S. Department of Agriculture soil mapping. Such maps often include many types of parameters, such as slope/soil inclination that are not related to soil background determination. In actuality, the Balon and Lonti soils are very similar soils (see below). EPA believes that the primary difference between the background data distributions of the Balon and Lonti soils is that the Lonti soil is on the east side of the river and the Balon soil is mostly (not entirely), on the west side of the river. The differences in the data are due to differing geological parent materials and physical differences between east and west of the river. For example, EPA calculated the BTV estimates for Balon soil on the east side of the river and for Balon soil on the west side of the river. Even though the soil type is all Balon, the BTV on the west was only about half of the BTV on the east side.

We also note that if all of the data from the Balon (both east and west) merged together as one dataset and the Lonti soil data are disregarded, the resulting BTV is actually higher compared to the BTV for a Balon west dataset. Again, it is more important to divide the data east/west than to divide the data according to soil type.

Regarding similarity between the Lonti and Balon soil types, we note that soils develop from parent materials which are a composite of various rocks and minerals. A BTV for arsenic in soils has inherent variability due to the mineralogical components in the parent materials rather than a specific Soil Mapping Unit. A BTV calculation should characterize the origin and natural transport mechanisms of the parent materials that are the source of the soil developed.

Moano soils are mapped on steeper residuum (bedrock) phyllite and schist hillslopes that surround the Site and the Agua Fria valley. Both colluvial and alluvial actions have contributed parent material for the soil development of the Lonti and Balon soils that formed on slopes and terraces below the Moano soils.

Lonti soils developed from old gravelly alluvium from mixed sources including granite, schist, sandstone, limestone, shale, and basaltic materials (National Cooperative Soil Survey [NCSS] 2008). The concentration of arsenic in the Lonti soils would thus depend on the specific source of geologic material and would be variable. Lonti soils are mapped on slopes ranging from 0 to 30 percent.

Balon soils also formed from mixed sources of alluvium dominantly of schist, granite, basalt, and other rocks (NCSS 2006). Balon soils are mapped on fan terraces with slopes ranging from 2 to 25 percent.

Based on the geographic setting and landforms on the Site and the varied composition of soils' parent materials for the Lonti and Balon soils, there is no soil mineralogical basis for disregarding the arsenic data from the 69 soil samples collected from the Lonti soil mapping unit. Arsenic concentrations from the Lonti background soils are therefore included in the BTV calculation.

See also *EPA Response to Comment D.20*.

C.21. Comment:

The Town requests that EPA re-evaluate the combined dataset by separating subsets of the data according to (i) aquifer setting (i.e., shallow verses deep), (ii) AOC location (e.g., MTP, Chaparral Gulch, residential neighborhood properties), and (iii) documented geochemical regime as per the distribution and nature of potential source media (e.g., tailings, waste rock, fugitive dust).

EPA Response:

EPA does not understand what is meant by" re-evaluation of the combined dataset by separating subsets of data. It is not clear what the commenter is recommending or why. EPA evaluates data in each medium in accordance with its route(s) of exposure, as was done in the RI and FS.

C.22. Comment:

The Town agrees that a remediation standard for lead (Pb) is best established based on site-specific risk assessment criteria as per A.A.C. R18-7-206, which is a state ARAR. However, EPA has relied on an antiquated risk assessment model that has been substantially revised. Reliance on an outdated version of a risk model does not satisfy the regulatory requirements of A.A.C. R18-7-204.B.2 and R18-7-204.B.3. The Town requests that EPA revise its calculations of potential risk to incorporate the calculated results from the revised version of the EPA IEUBK model (May 2021; IEUBK win ver. 2.0) and discard any conflicting results that might have been calculated using the aged version of the model.

EPA Response:

The risk-based calculations that resulted in the residential soil lead PRG of 197 mg/kg presented in the Proposed Plan, and the corresponding updated lead risk assessment in the 2022 FS Report (Tetra Tech, 2022), are consistent with the latest version of EPA's Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK)(version 2.0, USEPA 2021), and are not based on an 'antiquated' or 'archaic' version of the model.

The lead risk assessment in the HHRA presented in the RI applied the USEPA (2009) IEUBK model version 1.1. As noted in USEPA (2021), the 2021 version of the IEUBK model differs from the 2009 version primarily with respect to updated exposure factors based on newer information about the United States population lead exposure; however, both model versions share the same algorithmic approach. The FS lead risk assessment referenced the IEUBK version 1.1, but incorporated factors from the IEUBK model version 2.0 (USEPA, 2021). These updated factors included a more recent Centers for Disease Control recommended blood lead reference value of 5 µg/dL, and the adjustment of estimated soil/dust ingestion rates, which were an average of 65% lower than the values for the 0-to-84 month age range of the child receptor evaluated with IEUBK version 1.1. The residential lead PRG of 197 mg/kg presented in the Proposed Plan was derived from the updated lead risk assessment in the 2022 FS. This is essentially the same as a residential lead acceptable soil concentration that would be calculated with the more recent IEUBK version 2.0. The *residential soil lead PRG presented in the Proposed Plan is thus consistent with more recent child lead modeling methodology and protective of human health. Therefore, there is no need to update the residential soil lead cleanup level that is based on the IEUBK model.*

C.23. Comment:

The superposition of multiple contaminants (arsenic and lead) and the exposure to multiple pathways (e.g., ingestion, adsorption, and inhalation) should help in evaluating the threat of risk to the Town community and the surrounding ecological setting. The Town therefore requests that EPA provide a definitive, site-specific analysis of the health risk associated with co-occurring arsenic and lead, involving factors that address the multiple exposure pathways, in the RAOC.

EPA Response:

The risk of exposure to co-occurring arsenic and lead are already addressed in the cleanup levels for these two COCs. EPA's risk assessment methodology is unique for lead (for technical reasons), and thus is different from and incompatible with the principle of additivity that can be used for arsenic and the other chemicals of potential concern that were evaluated in the RI risk assessment and FS. Thus, the noncancer hazard posed by lead cannot be added to the noncancer hazard posed by arsenic (or any other COCs). Please see *EPA Response to Comment D.29* *for further explanation.*

C.24. Comment:

Fugitive Dust Contamination: The Town understands that historic mine and smelter operations are known to emit significant quantities of fugitive dust over long periods of time. The release of dust from active mine operations, windblown dust from piles of tailings and mine waste, and the emissions from smelter operations are known to present a contaminant load that accumulates as an apron around these source areas. This apron has blanketed the Town of Humboldt proper and surrounding residential properties. EPA's assessment of "ambient air" quality from 2008 to 2009 provided very little in the way of useful or applicable data to assess this condition.

Fugitive dust deposition has a documented effect on metals concentrations in surface soils within this apron area. This impact has been incompletely characterized in terms of "soil characterization" and has not been adequately accounted for in EPA's calculations of Background Threshold Values for Arsenic in soils within the IKM-HS Superfund Site. These issues are detailed elsewhere in these Comments.

EPA Response:

We strongly disagree with some of the assertions in this comment. EPA has collected thousands of soil samples to characterize the Area of Potential Site Impact (APSI) to soils, which is largely defined by the range of the effect of aerial dispersion from the mine tailings as well as former smelter stack missions. Appendix E of the RI included an extensive analysis of the extent of the APSI based on robust evidence. As examples, despite site-related lead and arsenic being co-dispersed, lead levels decline to background levels east of Highway 69 within the APSI close to the smelter property

(See RI Appendix E). Stack emissions from the smelter would be expected to have greater concentrations of lead as opposed to arsenic, but lead levels decline significantly as soon as one proceeds east for even a short distance. The same is true for copper and zinc. Also, ratios of surface sample results and 1 foot depth sample results in undisturbed soils on the east side of the river reach a value of 1 within a normal range of statistical variability. This also is true for elevated levels of site contaminants, including arsenic, that do not extend beyond that already identified by EPA. In addition, EPA's revised background assessment performed a geochemical signature analysis on the mix of metals found east of the Agua Fria River to evaluate whether there may have been aerial deposition of metals into areas east of the Site and determined that geological differences rather than aerial deposition accounted for any geochemical signatures.

Because fugitive dust is an important mode of transport of contaminants from source areas, EPA has performed an extensive characterization of the potential effect of fugitive dust emissions through sampling. Air sampling was conducted to evaluate the potential for current exposure to airborne site contaminants, not to establish the pattern of historical aerial dispersion.

C.25. Comment:

There is clear indication at other mine and industrial sites that fugitive dust is associated with pollutant impact to surface soils, surface water, and groundwater due to secondary transport agents. This correlation has not been considered, much less investigated at the IKM-HS Superfund Site. The Town requests that EPA conduct a suitable expansion of its investigation of soil, surface water, and groundwater exposure point concentrations that incorporates these receptor exposure pathways in the final conceptual site model.

EPA Response:

The RI included extensive sampling of surface soils, surface water, and groundwater. These reveal the contamination present from any sources, including presumably fugitive dust, although surface water and groundwater are undoubtedly impacted largely by other factors such as erosion of tailings material. It is not clear from the comment why fugitive dust is identified as a secondary "exposure pathway". It is in concept a transport mechanism, but exposure would be to the medium itself, which has been sampled extensively.

C.26. Comment:

The Town understands that research was conducted at the Iron King Mine MTP that concluded that mine rock oxidation in the upper zone of tailings generates a considerable volume of arsenic residue that is prone to aerial dispersion. The Town does not understand why EPA did not sustain meteorological monitoring of wind currents and fugitive dust sampling at air-monitoring stations in the Superfund Site for more than one (1) year. The Town requests EPA's explanation on this matter. Further, the Town does not understand why EPA did not conduct any meaningful investigation of the distribution of fugitive dust across accessible areas of the IKM- HS Superfund Site and in buildings located in the wind-shadow of the Iron King Mine and Humboldt Smelter properties. The Town requests EPA's explanation on this matter.

EPA Response:
EPA does not agree that its air investigations were not "meaningful".

The ambient air monitoring that EPA conducted would have captured the typical wind-generation of particulates from surface soils and wastes in the area. Please refer to Section 4.2.6 of the RI for a complete description of the air sampling effort and how it relates to the conceptual site model for risk to human health. In general, the historical airborne fugitive dust transport mechanism manifests in surface soil. While it is true that wind patterns can vary over the course of years, there were limits to how long such monitoring could be conducted. In principle, there would always be yet another year where such patterns could vary. It would not be practical to perform an essentially academic study of the climactic wind patterns in the Dewey-Humboldt area. EPA sampled air quality to assess current air exposures over the course of a year and recognized that any cleanup would have to encapsulate and isolate waste to prevent future entrainment of wastes into the air.

C.27. Comment:
The Town requests that the history of fugitive dust deposition across occupied areas of the Site be investigated by conducting a rafter-dust survey of suitable, statistically defensible buildings, including residential houses, within the dust apron surrounding the recognized source areas (Iron King Mine and Humboldt Smelter properties).

EPA Response:
A rafter survey would not provide a characterization of significant health risks because people are not exposed regularly to attics/rafters. Access to building rafters, highly intermittent and very short term in nature, is not an activity modelled for inhalation, dermal, or ingestion in risk assessment which typically models long-term, frequent behavior. EPA does not agree that a rafter survey would be useful in selecting a cleanup that is designed to eliminate further fugitive dust of contaminated materials.

C.28. Comment:
The Town considers the residential and commercial parcels north-northeast of the mine and smelter source properties to be a specific site area that requires specific attention as a RAOC. As such, this RAOC has characterization requirements that are specific to the area. In accordance with removal actions already conducted by EPA at the IKM-HS Superfund Site, within the RAOCs remedial actions that are proposed as time-critical or non-time-critical removal actions or as part of the comprehensive final remedial design, must attend to criteria that differ from criteria assigned to the 31 AOCs defined by EPA in the FS.

EPA Response:
It is not clear from the comment why these areas on the east are specifically of special concern or how they have special characterization requirements, beyond the attention

being given and the characterization already performed. It is not clear what the commenter intends with regard to differing criteria. It is not clear specifically what areas are being referred to in the comment.

EPA has collected thousands of samples in residential and commercial areas north of the mine and in residential areas north of the smelter. To refine understanding and remediation scope in areas north and northeast of the mine, EPA is currently performing additional sampling in accordance with reasonably anticipated future land uses. On the smelter side, the RI has identified the extent of Site contamination into residential areas to the northeast. As previously discussed, EPA has used results from thousands of soil samples to characterize the Area of Potential Site Impact (APSI) to soils, which is largely defined by the range of the effect of aerial dispersion from the mine tailings as well as former smelter stack emissions. Appendix E of the RI included an extensive analysis of the APSI based on robust evidence. See *EPA Response to Comment C.24* *for more details.*

C.29. Comment:

The Town requests that EPA incorporate a comprehensive characterization of fugitive dust dispersion throughout the residential and commercial community of properties that are located adjacent to the source areas (i.e., AOCs defined in the FS). The Town believes that the distribution of residual dust from primary (i.e., Iron King Mine and Humboldt Smelter) and secondary (e.g., redistributed tailings and waste rock) source areas has had a significant impact on the concentration of metals in surface and, by vadose transmission, subsurface soils.

EPA Response:

EPA has extensively sampled surface soils to characterize concentrations of the broad study area of the Site, which includes residential areas adjacent to AOCs that will be remediated under the Record of Decision. This includes characterization of fugitive dust that has manifested in surrounding soils historically. The selected alternative will prevent future fugitive dust release from the remediate AOCs to adjacent properties so that future risks will be mitigated.

C.30. Comment:

Understanding that the shallow aquifer setting is located at approximately 30 feet below ground surface in alluvial sediments, the Town requests that EPA conduct an assessment of arsenic and lead to demonstrate that the concentrations of these metals, remaining at depth, are protective of groundwater quality in conformance with A.A.C. R18-11-405 and responsive to the requirements of A.A.C. R18-7-203.B.1, which is an ARAR.

EPA Response:

This comment is not clear. Does this refer to soils 30 feet down? Or to groundwater contamination subject to contamination by leaching? Concentrations are referred to, but it does not say concentrations of what and where, therefore, EPA is not able to provide a substantive answer. EPA is addressing the waste and other contamination that could result in groundwater contamination and will be collecting more data and *performing more analysis in its final remedy for groundwater. The current provisions in this ROD for groundwater are interim in nature.*

C.31. Comment:

The Town is aware of Dr. Speyer's assessment regarding rafter-dust sampling and understands that there is a possible correlation between dust deposition and metals contamination of surface soil, subsurface soil, and groundwater. The Town requests that EPA conduct an appropriate rafter-dust sampling of the populated areas of the Superfund Site in order to assess the significance of this impact so that the distribution of contamination may be more completely understood and appropriate removal actions and ICs might be implemented. The Town requests that any such sampling plans or sampling activities be communicated to and coordinated with the Town's Advisory Board.

EPA Response:

See EPA Response to Comment C.27 regarding a rafter survey. The distribution of contamination has been investigated with approximately thousands of soil samples, including more than 5000 surface soil samples in residential areas and more than 250 samples in background areas.

C.32. Comment:

EPA indicated in the PRAP and again in its March 29, 2023 public hearing that additional soil sampling and follow-up soil removal actions are being considered. The Town requests that any actions planned and implemented by EPA to complete its characterization of the IKM-HS Superfund Site include provision for appropriate review and comment by the Town.

EPA Response:

Because of the lower cleanup levels selected in this ROD, additional residential properties may require cleanup. EPA will be collecting additional soil sampling in residential areas to refine which properties will require remediation. EPA will inform and coordinate with the Town on these activities, and the Town may give input to the process.

C.33. Comment:

The AOCs recognized in the FS report do not account for the extended history of redistribution of waste rock and tailings from the Iron King Mine and Humboldt Smelter properties to serve as road base and to provide foundation for structures, or from stormwater run-off within the boundaries of the IKM-HS Superfund Site. In many cases, these materials are left to surface degradation and represent an on-going source of contaminants that may be transported as fugitive dust and with surface water run-off following storm events. …The Town believes that it is unreasonable to expect that institutional controls will be sufficient to contain or control the exposure pathways associated with these occurrences (e.g., inhalation during a dust storm, surface water run-off leading to the Agua Fria River), unless EPA sets aside Superfund money for the Town to use in addressing such matters in administering its expected institutional control ordinances.

EPA Response:
EPA acknowledges based on past input from Town residents that tailings may have been used as fill or as base in the past. This has been particularly difficult to address directly because there is no information available as to where this may have occurred. EPA has conducted and continues to conduct extensive sampling to identify and address areas of contamination. Inhalation during a dust storm should not be a factor if the tailings remain buried (and presumably unidentified). Likewise, discharges to the Agua Fria River from road base is highly unlikely.

While the Agency is not in a position to offer funds for the Town to carry out its usual governmental functions, EPA can coordinate with the town on development and implementation of appropriate institutional controls.

C.34. Comment:
Adjacency of properties with differing cleanup standards results in contaminant drift due to surface water runoff from higher to lower elevation, and aerial dispersion of surface dust due to prevailing winds. The Town therefore requests that EPA provide provisions in the ROD that the Town may rely on to address this problem now and in the future under the Town's contemplated institutional controls program.

EPA Response:
Please see EPA Response to Comment C.12 regarding different cleanup standards. Properties will be addressed to the appropriate standard.

C.35. Comment:
The Town would like to assure community landowners with property within the IKM-HS Superfund Site that the condition of their land is warranted clean in accordance with the ROD. The Town requests that EPA advise what assurances can be provided to affected residential and commercial landowners that their properties are established as "clean and compliant" with the final remedy, once the remedy is confirmed completed.

EPA Response:
It is understood why landowners would want such assurances. EPA is willing to work with the Town on this concern. As outlined in the Proposed Plan, EPA will provide documentation to landowners that cleanup actions removed contaminated surface soils from yards and replaced with clean soil where exposure point concentrations of lead and arsenic exceeded cleanup levels. EPA will publish a Remedial Action cleanup report that documents the information for the cleanup on all properties.

C.36. Comment:
EPA recognizes that groundwater conditions are not adequately understood at the IKM-HS Superfund Site. The Town understands EPA's tight timeframe for securing Bipartisan Infrastructure Law funding for the final site remedy but is also sensitive to the NCP requirements for a complete site characterization and a final remedy that that is fully protective of human health and the environment, especially in regard to groundwater conditions for a community that relies heavily on groundwater resources as a source of

drinking water. The Town therefore requests that any actions planned and implemented by EPA to complete its characterization of the IKM-HS Superfund Site include provisions for appropriate review and comment by the Town.

EPA Response:
Provisions in the ROD for groundwater are interim. Additional groundwater monitoring wells and data collection are envisioned before EPA selects a final remedy for groundwater. EPA will inform and coordinate with the Town on these activities and the Town may give input to the process.

C.37. Comment:
The RI and FS reports represent the majority of 64 privately-owned wells that were included in the investigation of groundwater conditions with identifiers that are not correlated to ADWR 55-Series well registration numbers. The Town requests that all wells involved in EPA's analysis of groundwater be (i) properly registered with the ADWR, (ii) represented according to the ADWR 55-Series registration number, and (iii) be tabulated with available file data so that additional clarity regarding total depth, well construction, well water use, and age, as available, may be easily accessible.

EPA Response:
The Groundwater Permitting and Wells section of the Arizona Department of Water Resources (https://new.azwater.gov/permitting-wells) at (602) 771-8527 indicated that wells installed prior to 1980 are not included in the "Wells 55" database. In order to be included, private well owners of wells installed prior to 1980 would need to submit a "Late Registration" form. The form and information cannot be uploaded to the "Wells 55" database without the owner's consent and signature. Neither EPA nor the State of Arizona could unilaterally compel owners of private wells to do this.

C.38. Comment:
EPA has provided groundwater quality data for numerous wells within and outside the boundary of the IKM-HS Superfund Site. The Town believes that EPA should group available groundwater data in a way that addresses the two (2) populations of data, deep and shallow aquifer settings, so that these aquifer settings can be adequately and independently characterized. Once these datasets have been appropriately analyzed and shallow (cf. alluvium) and deep (cf. bedrock) aquifer settings are appropriately characterized with respect to groundwater quality parameters, including metals, it should be possible to construct efficient models that evaluate the relationship between shallow deep aquifer settings.

EPA Response:
While the hydrogeology of the Site is complex – there are not uniformly a shallow and deep regime across the entire site which would make modeling very intricate – EPA could discuss these ideas in setting plans for future acquisition of groundwater data prior to selecting a final groundwater action. The measures in the ROD for groundwater are interim.

C.39. Comment:

The Town believes that EPA has not provided an established, applicable sense of background groundwater quality for the IKM-HS Superfund Site. EPA's assessment of "background" conditions suffers from (i) mixed data from shallow and deep aquifer settings, (ii) lack of necessary geographic resolution as relates to separate watershed areas for shallow aquifer settings, and (iii) inadequate or miss-applied analytics. The Town believes that EPA should more thoroughly and convincingly demonstrate why Arizona Aquifer Water Quality Standards (AWQS) for mine waste- related contaminants are not applicable.

EPA Response:

EPA has acknowledged that additional groundwater data and analysis will be needed to select a final remedy for groundwater. Provisions in this ROD for groundwater are interim. EPA has not determined standards for groundwater cleanup at this time. Additional data collected may include additional monitoring well installations and other analyses to be determined later and after this ROD is issued.

C.40. Comment:

The Town requests that EPA's characterization of groundwater conditions at the IKM-HS Superfund Site be revisited with (i) rigorous attention, (ii) additional groundwater monitoring well installations, (iii) site-specific data management, (iv) focused analytics, and (v) appropriate modeling.

EPA Response:

Please see EPA Response to Comment C.39.

C.41. Comment:

The Town requests EPA to provide an on-going monitoring program that is focused on groundwater monitoring wells that are strategically located to provide critical data without direct reliance on landowner wells or service wells located in the IKM-HS Superfund Site. The monitoring program should provide groundwater elevation and quality data that provide an active and affirmative understanding of the status of groundwater quality and provide a basis on which changes may be diagnosed and, as necessary, addressed.

EPA Response:

Please see EPA Response to Comment C.39. EPA anticipates developing a groundwater monitoring program of the type described in the comment.

C.42. Comment:

The Town believes that no less than an additional 15 groundwater monitoring wells and as many as 25 such wells are necessary to adequately resolve the inadequacies of EPA's current groundwater characterization study. In addition, the Town is concerned that, based on Superfund site work elsewhere, groundwater contamination in residential areas of the IKM-HS Superfund Site may be due to the downward dispersion of metals, including arsenic and lead, from surface fugitive dust deposits through vadose soils to the shallow, alluvial groundwater. The Town requests that staged soil samples, collected from boreholes drilled during the process of installing the 15 to 25 additional groundwater monitoring wells, should be collected and analyzed according to Priority Pollutant Metals (EPA Method 6010/6020), which includes arsenic, lead, and beryllium. These soil samples can be applied to develop informative diffusion models to assess the impact of fugitive dust on shallow groundwater quality and, thus, provide a more comprehensive and meaningful characterization of groundwater conditions across the entire IKM-HS Superfund Site, including the most sensitive potential receptors, namely children.

EPA Response:
Please see [*EPA Response to Comment C.39*]*. It is not clear how dry fugitive dust at the ground surface would be related to groundwater contamination and samples from deep underground. EPA will determine what kinds of modeling, if any, and how many additional monitoring wells are appropriate for groundwater after the issuance of this ROD.*

C.43. Comment:
To date, EPA has defined 31 AOCs and recognizes nine (9) separate remediation standards, as presented in the FS and summarized in the PRAP, and as indicated above intends to conduct further characterization work and potential remedial or removal action(s). The Town and its residents find EPA's management of its response actions at the IKM-HS Superfund Site confusing, particularly when EPA is proposing a "final remedy" on the one hand and suggesting additional work for soils and groundwater on the other hand.

EPA Response:
EPA can appreciate that some aspects of the Superfund process can be confusing. First, the remedy is only "final" with respect to the waste/source areas and the residential properties. It is interim with respect to groundwater, which means that additional groundwater characterization work will take place prior to selecting the remedy for groundwater. Second, the remedy selection process that culminates with this ROD only selects the alternative that will be designed, fleshed out and implemented. It does not preclude the collection of more samples or information for use in designing the remedy. For example, we know that additional cleanup in residential areas will be performed and what it will entail, but we need more data to identify exactly which properties (and where in those properties) may need remediation. Groundwater provisions in this ROD are not considered final, but rather are interim pending additional information.

C.44. Comment:
…The Town therefore requests that the 31 AOCs be categorized in the context of an expanded definition of AOCs that includes provisions for (i) residential properties (cf. RAOC), (ii) environmental media of vital concern regarding receptor exposure, and (iii) established primary and secondary source areas (e.g., majority of AOCs defined in the FS report).

EPA Response:
As discussed in response to earlier comments such as in [*EPA Response to Comment C.14*]*, EPA agrees that existing residential areas are an AOC. While this is explicit in*

the Proposed Plan (the proposal includes a cleanup action in those areas), the 31 AOCs in the FS did not include existing residential areas. The ROD has identified residential areas as an additional AOC to avoid confusion.

Beyond this, the comment is not clear. EPA does not understand the expanded definition of AOC requested in the comment, with provisions for "…environmental media of vital concern" or "established primary and secondary source areas". EPA's AOCs already have been sampled and characterized for media of concern and source areas. EPA does not conclude that additional or expanded AOCs are necessary at this time.

C.45. Comment:

To date, EPA has established only one (1) OU at the IKM-HS Superfund Site. The Town believes that additional OUs should be identified and defined so that all involved parties have a reasonable framework within which remedial work planning, progress, and completion may be tracked and communicated and therefore requests such an adjustment in EPA's management of the IKM-HS Superfund Site. The… Town recommends that at least four (4) Operable Units be established at the IKM-HS Superfund Site, as follows:

OU 1 | Iron King Mine and Humboldt Smelter (Repository 1 and 2)
OU 2 | Groundwater
OU 3 | Soils, including Residential Properties
OU 4 | Surface Water & Sediments

EPA Response:

It would not be appropriate to create separate operable units (OUs) at the Site at this time. A brief discussion of the concept of operable units is in order. EPA can divide the remedy selection and implementation process into discrete actions that each contribute to the overall protectiveness of a site. Each operable unit, however, usually requires its own investigation, feasibility study, and ROD. Separate OUs are especially useful when one area or medium of a site can be addressed independently and much sooner than other areas (i.e., breaking out an operable unit would allow cleanup to proceed in that area while the areas requiring more time are addressed in another operable unit.)

However, in this case, the existing investigation and feasibility study already covered soils (including residential as well as non-residential), the mine, the smelter, surface water, and sediments. It would be extremely duplicative, inefficient and cause needless additional delays to perform separate investigations, feasibility studies and RODs for all these areas. Only groundwater in this case is interim in nature, and EPA will decide whether to create a groundwater OU at a later date. There are options for proceeding other than creating a groundwater OU.

C.46. Comment:

The RI and FS state and have demonstrated, based on analytics of the data that EPA has compiled, that soil and groundwater conditions in the IKM-HS Superfund Site areas that are located east of the Agua Fria River are distinct from and do not correlate to background conditions that characterize soil and groundwater that occur west of the Agua Fria River. Mixing data from these areas is not consistent with the recognition of "site-specific" criteria and does not honor the intent of applicable ARARs, including Article 2 of A.A.C. R18-7. These areas should be recognized as distinct and treated separately in terms of remedial standards that are identified in the ROD and implemented in the final remedial design.

EPA Response:
See EPA Response to Comment C.6 and EPA Response to Comment D.20. It is noted that EPA has divided the background population east and west of the river and calculated revised BTVs accordingly. However, EPA does not agree that the analysis performed as discussed in EPA Response to Comment C.6 is not site-specific nor that particular data should be removed from east of the river. See comments cited.

C.47. Comment:
The concentrations of arsenic and lead in soils on properties that are located east of the Agua Fria River indicate that the east and northeast boundary of the IKM-HS Superfund Site might not include all properties impacted by recognized source areas in the IKM-HS Superfund Site. This means that the overall boundary of the IKM-HS Superfund Site has not been adequately resolved and, therefore, may need to be expanded. Existing data may be supplemented with a statistically defensible analysis of building rafter-dust data from buildings across the IKM-HS Superfund Site and in bordering areas. The Town believes that this expansion is necessary to address critical NCP requirements and make an affirmative and lasting statement regarding the boundary of the IKM-HS Superfund Site.

EPA Response:
We disagree that the boundary of the Site needs to be expanded to the east. It has been confirmed that the higher levels of arsenic on the east side of the river are due to geologic differences. The derivation of the area of potential site impact around the site was defined in Appendix E of the RI. This area is established based on sound data and robust evidence. See EPA Response to Comment C.24. Regarding a rafter survey, please see EPA Response to Comment C.27.

For further response detail, see EPA Response to Comment A.13.

D. EPA RESPONSES TO "TOWN OF DEWEY-HUMBOLDT COMMENT PACKAGE: TECHNICAL MEMORANDUM: TECHNICAL REVIEW & FINDINGS, USEPA FEASIBILITY STUDY, IKMHS SUPERFUND SITE, MAY 28, 2023"

D.1. Comment:

USEPA's protracted attention to conditions at the IKMHS Superfund Site has sustained a negative perception among residents, the Town Council, and community at large. There is a general belief that USEPA is ignoring certain chemicals and down-playing the significance of others. Table 1 was reduced from information provided in the RI and adopted in the FS. Six (6) metals, air sample data for which were graphically presented in the RI, exceeded corresponding Screening Levels at, at least one (1) sampling location in the Superfund Site but were not listed as COIs.

EPA Response:

EPA understands that it has taken a long time to address the non-residential portions of the Site, however three removal actions have been undertaken by EPA to address the highest concentrations of contaminants in residential areas. For complex sites like this one, a lengthy and exacting legally required process must be followed to ensure sites are thoroughly and adequately assesses and cleaned up. Due to the many areas and environments with contamination, extensive investigations in all these areas have been necessary.

The Site has been investigated for a wide variety of metals and chemicals other than arsenic and lead. Section 7.0 of the RI includes a full discussion of the nature and extent of contamination at the Site. For example, thousands of soil samples were analyzed for a standard suite of metals and metalloids including aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc. Samples have also been analyzed at the smelter for polycyclic aromatic hydrocarbons and dioxins/furans. Groundwater has also been sampled for nitrate, chloride, sulfate, and total dissolved solids. All of these have been considered and evaluated by EPA.

The focus on arsenic and lead is because these two metals account for the vast majority of the potential health risks associated with the Site.

Without more information, it is not possible to verify the air sample data comment above.

D.2. Comment:

Our review of sample location maps indicate that sampling plans varied, sometimes greatly, among the several iterations of sampling that were conducted in the residential areas of the Superfund Site. Some parcels were grided and samples were collected at all nodes. In other parcels, sometimes in the same report, sample locations were purposefully selected and clustered in areas of presumed contamination. These datasets cannot be combined with any reasonable expectations of achieving a coherent analytical base. Deterministic sampling (i.e., selecting sample locations based on pre-design or professional insight) precludes any meaningful data reduction and application of statistical calculations to characterize appropriate EPCs or calculate adequate PRGs.

EPA Response:
It is not uncommon for sampling plans to vary over time as multiple sampling efforts are developed based on expanding knowledge of the site. However, EPA did not dramatically change the residential sampling approach between the 2009 sampling and the 2012-2013 sampling. Ten to 20 samples were collected from each residential property depending on its size and sample locations were largely random. If there were areas likely to be occupied more frequently, such as children's play areas, a slightly greater density of samples was selected for those locations. EPA does not agree that these differences invalidate the results of the thousands of samples collected in residential areas or that the exposure point concentrations are compromised.

D.3. Comment:
The gross number of soil samples collected (9,478, as reported in the FS), primarily in residential areas of the Superfund Site, provides a buffer to the effects of sampling bias on statistical calculations. A discrete data-gap analysis as part of assessing DQOs is recommended.

EPA Response:
The nature and scope of the data gap analysis referred to is not clear, so it is difficult to respond to the comment.

D.4. Comment:
The data are fundamentally flawed despite the presentation of minimum and maximum values for metals in fugitive dust at each of the four (4) areas. The four (4) areas are incompletely diagnosed, not consistently represented in the dataset, and do not provide adequate, affirmative characterization of the areas with respect to ambient air conditions. The Iron King Mine station, where a complete set of data for the entire year was compiled, is a possible exception and provide a discrete, though limited estimate of seasonal variations.

EPA Response:
The comment is not clear. EPA does not agree that the data are flawed. The comment uses phrases such as "incompletely diagnosed," "affirmative characterization," and "areas not consistently represented in the dataset" without any substantiation or clarity.

D.5. Comment:
Data tabulated in the RI show clear indication that fugitive dust is activated at the Iron King Mine and the Humboldt Smelter locations. What it does not show is the dispersal or destination of this dust. Additional down-gradient sample locations, situated between the known source with an anticipated elevated concentration of metals, including As and Pb, and the Town and residential areas of the Site would have assisted in refining the Conceptual Site

Model (CSM). Standard air sampling stations should have been set at additional, strategic locations across the Site, with a specific emphasis on Town and Community locations. Each of these stations should have been sampled on a consistent, periodic basis over the course of the entire eight (8) years that USEPA has been engaged with this Site leading up to the 2016 release of the RI. Likewise wind current data should have been compiled from historic sources, such as are available from sources that maintain data at a station located in Prescott Valley. These data, in concert, may have provided sufficient foundation to make statements regarding the EPC of fugitive metals in residential areas of the Superfund Site.

EPA Response:
Please refer to Section 4.2.6 of the RI for a complete description of the air sampling effort and how it relates to the conceptual model for risk to human health.

EPA conducted sampling of ambient air to assess current airborne exposures over the course of a year and determined that there were not unacceptable risks. While fugitive dust occurs at the Site, the levels of contaminants at the sensors were low. The ambient air monitoring that EPA conducted captured the typical wind-generation of particulates from surface soils and wastes in the area. The extensive soil sampling in the RI shows the fallout pattern of the aerial dispersion of dust. In general, a past airborne fugitive dust transport mechanism manifests in surface soil. EPA did not perform an academic study of the historical climactic wind patterns in the Dewey-Humboldt area.

D.6. Comment:
Speyer recommends that an adequate random sampling (defined here as rendering an appropriate set of data that is representative of the "true" population) be conducted to quantitatively assess the distribution of fugitive dust residues in the rafters of buildings that are located in proximity to known source of contamination.… The results of implementing the "Rafter Dust" SAP should be used in concert with the 2008 to 2009 data to evaluate critical differences and, as appropriate and applicable, with soils data for areas where building rafter data are available...

EPA Response:
See EPA Response to Comment C.27 regarding rafter survey. EPA does not believe that a rafter survey is indicated. It is not clear what additional "exposure pathways" the comment refers to.

D.7. Comment:
Arsenic (As) is recognized as the most widespread, prolific, and risk-sensitive of the COCs at this Superfund Site. This challenge is compounded by a very low EPA Screening Level, a presence in each of the primary environmental media, and a known background presence in natural settings.

Arsenic is a carcinogen with a SL that is less than 1 mg/Kg in soil (0.68 mg/Kg).

***EPA Response**:*
At the Site, as in many locations in the western US and around the country, natural background concentrations of arsenic in soil are greater than the EPA Residential Regional Screening Level (RSL). Under Superfund guidance, cleanup levels should not be established below background levels. The establishment of soil arsenic background concentrations for the Site is addressed in EPA Response to Comment C.6.

EPA notes that the cancer RSL for arsenic in residential soil, which corresponds to a 10^{-6} risk value, is not 0.68 mg/kg at this Site but 1.5 mg/kg. This is because, while the default assumed bioavailability by way of ingestion is 60%, there are site-specific in-vivo and in-vitro bioavailability data that lead to a predicted relative bioavailability of only 22.5%.

D.8. Comment:
Arizona promulgated a 10 mg/kg threshold for Residential (rSRL) and Non- Residential (nrSRL) Soil Remediation Levels (SRLs). This allowance is based on general State-wide background conditions and, justifiably, ignores the federal health-based guidelines.

EPA Response:
See EPA Response to Comment C.5 for a detailed response. Importantly, unlike other Arizona RSLs, 10 mg/kg is not a risk-based number. This is unique to arsenic. Cleanup to this number is not required by the state unless remediating parties choose to omit risk assessments and background assessments.

D.9. Comment:
As discussed above (Section A), USEPA contractors, over the period of 2006 to 2013, sampled soils in residential areas of the Superfund Site and conducted removal actions with very different target values for Arsenic and Lead (see Table 2). Target concentrations calculated by CH2M-Hill (2016) and Tetra Tech (2022), likewise, do not match previous remedial actions. These inconsistencies present additional challenges to completing a comprehensive remediation that includes all AOCs as well as residential and Town properties.

EPA Response:
See EPA Response to Comment C.12. Please note that the actions conducted by EPA in 2011 and 2017 were removal, not remedial actions.

D.10. Comment:
CH2M-Hill (2016; Appendix E) and Tetra Tech (2022; Appendix C-6) present determinations of a Background Threshold Value (BTV) for Arsenic based on data from samples collected outside the boundaries of the Superfund Site. Tetra Tech uses the CH2M-Hill dataset and applies a different statistical protocol, including data clusters, Voronoi tessellation, and a staged calculation of the 95% Upper Confidence Limit (UCL) that rejects ProUCL based on an algorithm inability to apply clustered data. CH2M -Hill calculated a

BTV for Arsenic of 112 mg/Kg. Tetra Tech calculated a BTV that is 92 mg/Kg based on the same dataset consisting of 269 data.

EPA Response:
See EPA Response to Comment C.6 for discussion about EPA's recent revised background derivation.

D.11. Comment:
Arizona Administrative Code (AAC) R18-7-203 states that remediation of contamination must address one of three (3) methods for determining acceptable cleanup target values.

AAC R18-7-204 includes provisions for determining a target concentration standard for remediation based on background concentrations of the chemical. This is a State ARAR with specific criteria that must be satisfied for acceptable implementation.

Site-specific historical information concerning land use.

Site-specific sampling of soils not affected by a release, but with characteristics similar to those affected by the release.

Statistical analysis of background concentrations using the 95% upper confidence limit.

Tetra Tech's determination of a BTV for Arsenic appears to address these requirements but does not adequately incorporate site-specific criteria pursuant to R18-7-204(B)2.

EPA Response:
See EPA Response to Comment C.5. See EPA Response to Comment C.6 for general discussion about background derivation and selection of residential soil arsenic cleanup values.

Please note that EPA has determined in the ROD that AAC R18-7-204 is not an ARAR, but rather a To-Be-Considered criterion.

The comment misquotes AAC R18-7-204.B.3. It does not say "the 95% upper confidence limit" but rather "the 95th percentile upper confidence limit."

In addition to EPA Response to Comment C.5, we note that the comment misinterprets AAC R18-7-204.B. Background soil sampling was conducted in a wide area around the impacted area, taking site-specific characteristics into account. Soil type and location (east or west of the Agua Fria River and in various soil types) is site-specific historical information. Please see EPA Response to Comment D.20 regarding the use of the soil mappings such as Balon and why EPA's background assessment is site-specific.

D.12. Comment:

A dataset comprising 269 data for the "local" background concentration of Arsenic was compiled over the course of USEPA investigations at the Superfund Site. Samples were collected during three (3) events and consisted of one (1) collected by ADEQ in 2002- 2004, nine (9) were collected by EA Engineering, Science & Technology, Inc. (EA) in 2010, and 259 data collected by CH2M in 2012-2013. These soil samples were collected under differing SAP criteria (whether these were recorded or not) and are potentially incompatible with the objective of the analysis.

EPA Response:

It is very common at environmental remediation sites, especially at Superfund sites, for data to have been collected in multiple sampling events. Each of these sampling events may have a slightly different strategy and purpose. Early sampling is to assess the degree of immediate hazard to help determine the need for an emergency action. Remedial sampling events are designed to gain a more complete understanding of the site and background and to fill in "data gaps." Data gaps identified in one phase of the investigation may lead to additional sampling in subsequent phases. Differing objectives and use of different contractors still provides accurate and definitive data to be used for Site evaluation and background determination. An accepted method to address this and to use data combined from different phases of site investigation is to use statistical declustering, which involves the use of declustering weights to compute statistics of interest. EPA guidance supports the use of declustering, including in assessing background values for chemicals. See EPA 540-R-01-003, Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites at page 3-14.

D.13. Comment:

Soil sample locations were recorded and categorized according to the distribution of native soils and location with respect to the Agua Fria River (East or West). These are reasonable and worthwhile characteristics and serve the intent of R18- 7-204(B)2. Specific comparisons of data subsets are presented in Attachment 1 to this memorandum. Tetra Tech disregarded these categories and combined the data to calculate a single BTV for all applications across the entire Superfund Site (see Attachment 1.1).

EPA Response:

EPA has reevaluated BTVs of arsenic in surface soils at the Site and is using two BTVs. See EPA Response to Comment C.6.

D.14. Comment:

Tetra Tech introduced an unacceptable bias into the calculation of an applicable BTV by transforming the raw concentration data into weighted values that are based on a Voronoi Tessellation protocol. This bias was introduced by weighting of the significance of concentration values in the calculation according to tessellated polygon area. The greater that area translates into the greater the significance of the datum representing that area. The ad hoc weighting of data values imposes an unacceptable bias that arbitrarily exaggerates or minimizes datum significance based on sample density. Consequently, sparsely distributed data have greater significance than closely spaced sample data. The decision to apply raw data is defensible based on the broad range of sample locations that are organized according to soil type and location with respect to the Agua Fria River.

EPA Response:
EPA used a somewhat modified approach to weighting in its revision to the BTVs than was used in the Tetra Tech evaluation on which the comment was based, as discussed in EPA Response to Comment C.6 and Appendix C to this ROD, regarding EPA's revised background derivation. EPA also used an expanded data set in its revised analysis.

However, EPA disagrees with this assessment that the Voronoi Tessellation was inappropriate and introduced bias.

Computing weighted statistics with de-clustering weights is a recognized and appropriate means of obtaining unbiased estimates from sampling designs that are based on unequal probability sampling. Sampling designs using unequal selection probability have a long history (since at least the 1950s) in natural resource estimation. Appropriate statistical methods, such as Horvitz-Thompson estimation, have been developed to produce unbiased estimates from data collected through unequal probability sampling by weighting the observed data inversely proportional to the probability of selecting the location at which the observation was made (sample collected).

In the original arsenic background analysis, the purpose of applying the Voronoi Tessellation was to account for the samples co-located/spatially clustered that were present in the dataset. As stated in Section 3.3.3 of the Technical Memorandum, this approach can reduce the effects of higher concentration areas/clusters relative to other background measurements in the dataset and intends to reduce bias in background calculations. The data were not standardized and were used as-is. In the revised arsenic background calculation, equal weighting was applied to each distinct sampling location to avoid bias. Because there are multiple samples/arsenic values collected at the same locations, equal weighting was applied to the samples by dividing by the number of measurements at the location.

Voronoi Tessellation of a set of points constructs a polygon around each point such that all the locations within the polygon are closer to the enclosed point than to any other. Since points that are closer together have smaller Voronoi polygons, the reciprocal of the areas of the Voronoi polygons gives an estimate of the spatial sampling intensity function, which is proportional to the probability of selection for any given location. Horvitz-Thompson estimation weights by the inverse of the location selection probability, which is approximated by weighting by the area of the Voronoi polygons. Voronoi polygon weights are used to reduce the effects of spatial clustering in environmental data.

Another way to look at this weighting is to view each sample location as representing the locations within its Voronoi polygon (that is, all the locations that are closest to the sample locations. Weighting based on Voronoi polygon areas is more appropriate than using equal weighting for the data in computing statistics.

The context text around this comment within the submitted comment document implies that ProUCL should have been used. The decision to not use ProUCL in this case was entirely appropriate, because spatial declustering was needed to address the fact that the data were in part spatially clustered.

D.15. Comment:

Tetra Tech cited a standard USEPA guidance document to calculate outliers (USEPA, 2002) in the Background Arsenic dataset but failed to apply the results of the calculation in refining the dataset for calculating a 95% UCL. Although the USEPA guidance calculation identified eight (8) outliers, only four (4) "extreme outliers" were removed by Tetra Tech from the dataset prior to completing their calculations. Tetra Tech removed four (4) obvious outliers ("extreme") from the BTV dataset and ignored four (4) additional data that were identified by the EPA guidance calculation (USEPA, 2002). These additional four (4) values have significant impact on the data.

EPA Response:

See EPA Response to Comment C.19 regarding outliers.

D.16. Comment:

Tetra Tech stated that a 95% UCL was calculated. The result of this calculation, 92 mg/Kg, was applied as the single BTV across all areas of the Superfund Site as a conservative target concentration applicable to residential exposure situations. This value is the basis for Preliminary Remediation Goals (PRGs) presented in the FS for all AOCs, including residential, and commercial properties within the boundaries of the Superfund Site (see Table 3). This determination does not address the requirement to demonstrate site-specific applicability.

EPA Response:

See responses to many similar comments. Please note that EPA has modified its background derivation and residential cleanup values; see EPA Response to Comment C.6. Exposure point concentrations were calculated as 95% upper confidence limits. Background threshold values were calculated at 95-95 upper threshold values. EPA did not assign 92 mg/kg as a cleanup level for industrial/commercial properties within the Site.

The arsenic background database includes background measurements collected as a part of the RI and during scoping for background areas in the vicinity of the Site. We disagree with the assertion that the background analysis is not site-specific. To the extent that this comment refers again to numerous previous comments about the soil mappings and whether certain mappings are site-specific, see EPA Response to Comment D.20 for a lengthy discussion.

D.17. Comment:

For reasons not explored by Tetra Tech, all eight (8) outliers, including the four (4) removed as "extreme outliers" and the four (4) that were retained despite the guidance calculation, occur at sample locations that are east of the Agua Fria River (see Attachments 1.2 & 1.4).

EPA Response:

See EPA Response to Comment C.19 regarding outliers. In EPA's revised assessment of background as discussed in the EPA Response to Comment C.6. Outliers were removed from the database with a more conservative approach, which intends to be more representative of reasonable expectations for variability in background present in these types of datasets. In the updated arsenic background analysis, discussed in EPA Response to Comment C.6, 14 outliers are removed from the database from three individual sampling locations that exceed 270 mg/kg for arsenic. An updated index plot included in the Revised Technical Memorandum attached to the ROD identifies these outliers that are removed from the updated arsenic BTV calculations.

D.18. Comment:

There is a difference between a 95% upper confidence limit (UCL) and a 95% upper confidence internal (UCI). AAC R18-7-204 requires, specifically, calculation of the "upper confidence limit."

EPA Response:

Please note that EPA has determined in the ROD that AAC R18-7-204 is not an ARAR, but rather a To-Be-Considered criterion.

Please refer to prior comment responses regarding the distinction between the UTL95-95 Upper Threshold Limit (UTL) and the 95% Upper Confidence Limit on the Mean (UCL95). These values are different and are recommended by USEPA for different purposes--for example, UCL95 is typically recommended for estimating the exposure point concentration for a contaminant at a site. ProUCL can calculate both the upper confidence limit and the upper tolerance limit for background datasets using different distributions identified by goodness of fit. USEPA RAGS guidance and ProUCL guidance recommend calculation of the UTL95-95 for the BTV. The confidence interval for a dataset is a statistical measure that is not applied in BTV calculations because the background limit is, fundamentally, intended to represent a threshold and not a range of likely values.

AAC R18-7-204 discusses use of the "95th percentile upper confidence limit." This refers to a "percentile", not "percent."

D.19. Comment:

Tetra Tech's Table 1 (Appendix C-6) is incorrect, is contradicted by Figures 3 & 4 (FS Appendix C-6), and, therefore, does not adequately represent the background concentration of Arsenic in the various soils that are present in the vicinity of the Superfund Site (see Table 3).

EPA Response:
Table 1 is correct, and it is not contradicted by Figures 3 and 4 because they are showing different types of soils. The soil types were identified for the area around the Site, and different BTVs were calculated for each soil type and soil grouping. Soil type-specific BTVs are provided in the arsenic background technical memorandum in Sections 4.2, 4.4, 4.5, 4.6, and 4.7.

D.20. Comment:
Balon Soil characterizes the majority of the Superfund Site that is occupied by residential and Town properties (Attachment 1.2).

Lonti Soil does not occur within the boundaries of the Superfund Site [Figures 3 & 4; Appendix C-6 (Tetra Tech, 2022)] and has no corollary that would validate including Arsenic concentration data from this subset population (n=69) of the complete 269 dataset, in the Superfund Site data population… A disproportionate number of outliers occur in the Lonti Soil which was sampled only at locations east of the Agua Fria River… These 69 data should be removed from the BTV dataset as not applicable.

EPA Response:
EPA acknowledges the difference between the background data from east versus west of the river, and therefore has revised its background evaluation (See *EPA Response to Comment C.6**) calculating different BTVs for east and west of the river.*

Lonti soil occurs only east of the River, while Balon soil occurs both east and west of the river. Some residents are living east of the river on Lonti soil. Therefore, we disagree both that Lonti soil data should be removed from the background dataset and that Lonti soil is not "site-specific" as has been contended in other comments.

The comment places too much importance and emphasis on the USDA soil mapping units. Such mappings often include many types of parameters, such as slope/soil inclination that are not related to soil background determination. In actuality, the Balon and Lonti soils are very similar soils. EPA believes that the primary difference between the background data distributions of the Balon and Lonti soils is that the Lonti soil is on the east side of the River and the Balon soil is mostly (not entirely), on the west side of the river. The differences in the data are due to differing geological parent materials and physical differences between east and west of the river. For example, EPA calculated the BTV estimates for Balon soil on the east side of the river and for Balon soil on the west side of the river. Even though the soil type is all Balon, the BTV on the west was only about half of the BTV on the east side.

We also note that if all of the data from the Balon (both east and west) merged together as one dataset and the Lonti soil data are disregarded, the resulting BTV is actually higher compared to the BTV for a Balon west dataset. The BTV for an all-Balon dataset is also virtually the same as EPA's BTV for Balon and Lonti soils together on the east side only. Again, it is more important to divide the data east/west than to divide the data according to soil type.

Here is some additional detail about the similar relationship between the Lonti and Balon soil types. Soils develop from parent materials which are a composite of various rocks and minerals. A BTV for arsenic in soils has inherent variability due to the mineralogical components in the parent materials; not specifically to a Soil Mapping Unit. A BTV calculation should characterize the origin and natural transport mechanisms of the parent materials that are the source of the soil developed.

Moano soils are mapped on steeper residuum (bedrock) phyllite and schist hillslopes that surround the Site and the Agua Fria valley. Both colluvial and alluvial actions have contributed parent material for the soil development of the Lonti and Balon soils that formed on slopes and terraces below the Moana soils.

Lonti soils developed from old gravelly alluvium from mixed sources including granite, schist, sandstone, limestone, shale, and basaltic materials (National Cooperative Soil Survey [NCSS] 2008). The concentration of arsenic in the Lonti soils would thus depend on the specific source of geologic material and would be variable. Lonti soils are mapped on slopes ranging from 0 to 30 percent.

Balon soils also formed from mixed sources of alluvium dominantly of schist, granite, basalt, and other rocks (NCSS 2008). Balon soils are mapped on fan terraces with slopes ranging from 2 to 25 percent.

Based on the geographic setting and landforms on the Site and the varied composition of soils parent materials for the Lonti and Balon soils, there is no soil mineralogical basis for disregarding the arsenic data from the 69 soil samples collected from the Lonti soil mapping unit. Arsenic concentrations from the Lonti background soils should be included in the BTV calculation.

D.21. Comment:

All (100 percent) of the outliers (“extreme” and additional) occur in soils that were collected from sample locations east of the Agua Fria River.

The data pattern indicates that there is likely an inherent bias involving soils collected east of the River that does not, in general, affect soils that are present west of the River, regardless of the soil type. Residential properties that are located east of the River and are located within the boundaries of the Superfund Site may require additional attention to resolve the issues raised in this analysis.

EPA Response:

EPA agrees that there is a difference between the background data east versus west of the river, and that it is best not to calculate a single BTV for the undivided dataset. EPA’s revised background evaluation (See EPA Response to Comment C.6) calculates different BTVs east and west of the river.

See EPA Response to Comment C.19 regarding elimination of outliers. In EPA's re-evaluation of background concentrations (See EPA Response to Comment C.6), soil types and the parent geological materials of soil differ on each side of the Agua Fria River. Outliers were removed to eliminate potential bias in the background calculation; this is an environmentally protective measure to preclude overestimating background concentrations. Within the dataset for the soil samples collected only on the East side of the river, the same samples are identified as outliers. Similarly, when evaluated independently, the data from the West side of the river does not contain any outliers. Background calculations were grouped based on East/West side of the Agua Fria River to maximize the statistical difference between BTV estimates, maximize the number of measurements in each grouping, minimize the number of areal-specific BTVs, and maximize the fit of the data in each grouping to a known statistical model.

D.22. Comment:

These documented biases, introduced by an inadequate compilation of soils within the Superfund Site and inclusion of soil samples from areas east of the Agua Fria River that show evidence of an unknown bias, are further exacerbated by Tetra Tech's Voronoi Tessellation transformation of the data to generate a weighted dataset. A weighted dataset is not necessary to address representativeness and area-specific BTVs may be confidently calculated on the basis of available data for each of the soil types documented within the boundaries of the Superfund Site.

EPA Response:

EPA disagrees. See EPA Response to Comment D.14 for significant discussion regarding weighting, de-clustering, and tessellation of background data. However, as stated above, EPA has agreed that the distributions of data and geological properties west versus east of the river vary, and EPA has derived one BTV for arsenic for each side of the river. See EPA Response to Comment C.6.

The use of the Veronoi Tesselation is appropriate. (Note that in EPA's re-evaluation of the BTV's de-clustering and weighting was adjusted from what was done in the BTV derivation on which the comment is based.) The purpose of applying the Voronoi Tessellation was to account for the samples co-located/spatially clustered that were present in the dataset. As stated in Section 3.3.3 of the arsenic technical memorandum, this approach reduces the effects of higher concentration areas/clusters relative to other background measurements in the dataset and intends to reduce bias in background calculations. In the revised arsenic background calculation, equal weighting was applied to each distinct sampling location to avoid bias. Because there are multiple samples/arsenic values collected at the same locations, equal weighting was applied to the samples by dividing by the number of measurements at the location.

D.23. Comment:

A robust dataset for metals in soils at the Superfund Site has been compiled since before 2012 and is available to support the development of a comprehensive co-occurrence matrix which provides adequate assessment of metals concentrations with respect to the distribution and concentration of As and Pb in most areas of the Superfund Site. This matrix can be used to confirm that accessory metals (i.e., not As or Pb) are adequately removed at the time that As and Pb concentrations are remediated.

EPA Response:
EPA does not understand what a "co-occurrence matrix" is and how this would be related to confirming the removal of accessory metals. The comment is unclear. As part of its original background analysis in the RI (Appendix E) (but before determining BTVs), EPA performed an extensive analysis of the co-occurrence of several metals and where these reached background concentrations.

D.24. Comment:

- An Arsenic BTV should be calculated that incorporates only those data that pertain to a defined Area of Interest AOI).
- Remove all consideration of Lonti Soil data as not applicable.
- Remove all data from areas East of the Agua Fria River as not applicable due to suspected bias.
- In our opinion it is not necessary to supplement the existing background dataset with additional sample data. The existing datasets, based on individual soil types, is adequate to accomplish the necessary calculations to determine applicable BTVs for each identified and prospective AOC.
- Apply the data in accordance with the ProUCL (ver. 5.2) regarding calculation of an 95% UCL as required by State ARAR.
- Complete these calculations for each identified AOI according to AOCs that are recognized by Tetra Tech's FS with provisions for increasing the total number of AOCs, as warranted based on revised EPC values.
- Revise Arsenic (As) PRGs in accordance with AAC statute and as per comments presented herein. Incorporate these values into all calculations of PRGs for all AOCs identified by Tetra Tech.
- Expand the number of AOCs to include areas that are subject to remediation based on revised PRGs for Arsenic.

EPA Response:
EPA disagrees with removing all Lonti data from the background data set. See EPA Response to Comment D.20.

See EPA Response to Comment C.6 – EPA has re-evaluated BTVs and derived separate BTVs for arsenic for east and west of the Agua Fria River. We cannot simply discard all data from east of the river as there are residences on the east side of the river within the APSI and a BTV is necessary for the east side.

EPA disagrees with removing all background data east of the river from the background data set. Residents do live east of the river and a BTV is necessary for the east side.

EPA disagrees that there is bias in the BTV. If the comment refers to the use of de-clustering, see EPA Response to Comment D.14. If the comment is suggesting that *combining data from east and west of the river may have biased the BTV high for the west side, EPA has performed a reevaluation. See EPA Response to Comment C.6.*

EPA does not agree with using Pro-UCL as the basis for determining the BTV, and that this is required. See EPA Response to Comment C.5.

EPA does not believe that the number of AOCs needs to be expanded upward. The RI and FS gave careful consideration to all areas of the site requiring remediation and their association with anticipated future land uses. Regarding AOCs vis a vis residential areas, please see EPA Response to Comment C.14. The area of potential site impact (APSI) derived in the RI (Appendix E) does not change as a result of the change in cleanup values. No new AOCs are necessary.

The ROD has revised the BTVs and the associated cleanup levels, in accordance with the anticipated future land use. EPA's revised cleanup level for lead is 200 mg/kg; the cleanup level for arsenic on the west side of the river is 48 mg/kg and east side of the river is 99 mg/kg. While the cleanup level for arsenic west of the river is based on background, this value corresponds to a cancer risk of about $3x10^{-5}$ and is less than a hazard index of 1 (78 mg/kg). This value is within EPA's risk range for remedy selection.

D.25. Comment:

Unlike Arsenic, Lead (Pb) is not a recognized carcinogen and its remediation level is based on Screening Levels that correlate to a Hazard Index (i.e., HI=1). This is represented in the federal Alert Level for Lead (Pb) in soil, which is 400 mg/Kg (USEPA, November 2022), and as adopted by Arizona as the Soil Remediation Level for residential properties (rSRL).

EPA Response:

This comment is incorrect; the screening levels for lead are not based on a hazard index (or hazard quotient) for non-cancer effects. Lead is evaluated for risk assessment independently and separately from the approach used for all other regulated chemicals that may cause cancer or non-cancer health effects; lead risk is based on model-predicted blood lead levels from exposure to environmental media, not on a hazard quotient (the HQ relies on a reference dose, which has not been established for lead, for technical reasons). In the ROD, EPA is using a cleanup level of 200 mg/kg for lead, which is lower than the SRL cited by the comment.

D.26. Comment:

Tetra Tech utilized an USEPA risk assessment model to calculate applicable Lead (Pb) cleanup levels for the Superfund Site [i.e., Integrated Exposure Uptake Biokinetic Model (IEUBK ver. 1.1)]. Tetra Tech did not provide justification for this decision or state why the 400 mg/Kg and 800 mg/Kg thresholds (i.e., Arizona SRL for Residential and Non-Residential properties, respectively) is not applicable. We believe that this is a reasonable expectation given that this threshold was used by CH2M-Hill (2016) and serves as the State ARAR.

EPA Response:
The use of the IEUBK model is standard nationwide for EPA and CDC when assessing lead risks for children. The residential lead cleanup standard of 200 mg/kg is lower and more protective than the state SRL cited in the comment.

The IEUBK model was used to calculate site-specific lead cleanup levels, rather than selecting default state lead soil targets as soil lead cleanup levels. The residential soil lead cleanup level for this site, 200 mg/kg, is more protective than the Residential Arizona SRL, because the cleanup level is based on an IEUBK prediction of a target blood lead level of 5 µg/dL (as a 95th percentile), whereas the SRL is based on a target blood lead level of 10 µg/dL (as a 95th percentile). The Response to Comment below supports the appropriateness of developing site-specific remediation goals.

D.27. Comment:
Tetra Tech failed to adequately address the complete scope of requirements outlined in AAC R18-7-206. Therefore, the determination of a PRG for Lead (Pb) is not adequate.

EPA Response:
AAC-R18-206 is identified as a potential ARAR in the FS and will be identified as an ARAR in the ROD. AAC-R18-206 allows for the development of site-specific remediation standards (versus using pre-determined remediation standards as prescribed in AAC-R18-205). AAC-R18-206(B) allows a remediation level to be determined using (1) a deterministic methodology; (2) a probabilistic methodology; or (3) an alternative methodology commonly accepted in the scientific community.

EPA used the externally peer-reviewed and published IEUBK model to identify a concentration of lead in soil that would correspond to a target maximum child blood lead level and thus would be appropriate for use as the remedial goal. The IEUBK model is a probabilistic methodology allowed under AAC-R18-206(B)(2). Additionally, the IEUBK model is an alternative methodology commonly accepted in the scientific community and thus permitted under AAC-R18-206(B)(3). Pursuant to AAC-R18-206(C) EPA is applying the residential lead goal to those areas of the Site currently used as residences or that may be used as residences in the future. AAC-R18-206(D) is not applicable for lead because lead is not evaluated as a noncancer hazard or cancer hazard.

Therefore, EPA's identification of the lead remediation goal of 200 mg/kg in the ROD complies with AAC-R18-206. EPA consulted the State of Arizona in identifying this State ARAR, and the State of Arizona concurs with EPA's proposed action, including the remediation goal for lead.

D.28. Comment:
The model implemented by Tetra Tech is an aged version of the EPA Model IEUBK ver. 2.0, which was released in May 2021. The statute requires, by inference, that the most recent version of a given model must be implemented or rejected with justification.

EPA Response:
For numerous reasons, there is no need to update the residential soil lead cleanup level that is based on the IEUBK model. Please see *EPA Response to Comment C.22* *for a detailed discussion of the compatibility of the site-specific Residential Soil cleanup level for lead with the most recent version of the IEUBK model (version 2.0, 2021).*

D.29. Comment:
The Tetra Tech application of the IEUBK Model does not appear to incorporate data for concurrent exposure to other contaminants (e.g., Arsenic).

EPA Response:
The risk of exposure to co-occurring arsenic and lead are already addressed in the cleanup levels for these two COCs. EPA's risk assessment methodology is unique for lead (for technical reasons), and thus is different from and incompatible with the principle of additivity that can be used for arsenic and the other chemicals of potential concern that were evaluated in the RI risk assessment and FS. Thus, the noncancer hazard posed by lead cannot be added to the noncancer hazard posed by arsenic (or any other COCs).

The data for concurrent exposure to arsenic or "other contaminants" cannot be incorporated into the IEUBK model as requested in the comment for the following reasons. The risk assessment methodology for lead is different from and incompatible with the risk assessment methodology for arsenic and the other chemicals of potential concern that were evaluated in the RI risk assessment. Specifically, the IEUBK model used to calculate the residential lead cleanup level is uniquely applied only to lead risk assessment because all of the model components (Exposure, Uptake, and Biokinetics) are specifically targeted to lead. Additionally, the output of the IEUBK model is expressed in blood concentrations, and no other COCs use blood concentrations as a metric for cancer risk or noncancer hazard. Lead risk assessment is based on the calculation of estimated population blood lead levels from multiple exposure pathways (including from site-specific environmental media) and the comparison of estimated blood lead level to a target blood lead level for children of 5 micrograms per deciliter (µg/dL). In contrast, arsenic risk assessment is evaluated on the basis of potential noncancer hazard and cancer risk from exposures to arsenic in site environmental media, and comparison of these to CERCLA-acceptable targets of noncancer hazard (hazard index $\leq$ 1) and the EPA cancer risk management range of 1×10^{-6} to 1×10^{-4}. Lead risk assessment methodology does not calculate noncancer hazards for lead that can be added to the hazard quotients of other chemicals of concern (COCs), such as arsenic, to result in a hazard index inclusive of lead.

D.30. Comment:
Certain of the residential properties appear to have a remediation standard that is sensitive to the ARAR and, in fact, includes provisions that render a human health-based remediation standard that is less than the federal Alert Level and State rSRL. These values should be

refined by applying the Lead (Pb) data to the most current version of the Model and incorporate provisions for concurrent receptor exposure to other contaminants (e.g., Arsenic).

EPA Response:
As discussed in EPA Response to Comment C.22, the lead PRGs presented in the PRAP are consistent with the most recent version of the IEUBK model (USEPA, 2021). Therefore, the lead cleanup level does not need further refinement.

With regard to the comment on concurrent receptor exposure to lead and other COCs such as arsenic, please see EPA Response to Comment D.29.

D.31. Comment:
Areas of Concern (AOCs) should be evaluated with respect to revised target concentrations (i.e., remedial standards) for COCs, especially Arsenic and Lead. AOCs should be clearly defined with reference to Exposure Point Concentrations (EPCs) for each COC, as applicable.

EPA Response:
No additional AOCs are identified for lead (see EPA Response to Comment C.22). Arsenic soil cleanup levels have been revised based on EPA's additional arsenic soil background (See EPA Response to Comment C.6) and risk assessment analysis. No new AOCs are necessary for arsenic based on current assessment. However, AOC "boundaries" could be adjusted based on the extent of contamination found during remediation.

D.32. Comment:
Failure to provide adequate foundation for elimination of Area of Concern (AOC) 12 from development of PRGs. Review criteria used to remove AOC 12 from remediation in light of information reported herein and revised target concentrations for Arsenic and Lead.

EPA Response:
The AOC 12 risk conclusions for lead have not changed. Risk levels in this area are below those warranting remediation.

D.33. Comment:
It seems likely that additional AOCs may be identified, including residential and Town areas, which have been targeted by USEPA for additional sampling and, possible, remediation.

EPA Response:
As stated in response to previous comments, the residential areas in town are in fact areas of concern and the ROD identifies remedial action for them. Without identifying new "AOCs", EPA will reevaluate which residential properties require cleanup in the remedial design phase, given the new cleanup standards in the ROD.

D.34. Comment:

AOCs that include residential properties should be reviewed to assess if site-specific criteria have been adequately addressed (e.g., BTV calculated on the basis of Balon Soil data). It appears that residential properties located east of Agua Fria River, for example, may have a separate, site-specific BTV for Arsenic than residential areas located west of the River.

EPA Response:

EPA concurs. See EPA Response to Comment C.6. EPA conducted additional arsenic background soil statistical analysis and risk assessment that supports separate soil cleanup levels for the areas east and west of the Agua Fria River. The revised soil arsenic cleanup levels for areas east and west of the river are incorporated into the ROD.

Regarding the use of Balon versus other soil mappings, please see EPA Response to Comment D.20 and numerous other responses to similar comments.

D.35. Comment:

Failure to specifically mention the status of residential and town properties is a Public Relations inadequacy. An assignment of AOCs should acknowledge the sensitivities of the Community and include provisions for those areas of the Superfund Site most obvious to the pedestrian reader. A decision that residential and town areas are not subject to remediation and, accordingly, PRGs have not been assigned, should be plainly explained, and justified.

EPA Response:

Please see EPA Response to Comment C.14. As stated previously , the residential areas in town are areas of concern and the ROD identifies remedial action for them. Without identifying new "AOCs", EPA will reevaluate which residential properties require cleanup given the new cleanup standards in the ROD.

D.36. Comment:

There appears to be an incomplete or incorrect correlation between current Town Zoning, intended Land Use, and AOC assignments.

EPA Response:

The specifics of this comment are not clear. EPA would be willing to discuss this matter with the Town. EPA has considered the anticipated future land use of the town in developing the preferred remedial alternative.

D.37. Comment:

We recommend that the following tables [See original document] and/or maps that incorporate available and developing information may provide useful summaries for purposes of communicating with the public, providing an overview of remedial plans, and summarize remedial target values on an area-by-area basis.

EPA Response:
After the ROD is issued, figures and tables that would be of assistance in addressing the Town's needs can be discussed. Figure 4 of the ROD is useful in reviewing the land use in relation to the cleanup levels. This was not available at the time this comment was written (February 2023).

D.38. Comment:
The PRGs represented by Tetra Tech for Arsenic (As) and Lead (Pb) are inadequate due to reliance on flawed or outdated risk assessment determinations (Pb), inadequate or incomplete attention to State ARARs, and flawed statistics in assigning applicable BTVs (As).

EPA Response:
EPA disagrees that the PRGs are inadequate, flawed, or outdated. The cleanup levels for arsenic and lead are updated based on additional analysis that EPA has conducted. The new cleanup levels are presented in the ROD.

Regarding the comment on the lead PRG, EPA maintains that RI lead risk assessment is not flawed. Please see EPA Response to Comment C.22 for further discussion on the adequacy of the lead risk assessment and how a revision based on the version of the IEUBK model is not necessary.

D.39. Comment:
PRGs for each AOC should include provisions for Town residents who live, work, and recreate within the Superfund Site on an annualized basis.

EPA Response:
The PRGs already do this; they are based on residential, industrial/commercial, and recreational land uses.

D.40. Comment:
PRGs should include explicit provisions for possible receptor exposure to multiple COCs, due to multiple pathways, involving different EPCs.

EPA Response:
PRGs are a result of the risk assessment, which takes into account sensitive receptors, multiple exposure pathways, and multiple COC exposure. See EPA Response to Comment D.29 for discussion about risk assessment with regard to co-exposure to arsenic and lead.

D.41. Comment:
Speyer requests that Figures, including maps, that depend on assigned PRGs be revised pursuant to significant changes so that the critical information regarding EPCs and PRGs is easily accessed and communicated. Speyer assumes that Tetra Tech will develop a confirmation sampling plan for determining adequacy of remediation at all targeted AOCs at the Superfund Site. This sampling plan should be comprehensive and site-specific, as

warranted by predetermined EPCs, and available for review by the Town's consultant prior to implementation.

EPA Response:
Sampling plans will be prepared for confirmation sampling during the residential cleanup. EPA can provide and discuss such sample plans with the Town upon request.

D.42. Comment:
This additional work should be based on a focused sampling plan (i.e., SAP) that is designed to address the findings of a data-gap analysis of existing soils data, and a comprehensive remediation plan that is based on revised BTVs and risk assessment determinations (i.e., Pb). Both plans and the data-gap analysis should be reviewed by the Town's consultant to ensure on-going community involvement and a sustained sense of positive public relations.

EPA Response:
This comment is vague and unclear with respect to data gaps. What are they? EPA is planning to prepare Remedial Design plans for residential areas, including work plans and SAPs. EPA can provide and discuss such plans with the Town upon request.

D.43. Comment:
To the degree practicable and as authorized by USEPA, soils data, including additional data that may be available due to supplemental work at Town and residential properties, should be incorporated with fugitive dust data derived from a systematic building rafter survey…

EPA Response:
Please see *EPA Response to Comment C.27*.

D.44. Comment:
Speyer recommends that USEPA complete a comprehensive review of existing data to identify significant data-gaps in soil data in residential and commercial areas of the Superfund Site. The data-gaps represent target areas for additional soil sampling, as necessary. As stated previously, there is considerable data from USEPA work completed in 2010, 2011, and 2012 that should be compiled and serve as the raw dataset from which informed decisions concerning additional sampling in residential areas of the Superfund Site may be made.

EPA Response:
EPA cannot respond to this comment due to its vagueness. What is meant by "data gaps" in soil data? EPA has compiled data from previous investigation and removal efforts. These are part of the Administrative Record and this information is available to make informed decisions. EPA plans to conduct additional sampling on residential properties to identify where soil removal should occur in accordance with the ROD.

D.45. Comment:
Sampling Plans intended to address data-gaps should be reviewed by the Town's consultant to sustain a cooperative interaction between the agency and the community. Removal Plans

should, likewise, be reviewed and discussed with the Town's consultant before contractors are mobilized.

EPA Response:
To the extent that any plans will be prepared in connection with the Remedial Design and Remedial Action, EPA can provide and discuss them with the Town upon request.

APPENDIX B

STATE OF ARIZONA CONCURRENCE

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Katie Hobbs
Governor

Karen Peters
Cabinet Executive Officer
Executive Deputy Director

October 19, 2023
FPU 24-076

Michael Montgomery
Director, Superfund and Emergency Management Division
U.S. EPA, Region IX
75 Hawthorne Street
San Francisco, CA 94105

RE: State Record of Decision Concurrence
Former Iron King Mine - Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona

Dear Mr. Montgomery:

The Arizona Department of Environmental Quality (ADEQ) has reviewed the Record of Decision and the Remedial Action alternative selected by the U.S. Environmental Protection Agency (EPA) for the cleanup for the Iron King Mine - Humboldt Smelter Superfund Site in Dewey-Humboldt, Arizona. ADEQ concurs with EPA's selection of this alternative to address contamination at the mine and smelter site area and soil in the residential area. The selected remedy consists of the following:

- Wastes in Non-Residential Areas: Excavation of mine wastes and contaminated soils from the former mine and surrounding areas west of Highway 69 will be moved into a repository on the existing mine tailings pile;
- Waste at the former smelter and in the Chaparral Gulch east of Highway 69 will be moved into a second waste repository on the former smelter property;
- Residential Yards: Excavation and removal of impacted soil from residential yards; soils will be placed into one of the two repositories.

ADEQ believes that the selected alternative will be protective of human health and the environment and will keep people and wildlife from being exposed to the waste. ADEQ looks forward to working with EPA in implementing the selected remedy. If you have any questions, please contact Karin Harker at harker.karin@azdeq.gov.

Sincerely,

DocuSigned by:
335165505729449
Ana Vargas
Interim Division Director
Waste Programs Division

APPENDIX C

RE-EVALUATION OF ARSENIC BACKGROUND CONCENTRATIONS

TETRA TECH

Technical Memorandum

To:	Jeffrey Dhont, Superfund Project Manager, U.S. Environmental Protection Agency (USEPA) Region 9
From:	Kevin Bricknell, Project Manager, PE
Date:	September 15, 2023
Subject:	Pre-ROD Refined Background Threshold Value Calculations for Arsenic at the Iron King-Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona

1.0 CONTEXT, PURPOSE, AND OBJECTIVES

Under Contract W912P718D0001, U.S. Environmental Protection Agency (USEPA) tasked Tetra Tech, Inc. (Tetra Tech) with reviewing and revising existing estimates of background levels of arsenic concentrations in undisturbed surface soils near the Iron King Humboldt Smelter (IKHS) Superfund site (the site) in Dewey-Humboldt, Arizona. This revision has been prompted by concerns that have been raised about the previously derived background values and the distribution of arsenic in background samples. These concerns for previous background threshold value (BTV) estimates primarily focused on sampling concerns indicated in the data. Namely, previously undetected instances of repeated sampling at some locations were found during review of data generated by CH2M Hill, Inc (CH2M Hill). Upon analysis, this was believed to have caused a biasing effect. Additionally, there was concern that a subset of the data could be statistical outliers, which prompted a plan to consider removal of these data, if supported by statistical (leverage and influence) and scientific analyses.

1.1 CONTEXT

A BTV is a statistical estimate of background concentration of a contaminant of interest (USEPA 2015). Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process, BTVs support risk assessment and development of remediation objectives. At IKHS, arsenic BTVs are based on soil measurements within background areas, which are designated as soils near the site not having been affected by mine- and smelter-related contamination from IKHS. Site-specific BTVs can be used to inform future cleanup decisions regarding the area impacted by mine- or smelter-related arsenic contamination from IKHS.

More than 500 arsenic measurements have been taken in background areas in the vicinity of IKHS. However, despite the significant size and vast spatial distribution of the dataset, the arsenic background derivation at IKHS is particularly complex because arsenic concentrations do not decrease with distance from the former mine and smelter properties. Soil concentrations of other site-related metals, including lead, copper, and zinc, decrease with increasing distance from the site. Local geology influences concentration of arsenic in soils. For example, arsenic levels in soils on the east side of the Agua Fria River are higher than those in soils on the west side of the river because of differences in underlying geology and geomorphology.

USEPA has derived and refined the background estimate of surface soils for the site three times, including the effort leading to this memorandum. In Appendix E to the remedial investigation (RI) report regarding the site (CH2M Hill, 2016), CH2M Hill applied a statistical approach to calculate a BTV of 112 milligrams per kilogram (mg/kg) arsenic for the site. As part of this effort, CH2M Hill used a dataset of 254 values from background samples. Appendix E also delineated, based on several lines of evidence, the Area of Potential Site Impact (APSI) within which the site could be influencing soils, rendering samples from there unusable for background calculations. Only samples from outside the APSI were included in the background dataset.[1]

In 2022, the background arsenic BTV derived in Appendix E to the RI report (112 mg/kg) was re-examined. A more advanced and robust statistical approach was applied, and results of the assessment were documented as Appendix C-6 to the Feasibility Study (FS).

This second effort arose because the arsenic BTV at IKHS presented in the RI report appeared to be higher than indicated in the site dataset. Accordingly, USEPA refined the statistical approach to re-evaluate the methods applied to calculate the arsenic BTV. Results of the refinement indicated that the arsenic BTV for IKHS should be recalculated because standard methods of calculating BTVs using ProUCL and Minitab (previously used in Appendix E to the RI report) did not account for spatial weighting of sample measurements.

The nonparametric weighted bootstrap model for calculating the 95 percent upper tolerance limit with 95 percent coverage (UTL95-95) statistic was selected as the new method of calculating arsenic BTVs based on its account of the spatial distribution of samples by application of a statistical weighting factor (k). The weighting factor is given as the inverse of the number of duplicate data (a) for a given sample location ($k = 1/a$). Bootstrapping is a method of inferring results for a population from results found on a collection of smaller random samples of that population, using replacement during the sampling process. Because this method retains all samples included in the dataset, it is a more rigorous analytical approach to cluster analysis than the manual cluster analysis via visual inspection of sample locations.

The result of this second background effort resulted in revision of the arsenic BTV to 92 mg/kg. This single value was used in USEPA's proposed plan as both the BTV and the cleanup value for arsenic in residential soils. It was applied both east and west of the Agua Fria River and to all soil types across the site.

Comments received during the public comment period on the proposed plan included concerns that the two previous background evaluations performed for the site in the RI (RI Appendix E) and FS (FS Appendix C-6) were too high because they derived a single BTV of arsenic in surface soils across the area surrounding the site. These comments included claims that background sampling results from the east side of the river have been consistently higher and belong to a separate background population than those from the west side, which elevated the

[1] The APSI was determined for the RI to be the boundary distanced from IKHS where lead, zinc, and copper (other site contaminants associated with IKHS) reached their respective background levels. The boundary is also based on locations of pairs of shallow and 1-foot deep soil samples collected in undisturbed areas around the site. Closer to the mine and smelter, the ratio of contaminant levels in surface soil to subsurface soil was significantly greater than 1, indicating an influence or source at the surface. Outside a certain area, this ratio was not statistically different from 1, indicating that lead, zinc, and copper in surface soils and deeper soils were similar in concentrations and not influenced by the site. These ratios are statistically significant because they treat each location as a sample-to-baseline comparison, which can then be plotted spatially to see where contamination effects become indistinguishable from the natural contaminant concentration. This is a maximally robust technique for measuring trends that are spatially dependent, and together, these lines of evidence converged on the same area for the APSI.

value of the resulting BTV. Comments also suggested that USEPA should estimate the background for specific soil types in the area.

1.2 PURPOSE

The purpose of this technical memorandum is to address remaining issues related to the background level of arsenic for the site. To perform this third background effort, USEPA acquired statistics assistance from its Office of Research and Development. A team of experienced, highly expert statisticians from Neptune and Company (Neptune) joined USEPA's regional project management staff and USEPA's original contractor, Tetra Tech, in performing this work. A memorandum from Neptune documenting some key facets of its involvement is attached to the end of this memorandum.

This technical memorandum provides estimates of BTVs for arsenic in soil around IKHS based on existing soil data and data obtained from (1) laboratory analysis of soil samples collected around the site, and (2) samples analyzed in the field by use of an X-ray fluorescence (XRF) spectrometer.

1.3 OBJECTIVES

Objectives of this technical memorandum and the attached memorandum from Neptune are the following:

- Review the statistical approaches for BTV calculations and consider alternative approaches.
- Determine the appropriate dataset and data treatment to address remaining issues in the background dataset.
- Evaluate statistics for subpopulations of data based on soil type and groupings of soil types and determine property groupings with which to proceed in determining revised BTVs.
- Examine chemical signatures in background samples east of the river to affirm previous determinations that arsenic concentrations are higher on the east side than the west side of the river because of geologic differences.
- Describe approaches to calculate soil arsenic BTVs by separate consideration of three statistical models to calculate upper tolerance limits (UTLs).
- Present arsenic BTV calculations following several alternative approaches, including nonparametric weighted bootstrap models. These calculations were conducted in the statistical programming language R.

2.0 SITE LOCATION AND DESCRIPTION

IKHS is adjacent to the town of Dewey-Humboldt in Yavapai County, Arizona. The site consists of the Iron King Mine and the Humboldt Smelter. The Iron King Mine was active from the 1890s through 1968 (CH2M Hill, Inc. 2016). Ores produced from the Iron King Mine included lead, zinc, copper, silver, and gold. The Humboldt Smelter conducted operations from 1876 to 1968, and included three smelters and one smaller mine. Operations at the smelter included copper processing and additional recovery of gold, silver, zinc, and aluminum from ores.

Major features at and near IKHS, including drainages near the site and the town of Dewey-Humboldt, appear on Figure 1. The boundaries shown on Figure 1 have not changed from those in the RI report. An APSI was identified around IKHS to delineate the approximate extent of contamination related to site operations as a part of the RI effort (CH2M Hill, Inc. 2016). The boundary shown on Figure 1 is distinguished from the potential effects zone (PEZ) of contamination, which was evaluated during a cultural resources survey before the RI (Archaeological Consulting Services, Ltd. 2008). The area including the combined APSI and PEZ represents the background boundary; areas outside of this boundary are assumed not to have been affected by contamination from IKHS.

An important regional feature is the Agua Fria River, adjacent to the town of Dewey-Humboldt and flowing through the IKHS boundary. Two major intermittent surface water drainages, Chaparral Gulch and Galena Gulch, are south of the town and flow through the APSI. Both drainages discharge into the Agua Fria River and have facilitated transport of contamination from IKHS outside of the background boundary.

2.1 SITE GEOLOGY AND SOIL CLASSIFICATIONS

Figure 2 shows the underlying geology of the APSI around IKHS. Major geologic features of the region include Precambrian metamorphic rocks covered by Tertiary volcanic and sedimentary rocks from the Hickey Formation (CH2M Hill, Inc. 2016). Further, quaternary alluvial deposits consisting of Hickey Formation materials are present along the Agua Fria River and active drainages, including Chaparral Gulch and Galena Gulch.

Tetra Tech reviewed the soils mapped by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) in the Web Soil Survey for IKHS (USDA NRCS 2022). Table 1 lists the major soils mapped for an APSI of approximately 10,000 acres surrounding and including IKHS. Soil mapping units were combined by soil series (alluvial land, Balon, Lonti, and Moano) to provide manageable soil groupings. Because of similar characteristics, Lynx soils and alluvium were grouped together and are referred to as alluvial land in this technical memorandum. Attachment A presents the Web Soil Survey output and official NRCS soil series descriptions of the major soils that occur at IKHS. Figure 3 is a map of the soil units identified for the APSI. The major soil units around IKHS include:

2.1.1 **Springerville**:

The Springerville-Cabezon Series soils are deep soils found south of the Humboldt Smelter. Springerville soils formed in alluvium from tuff, volcanic breccia, and basalt. Springerville soils are not represented outside the APSI, and no residences near IKHS are currently built on these soils.

2.1.2 **Lonti**:

Lonti Series soils are very deep soils but are mapped on nearly level plains and fans only on the east side of the Aqua Fria River. These soils developed in old gravelly alluvium from mixed sources.

2.1.3 **Balon**:

Balon Series soils are very deep (> 6 feet) soils found on the fan terraces of the Aqua Fria River Valley. These soils are mapped on both the east and west side terraces but are most extensive west of the Aqua Fria River. Most of the Humboldt townsite is built on Balon Series soils.

2.1.4 **Moano**:

Moano Series soils are found in the higher hills and mountain slopes east and west of IKHS. These very shallow soils developed in residuum (bedrock) materials and are typically less than 2 feet thick above hard schist bedrock.

2.1.5 **Alluvial Land and Lynx**:

Lynx Series soils are found on flood plains and alluvial fans, and have characteristics similar to the soil mapping unit labeled sandy and gravelly alluvial land found northeast of IKHS. These soils are deep and formed in mixed alluvium.

Soil characteristics, including naturally occurring soil arsenic concentrations, vary across soil types and also vary based on direction from the Agua Fria River. These distinctions can be attributed to differences in how soils formed from parent materials and composition of underlying geology. For example, Moano soils are mapped on steeper residuum (bedrock) phyllite and schist hillslopes that surround IKHS and the Agua Fria valley.

Both colluvial and alluvial actions have contributed parent material for development of Lonti and Balon soils that formed on slopes and terraces below the Moano soils. Lonti soils developed from old gravelly alluvium from mixed sources including granite, schist, sandstone, limestone, shale, and basaltic materials (National Cooperative Soil Survey [NCSS] 2008). Lonti soils are mapped on slopes ranging from 0 to 30 percent. Balon soils also formed from mixed sources of alluvium dominantly of schist, granite, basalt, and other rocks (NCSS 2006). Balon soils are mapped on fan terraces with slopes ranging from 2 to 25 percent.

2.2 SITE-SPECIFIC CONSIDERATIONS FOR BACKGROUND ASSESSMENT

Characteristics of surface soils on the east side of the Agua Fria River were noted to differ significantly from those on the west side of the river, even in the same soil series. Evaluations of background concentrations of contaminants from IKHS must consider that regional geology, soil types, and regional hydrology affect distribution of naturally occurring background levels of contaminants associated with IKHS. Concentration of arsenic in each soil type depends on the specific source of geologic material and the geologic depositional process. The mixed sources contributing to the soils on the east side of the river may be naturally higher in arsenic than the alluvium and residuum on the west side, leading to the possibility of more than one BTV for the site.

Neptune's supplemental analysis, in Attachment C, demonstrates that surface soils and subsurface soils on the eastern side of the river are naturally higher in arsenic than those soils on the west side of the river. Discussion of development of the background sample dataset is in Section 3.0. To show that the soils sufficiently differ on each side of the river, Neptune plotted log-transformed background arsenic concentrations against log-transformed background concentrations of other constituents associated with IKHS (chromium, copper, iron, lead, manganese, and zinc) determined at the same sample locations. Sample locations are clustered by the east and west sides of the river, and the relationship between concentrations of arsenic and the other analytes evaluated are similarly associated. Further, arsenic concentrations and concentrations of other analytes evaluated do not differ significantly between surface and subsurface soils on each side of the river. These relationships suggest that the underlying geology differs on each side of the river, justifying separate analyses of data from each side of the river.

Additional analyses occurred to determine if aerial dispersion from the IKHS smelter stack would affect arsenic concentrations in surface soils in the background area. As described in the Neptune technical memorandum in Attachment C, the wind roses provided in the RI report for the region show that wind direction varies throughout the year, and if any aerial dispersion has occurred, it is assumed to have impacted all directions from the smelter stack —arsenic would have deposited from stack emissions in no clear direction. The ratio of analyte concentrations in surface and subsurface soil samples collected in the background area, as previously described, also provided no statistical evidence that aerial dispersion had impacted surface soils outside the APSI.

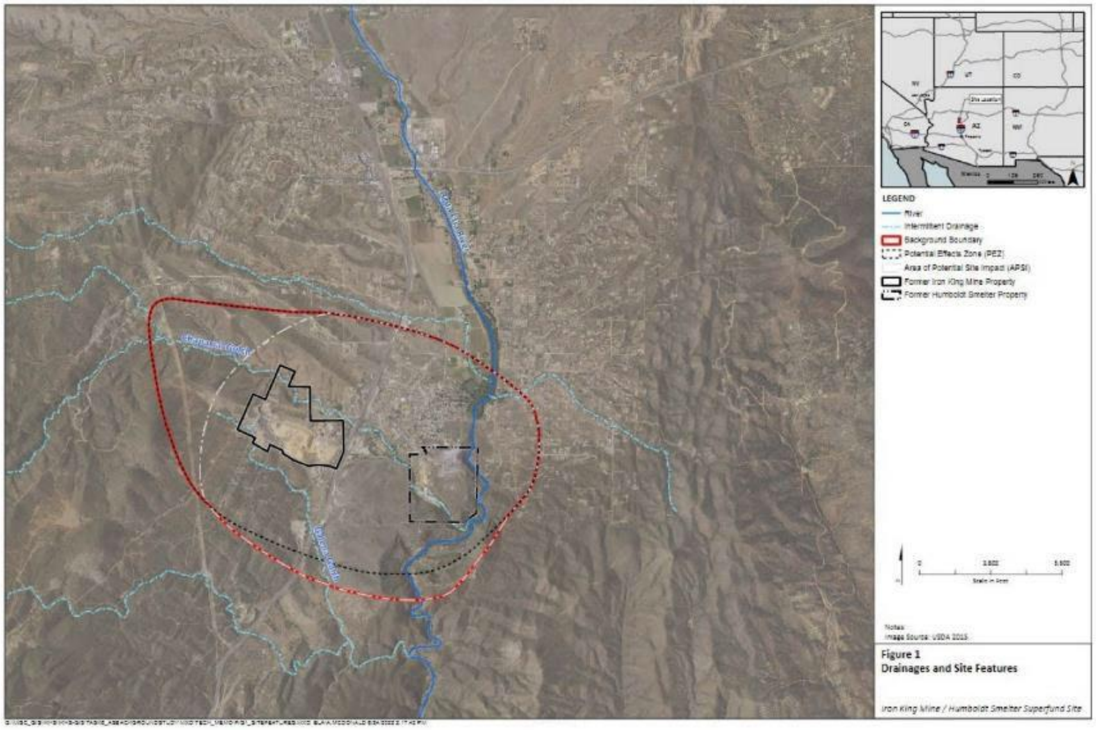


Figure 1. Drainages and Site Features

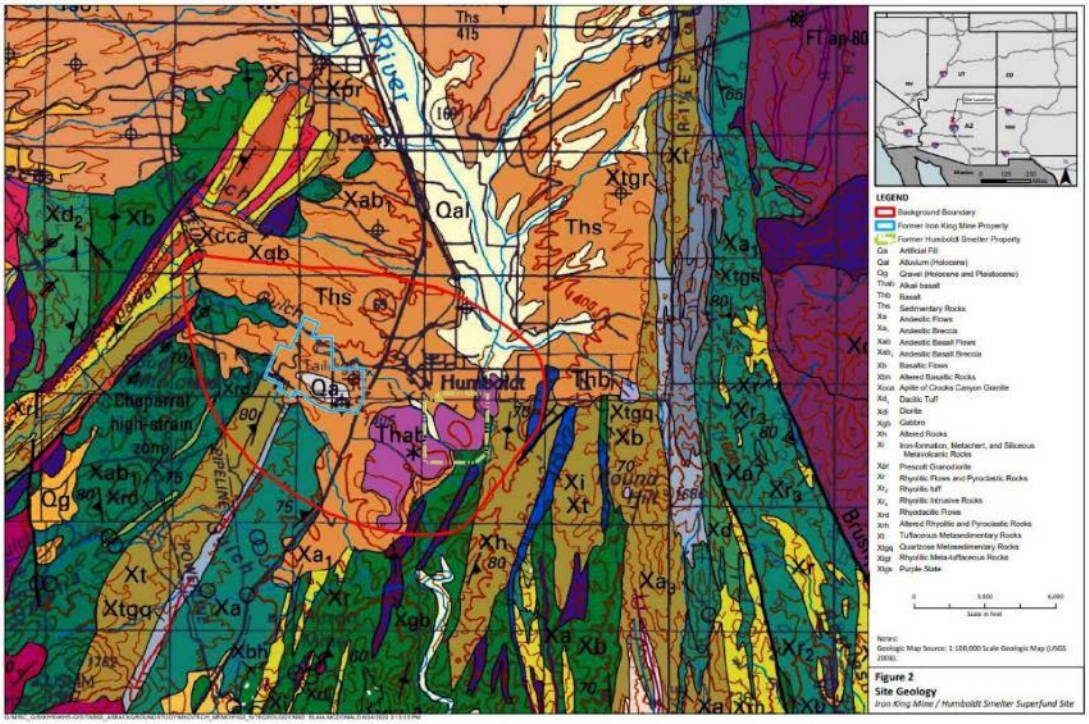


Figure 2. Site Geology

Table 1. Soil Classifications

Soil Grouping	Soil Unit Labels	Extent of Impacted Area (%)	Slopes	Source of Parent Material and Formation
Balon Soils	BgD	28.4	2 to 25	Formed in mixed alluvium dominantly from schist, granite, basalt, and related rocks.
Lonti Soils	LkD, LmB, LnC	17.8	2 to 25	Formed in old gravelly alluvium from mixed sources on alluvial fans.
Lynx Soils and Alluvial Land	Ly, Sa	15.4	0 to 8	Formed on flood plains and alluvial fans from mixed alluvium.
Moano Soils	MgD, MkF, MoD	32.9	8 to 60	Formed in residuum from phyllite and schist.
Springerville-Cabezon	SnD	3.9	0 to 10	Formed in alluvium from tuff, volcanic breccia, and basalt.
Others	n/a	2	n/a	n/a

Notes:

BgD	Balon gravelly sandy clay loam
LkD	Lonti gravelly sandy loam
LmB	Lonti gravelly loam
LnC	Lonti cobbly loam
Ly	Lynx soils
MgD	Moano gravelly loam
MkF	Moano very rocky loam
MoD	Moano extremely rocky loam
n/a	Not applicable
Sa	Sandy and gravelly alluvial land
SnD	Springerville-Cabezon complex

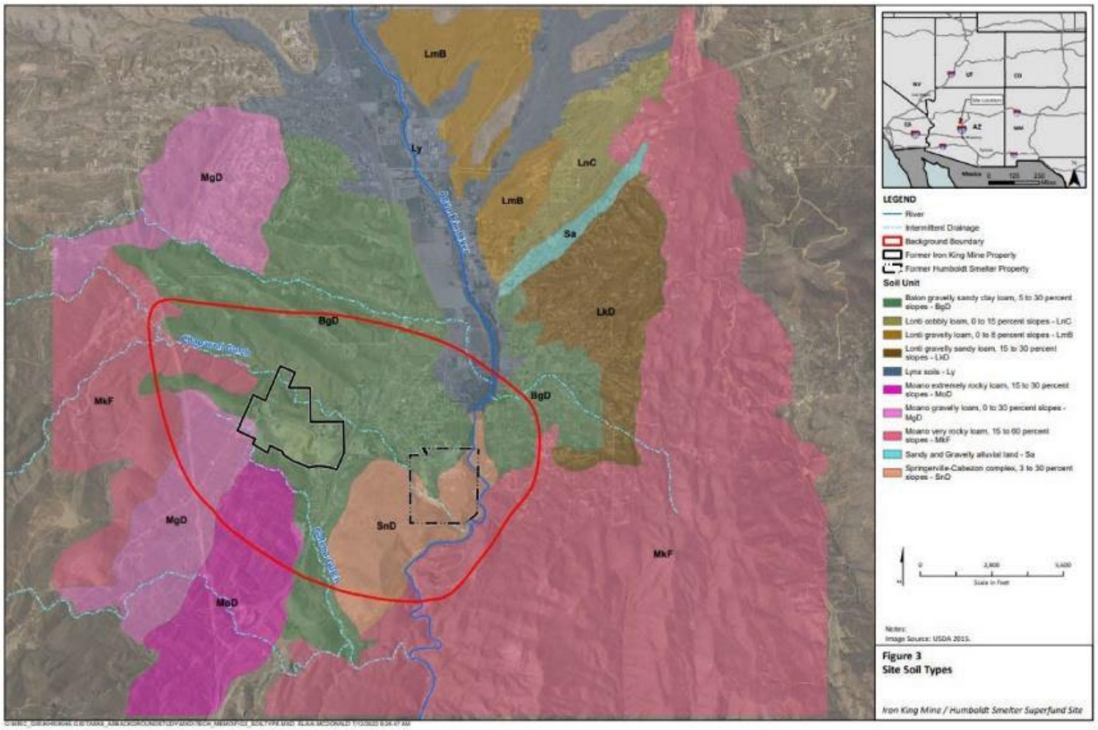


Figure 3. Site Soil Types

2.2.1 Springerville

The Springerville-Cabezon Series soils are deep soils found south of the Humboldt Smelter. Springerville soils formed in alluvium from tuff, volcanic breccia, and basalt. Springerville soils are not represented outside the APSI, and no residences near IKHS are currently built on these soils.

2.2.2 Lonti

Lonti Series soils are very deep soils but are mapped on nearly level plains and fans only on the east side of the Aqua Fria River. These soils developed in old gravelly alluvium from mixed sources.

2.2.3 Balon

Balon Series soils are very deep (> 6 feet) soils found on the fan terraces of the Aqua Fria River Valley. These soils are mapped on both the east and west side terraces but are most extensive west of the Aqua Fria River. Most of the Humboldt townsite is built on Balon Series soils.

2.2.4 Moano

Moano Series soils are found in the higher hills and mountain slopes east and west of IKHS. These very shallow soils developed in residuum (bedrock) materials and are typically less than 2 feet thick above hard schist bedrock.

2.2.5 Alluvial Land

Lynx Series soils are found on flood plains and alluvial fans, and have characteristics similar to the soil mapping unit labeled sandy and gravelly alluvial land found northeast of IKHS. These soils are deep and formed in mixed alluvium.

3.0 STATISTICAL APPROACHES AND METHODS FOR BACKGROUND THRESHOLD VALUE CALCULATIONS

The following section describes (1) development of a database of background arsenic samples from the area closest and surrounding IKHS outside of the background boundary, (2) treatment of outliers in the background sample database, (3) approaches for calculating BTVs with R, and (4) scenarios selected to group samples in order to calculate arsenic BTVs.

3.1 BACKGROUND SAMPLE DATABASE

Under the CERCLA process, RI activities have occurred in several stages at IKHS, including collection of soil samples at locations near the site considered background areas. Background areas are designated as soils near the site, but not affected by mine- and smelter-related contamination from IKHS. USEPA and the Arizona Department of Environmental Quality began scoping of background areas during the first CERCLA assessments of the site from 2002 to 2004. Arsenic data from two soil samples from the site inspection are included in the database developed for this analysis to calculate arsenic BTVs. Arsenic concentrations in these samples were determined via laboratory analysis. EA Engineering, Science, and Technology, Inc. (EA) performed a supplemental RI in 2010 that included measurement of arsenic in bulk soil via laboratory analysis. As a part of this effort, 10 samples were collected in areas believed representative of background in the site vicinity. Data from these background samples are included in the new database.

USEPA sampled more soil in 2012 and 2013 within an area of approximately 20 square miles near IKHS to evaluate background concentrations of contaminants associated with the site. This sampling effort, part of the RI, intended to characterize contamination with arsenic and other metals in nonresidential areas impacted by the site and at locations not expected to have been impacted by the site and not previously characterized during sampling by EA (USEPA 2012). The data were analyzed for arsenic via both laboratory analysis of bulk soil and in-field measurement by use of an XRF spectrometer (CH2M Hill 2016).

An initial analysis of background arsenic concentrations at IKHS by USEPA and Tetra Tech re-examined the background dataset of detections in 268 samples compiled by CH2M Hill in the RI, including those in the 12 background samples collected in 2004 and 2010. At each of multiple locations of XRF measurements, several XRF measurements were recorded. From arsenic background data, personnel performing the RI selected the highest XRF arsenic measurement at each location and removed the remaining data associated with that location. This approach artificially increased the calculated background concentration of arsenic. Following the first re-evaluation of the arsenic data from 268 sample locations presented in the RI, additional concerns were raised during the public comment period that the multiple BTVs calculated by soil type, various soil type groupings, and direction from the Agua Fria River still were elevated.

After an independent analysis by Neptune, provided in Attachment C, USEPA and Tetra Tech decided to add the XRF measurements initially removed by personnel conducting the RI back into the data to re-calculate the arsenic background concentration. To improve estimates of background arsenic concentrations at IKHS, the new background arsenic analysis presented in this technical memorandum includes arsenic data from 501 soil samples obtained via laboratory analysis and XRF screening. The 517 background samples collected near IKHS have been reviewed for calculation of arsenic soil BTVs. Additionally, it should be noted that 14 data were visually identified, upon inspection, as potential outliers. From a statistical perspective, Tetra Tech and USEPA consider outliers to occasionally possess high leverage, always possess high influence, and usually both. If a datum has high influence, this is sufficient to identify it as an outlier from a statistical standpoint, but high leverage alone is not sufficient evidence to claim a datum is an outlier. High leverage and high influence of a datum, however, is strong evidence that it is a statistical outlier. From a scientific perspective, it was assessed that these extrema likely were obtained incorrectly, as they probably resulted from XRF screening of solid rock rather than loose soil. Details of the approach to handle these potential outliers are presented in Section 3.2 below. The final dataset came from 297 samples that underwent XRF measurements and 204 samples analyzed at a laboratory via analytical methods described in the USEPA background study, yielding 501 total arsenic measurements (USEPA 2012).

Figure 4 shows locations of background samples included in the arsenic background sample database developed for this technical memorandum. The full background sample database of arsenic measurements, including sample groupings by soil unit and soil series, is in Attachment B.

Because the background parent data consist of data from samples collected during multiple sampling efforts and analyzed for soil arsenic via either XRF screening or bulk soil laboratory analysis, the characteristics of the data obtained by application of each method were compared. However, field XRF screening and soil analysis at the laboratory are not directly comparable (Crumbling 2021). XRF measurements are more representative of total metals present in a soil sample because they provide a direct measurement of all soil constituents, not solely arsenic. Laboratory soil analytical methods, including measurement via inductively coupled plasma (ICP), rely on partial digestion of a soil sample to extract metals. Accordingly, the laboratory analysis of soil via ICP is representative only of the soluble fraction of an analyte of interest. Soil analysis via ICP provides insight into the amount of a contaminant that is bioavailable for potential receptors under a risk assessment scenario. Both approaches furnish valuable information about the extent of contamination at a site.

Comparability between XRF and ICP datasets should be established if XRF data are to be used to supplement or support ICP data. Comparing results obtained by applications of different methods of acquiring data also depends on calibration of the XRF spectrometer. While XRF instruments are calibrated by the manufacturer, XRF spectrometers cannot be expected to retain their calibration unless regular maintenance and quality control checks occur. The calibration status of an XRF spectrometer is established by use of five or more certified reference materials (CRM) that span the concentrations of interest to the project. Further, calibration of XRF instrumentation used in the future on these soils near IKHS must also be chosen and compared to calibration of the XRF spectrometers originally used to acquire data. The data from two different XRF spectrometers cannot be used interchangeably unless their calibrations are equivalent.

The background XRF measurements obtained by USEPA also have been independently evaluated to assess their usability. In 2013, comparability of XRF and ICP datasets for arsenic were evaluated by use of linear regression and the Wilcoxon Signed-Rank test. Both statistical evaluations found the arsenic XRF and ICP datasets to be comparable. The following linear regression equation was obtained for the XRF arsenic (XRF-As) and ICP arsenic (ICP-As) datasets:

$$XRF\text{-}_{As} = 0.9242(ICP\text{-}_{As}) + 3.3$$

A slope of 0.9242 indicates that the XRF data and the ICP data behave with the same broad trend, which implies no systematic difference in the data. Results of the Wilcoxon Signed-Rank test between the XRF-AS and ICP-As datasets indicated no evidence of a slope statistically different from 1 ($p = 0.4247$).

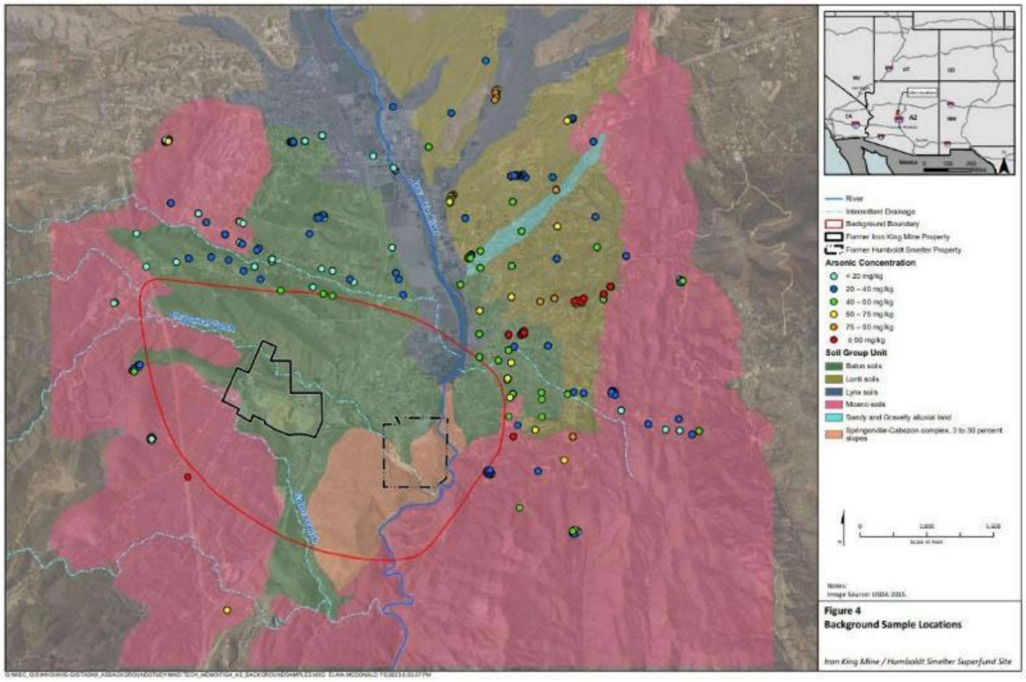
Regarding USEPA measurements in 2012 and 2013, five CRMs with concentrations ranging between 18 and 205 parts per million were used for calibration of the XRF spectrometer for arsenic measurements by linear regression calculated to be:

$$XRF\text{-}_{As} = 0.8667(CRM\text{-}_{As}) + 3.37$$

A slope of 0.8667 indicates that calibration of the XRF spectrometer used to acquire the data was biased low, which could have contributed to the comparability between this XRF spectrometer's results and the corresponding ICP results.

For the purposes of this technical memorandum, both field XRF and laboratory soil analytical measurements of arsenic are analyzed in the same dataset because of the limited number of samples collected outside the background boundary near IKHS, and because of no evidence of a systematic difference in data between the sampling techniques.

Table 2 lists summary statistics calculated in Minitab from the full background sample database for arsenic. In addition, the summary statistics are presented for the dataset classified by analytical method. To evaluate if the XRF and soil analytical datasets are statistically similar, a two-sample Student's t-test was performed in ProUCL software. At a confidence level of 95 percent, no significant difference exists between the means of background arsenic data from application of each analytical method.



Note:
mg/kg Milligrams per kilogram

Figure 4. Background Sample Locations

3.2 IDENTIFICATION OF OUTLIERS IN BACKGROUND SAMPLES

Before final analysis of the background data of arsenic soil concentrations, extreme outliers were identified and removed from the dataset to improve estimates of BTVs, in accordance with the existing best-practice guidelines established by the statistical community. Outliers are defined by USEPA (2002) as measurements not representative of a sample population. These values are frequently much larger or much smaller compared to the population from which they are drawn, and can be statistically identified with leverage and influence tests[2]. Outliers distort statistics if used in calculations of population characteristics (mean, standard deviation, etc.). For statistical analysis of environmental data, USEPA (2002) advises a preliminary review of data including identification of potential outliers. Final decisions on removal or retention of extrema relies on providing both a *scientific* and a *statistical* basis for their excision. Accepted best practice in the statistical community is to apply this two-layered approach for extrema exclusion because a statistical approach alone may induce a biasing effect in its own right.

From the statistical standpoint, multiple approaches are available to evaluate outliers in environmental datasets. USEPA (2006, 2015) guidance highlights the interquartile range (IQR) fence method as an initial approach, which is a semi-formal measure of influence not reliant on a formal hypothesis test. To evaluate for potential outliers measuring higher than would be representative of the sample population, measurements in a dataset that exceed an upper limit defined as the value for the IQR multiplied by 1.5 and added to the third quartile of the dataset (75^{th} percentile) are classified as outliers. Visually, by displaying all data on a boxplot, these observations are outside the fences on boxplots (above the upper bar and below the lower bar), and are considered statistical outliers according to EPA guidelines.

In the updated background data, the outliers identified for elevated arsenic concentrations are summarized in Table 3 and shown in red on Figure 5. Visual analysis of the updated background data indicated that 14 measurements, representing three distinct sampling locations (BKG-497, XRF-077, and XRF-079), exhibited substantially different concentrations from the background. All 14 values exceeded 270 mg/kg for arsenic.

[2] Leverage is the measure of whether a datum has an extreme predictor variable relative to the set of other predictor variable values. Before conducting formal tests for identifying leverage, it is best to visually inspect the data to determine whether such a test is needed. If no gap is noticeable between the potential extrema and the rest of the data, continuing to formal leverage tests generally is not advised. In this case, we did not notice this behavior upon visual inspection, and concluded that no additional steps were necessary to identify high leverage data. We therefore focused our following efforts on measuring influence, and pursuing the scientific basis for removal consideration.

Table 2. Summary Statistics for Arsenic, Updated IKHS Background Sample Database

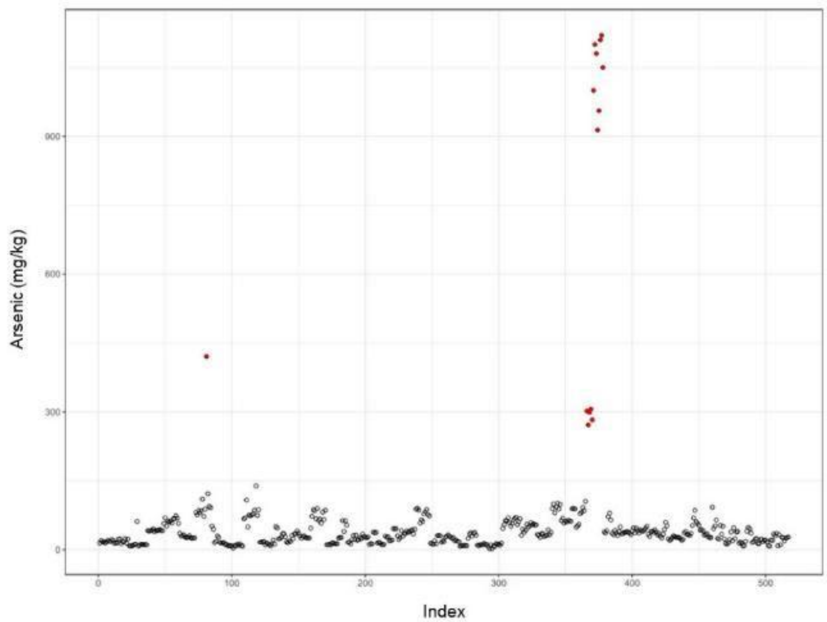
	Total Count	Arsenic (mg/kg)							
		Mean	Standard Deviation	Coefficient of Variation	Minimum	Q1	Median	Q3	Maximum
Full Dataset	517	55.9	130	233	3.4	18.4	32.6	52.1	1,120
All Extreme Outliers Removed (XRF and Lab)	501	37.0	23.9	64.6	3.4	17.8	31.4	49.5	139
XRF – Extreme Outliers Removed	297	38.2	21.8	56.9	6.7	22.5	34.4	48.9	105
Lab – Extreme Outliers Removed	204	35.3	26.7	75.6	3.4	14.4	26.0	51.1	139

Notes:
IKHS Iron King Humboldt Smelter
Lab Bulk soil sample analyzed in a lab setting
mg/kg Milligrams per kilogram
Q1 First quartile
Q3 Third quartile
XRF Sample measured in field via X-ray fluorescence spectrometry

Table 3. Outliers Removed from Updated IKHS Background Sample Database

Sample Name	Easting	Northing	Sample Date	Analytical Method	Arsenic (mg/kg)	Soil Unit	Soil Series	Direction from Agua Fria River
XRF-079*	612720	1278894	1/11/2012	XRF	1,120	LkD	Lonti	East
					1,110			
					1,100			
					1,080			
					1,050			
					1,000			
					956			
					914			
XRF-077*	612445	1278577	1/11/2012	XRF	306	LkD	Lonti	East
					302			
					299			
					283			
					272			
BKG-497	608976	1276846	1/26/2012	Lab	421	BgD	Balon	East

Notes:
* Multiple measurements were taken at XRF screening locations identified as outliers.
BgD Balon gravelly sandy clay loam, 5 to 30 percent slopes
IKHS Iron King Humboldt Smelter
Lab Bulk soil sample analyzed in a lab setting
LkD Lonti gravelly sandy loam, 15 to 30 percent slopes
mg/kg Milligrams per kilogram
XRF Sample screened in field via X-ray fluorescence spectrometry



Notes:
IKHS Iron King Humboldt Smelter
mg/kg Milligrams per kilogram

Figure 5. Index Plot of Full Dataset, IKHS Updated Background Sample Dataset

A formal test of these possible outliers was performed by application of an extended version of Rosner's multiple outlier block test at the 1 percent significance level. Rosner's test is a formal outlier procedure recommended in USEPA (2009) guidance documents. The original Rosner formulation was extended to accommodate any specified number of possible outliers (as opposed to the usual maximum of five), and to incorporate weighted data.

Results of Rosner's test confirmed formal identification of all nine visually extreme values as statistical outliers. Further, test calculations of the arsenic background BTVs found that including the apparent outliers significantly increased the threshold estimates over those resulting from calculations of BTVs that excluding them. Consequently, all the formal statistical outliers were removed from the data before calculations of final BTVs. In this case, removing outliers had the effect of increasing the number of locations where cleanup was to occur, and increasing the total volume of soil subject to controls, removal, or treatment.

3.3 STATISTICAL METHODS FOR BACKGROUND THRESHOLD VALUE CALCULATIONS

BTVs address statistical needs of soil background studies. Estimated site-specific or regional BTVs are used in background studies at CERCLA sites to (1) identify contaminants of potential concern, (2) identify areas of concern, and (3) compare on-site contaminant concentrations to site-specific or regional background contaminant concentrations. BTVs are calculated from the upper limits of established datasets. These upper limits, such as UTLs, are used to estimate BTVs or not-to-exceed values (USEPA 1992, 2002, 2009). For the purposes of this study, the BTV is set to the UTL95-95 for any given dataset. A UTL is designed to place a reasonable upper bound on the underlying background population. In this instance, the UTL technically represents a 95 percent upper confidence limit on the background 95th percentile estimates. UTL95-95 values for the IKHS background dataset were calculated by use of the statistical programming language R.

Because BTVs must justify site-wide cleanup goals protective of human health and the environment above background, BTVs had to be differentiated spatially. The irregular spatial pattern of the background measurements surrounding the APSI, including relatively tight clustering of many soil samples and associated hot spots, required statistical weighting to compute estimates of BTVs. Proper use of declustering weights reduces bias that would result from application of equally weighted statistics on spatially clustered data.

3.3.1 Statistical Weighting

This alternative strategy for calculating UTL95-95 values in R is predicated on weighting the individual observations differentially based on a Voronoi tessellation of the separate background areas when classified by a defining characteristic (that is, areal grouping [see Section 4.3.2]). A Voronoi tessellation parses a given background region into a series of nonoverlapping polygons, each containing one of the sample measurements and defined so that every point within a polygon is closer in distance to the contained observation than to any other background sample outside the polygon (Ripley 1981; Arlinghaus and Kerski 2014; Baddeley, Rubak, and Turner 2016). Therefore, the Voronoi tessellation of the background areas differentially weights each observation depending on size of its Voronoi polygon.

The net effect of a Voronoi tessellation is to construct smaller polygons for clustered samples and larger polygons for isolated or more sparsely distributed points. By assigning the area of each polygon to its contained observation as its statistical weight, the outcome is a differential, spatial weighting of the measurements in which each clustered value is down-weighted relative to the weights of non-clustered locations. Thus, clusters located in higher concentration subareas (for example, hot spots) are not given undue statistical weight relative to other portions of the background.

Tests of this approach on the IKHS arsenic background database found that a small number of spatially isolated but relatively high-level arsenic values unduly influenced the BTV estimates. Voronoi-type weighting tends to work well when sample locations are clustered because of the spatial delineation of hot spots, such that the smaller weights assigned to clustered locations avoid upward biasing of the statistical limits. However, the Voronoi polygons associated with isolated observations tend to be larger than either clustered measurements or samples laid out along a regular grid pattern. If some of these isolated values are unusually high in concentration, the reverse bias effect can occur, by which the isolated observations cause an upward bias because of their larger spatial weighting.

To avoid this reverse bias, a slightly different weighting scheme was ultimately applied to the IKHS arsenic background database for calculation of BTVs. Instead, equal weighting of each distinct sampling location was applied to reduce the effect of co-located samples and XRF measurements completed at the same location. This equal-per-location-weighting scheme is different than a strictly unweighted approach whereby each individual observation receives the same weight of 1. Instead, because many locations in the updated background data have multiple sample values (ranging from two to nine separate measurements at the same locations), the weights assigned to the values at each distinct sampling location were divided by the number of measurements at that spot. For example, four separate arsenic measurements via XRF spectrometer occurred at location XRF-046. Accordingly, the statistical weight assigned to each value at that location was 0.25 (one location divided by four measurements).

3.3.2 Areal Grouping

Multiple subgroupings of the IKHS background arsenic database were considered when calculating the final BTV estimates. The four different types of soils groupings (Lonti, Moano, alluvial land, and Balon) and a geographic divide between the east and west sides of Agua Fria River each potentially contributes to different representative background limits. Tests occurred of each possible grouping of soils type and location with respect to the Agua Fria River. While no arsenic BTV test value was the same from group to group, the final distinction of east-west was chosen to balance the following factors:

1. Maximize the statistical difference between BTV estimates from one grouping to the next.
2. Maximize the number of measurements in each grouping to avoid statistical artifacts and bias because of small sample sizes where these occur.
3. Minimize the number of separate BTVs to ease the logistical complexity of implementing the remedial program.

4. Maximize the fit of the data in each grouping to a known statistical model.

To aid in this decision, the Kolmogorov-Smirnov test was applied to each possible set of subgroups to assess whether the subgroup distributions differed in a statistically significant manner. The empirical distribution functions were also plotted to visualize any differences. Empirical cumulative distribution plots appear on Figure 6, Figure 7, Figure 8, and Figure 9 for the various areal groupings considered for BTV calculations. Overall, the largest statistical difference was found when the data were not subdivided by soils type but by location relative to the Agua Fria River. Based on the above criteria, and additional evidence provided in Section 2.2, the most distinct and statistically defensible data grouping was the east-west divide of the Agua Fria River. Subsequently, two sets of final BTV estimates were calculated—one for the east side of the river and one for the west side of the river. This finding differs from grouping by soils type, which would lead to many BTVs and multiple cleanup levels.

3.3.3 95 Percent Upper Tolerance Limit Algorithms

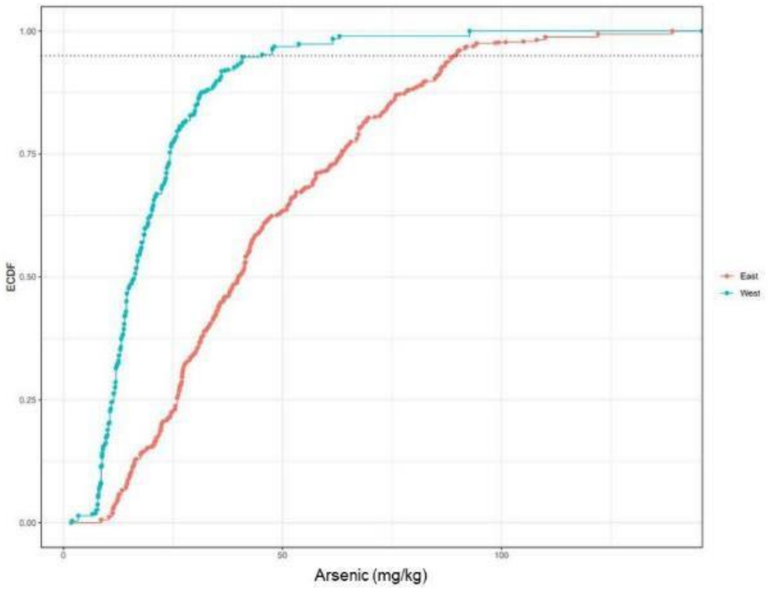
Applying the spatial weighting and areal grouping scheme described in the previous subsections, three different algorithms for calculating BTVs were compared: (1) a standard weighted parametric method, (2) a weighted bootstrap-t method, and (3) a weighted nonparametric bootstrap method. In each case, the outcome of the calculation was an estimate of the UTL95-95.

As stated previously, no methodology has been established for selecting BTVs in this situation. Tetra Tech and Neptune recommend the weighted nonparametric bootstrap UTL method because it incorporates bootstrapping, is not fit to a parametric distribution, and provides more conservative estimates of BTVs. The three methods are described in the following subsections.

3.3.3.1 Weighted Parametric Upper Tolerance Limit

In the parametric method, an attempt is made to find a known statistical distribution or model that closely fits the observed background data. In some instances, the well-known normal distribution may provide a good match to the data, but in many other instances, a mathematical transformation of the data may be necessary to normalize the measurements. Once an adequate model is found and tested for goodness of fit, a standard equation is employed for computing a parametric UTL based on calculating the sum of the mean of the data plus a multiple (κ) of the standard deviation (SD):

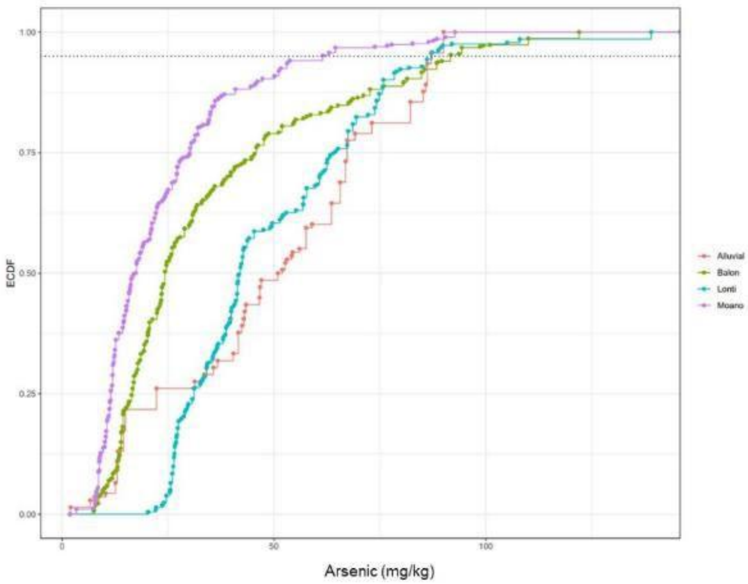
$$\text{UTL} = \text{mean} + \kappa \text{ SD}$$



Notes:

CDF	Cumulative distribution function
ECDF	Empirical cumulative distribution function
mg/kg	Milligrams per kilogram

Figure 6. CDF Plot (No Outliers) Grouped by Direction from the Agua Fria River



Notes:

CDF	Cumulative distribution function
ECDF	Empirical cumulative distribution function
mg/kg	Milligrams per kilogram

Figure 7. CDF Plot (No Outliers) Grouped by Soil Type

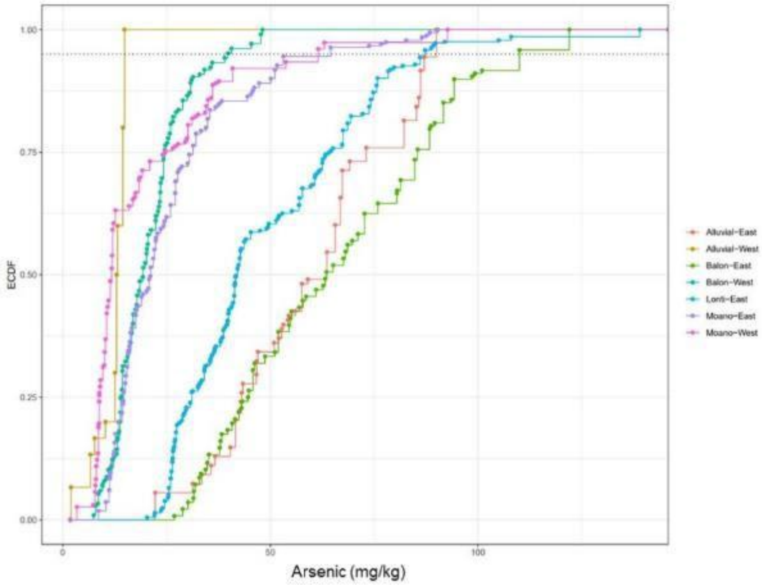
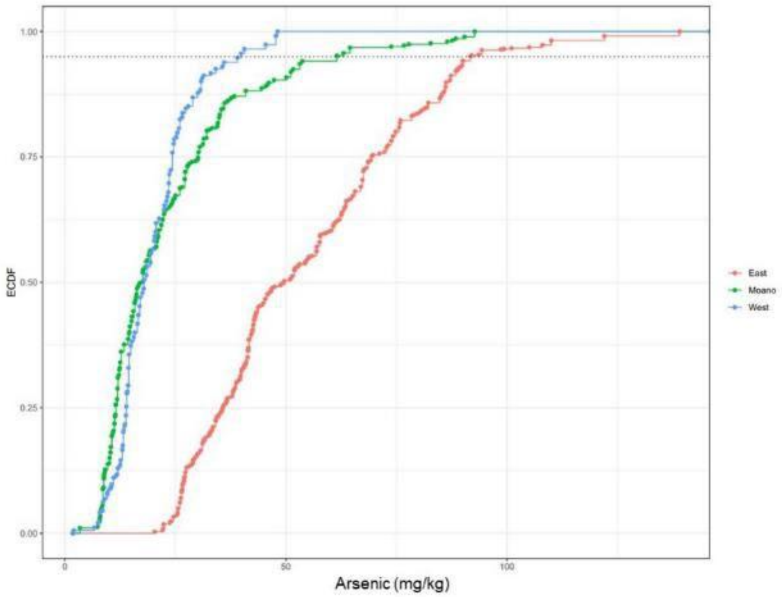


Figure 8. CDF Plot (No Outliers) Grouped by Soil Type and Direction from the Agua Fria River

Notes:

CDF	Cumulative distribution function
ECDF	Empirical cumulative distribution function
mg/kg	Milligrams per kilogram

Figure 9. CDF Plot (No Outliers) Grouped by Direction from the Agua Fria River with Moano Soils Separated



Notes:

CDF	Cumulative distribution function
ECDF	Empirical cumulative distribution function
mg/kg	Milligrams per kilogram

The value of the multiplier κ (also known as the tolerance factor) depends on the background sample size and the chosen levels of confidence and coverage (that is, the targeted upper percentile) for the UTL. If the data have been normalized via a transformation, the UTL equation is computed on the transformed data and then back-transformed to obtain an estimate in the original data scale.

The statistical weights from the equal-per-location weighting were employed by replacing the mean and SD from a typical unweighted parametric analysis (see formula above) by a weighted mean and weighted SD.

3.3.3.2 Weighted Bootstrap-t Upper Tolerance Limit

The bootstrap method is a modern resampling technique designed to enable statistical estimates of almost any sort even if the underlying data are complex and may not fit a standard statistical distribution. At a general level, the bootstrap method is computer-intensive, involving repeated resampling of the observed data with replacement to form a large series of bootstrap samples (also known as replicates). Each bootstrap replicate contains the same number of values as the original background sample. However, bootstrap resampling purposely allows any given measurement to occur multiple times within the same bootstrap replicate while other values are left out. This key aspect of the method can seem counterintuitive but leads to accurate statistical estimates even when the underlying population is unknown.

The bootstrap-t method is a special case of the general bootstrap resampling technique. The bootstrap-t method can be applied to unknown populations but works best when the underlying data are roughly symmetric (like the normal distribution) and not as well when the data are highly skewed. To avoid the problem of skewness, the bootstrap-t method was applied only to data that were first normalized via a transformation. Under this framework, the same parametric equation for a UTL was used, but the multiplier (κ) was not selected from a statistical table. Instead, bootstrapping was used to calculate a bootstrap multiplier, which was then combined with the mean and SD of the background data to calculate the estimated BTV.

The statistical weights from the equal-per-location weighting were also employed in computing the bootstrap multiplier so that the final estimate was not unduly influenced by the multiple background values from the same location. Further, the mean and SD of the unweighted parametric case were replaced by a weighted mean and weighted SD.

3.3.3.3 Weighted Nonparametric Bootstrap Upper Tolerance Limit

Unlike the bootstrap-t method, the nonparametric bootstrap method does not generally involve any model fitting or data transformation. Bootstrap replicates are formed by resampling with replacement from the original dataset, and then the statistic of interest is calculated on each replicate. In this case, for a UTL95-95, the 95^{th} percentile is calculated, leading to a long series of 95^{th} percentile estimates (one per bootstrap replicate). Finally, since the UTL represents a 95 percent upper confidence limit on the 95^{th} percentile, the 95^{th} percentile of this bootstrap series is taken as the final UTL or BTV.

To calculate a weighted bootstrap, each element of the series of bootstrap 95th percentiles was computed as a weighted percentile instead of an unweighted percentile. Consequently, background values with smaller equal-per-location statistical weights have less impact on the percentile outcome than measurements with larger weights.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Tetra Tech applied a statistical strategy and approach to calculate arsenic BTVs for soils near IKHS. Bootstrap models for spatial weighting were used to calculate parametric and nonparametric BTVs in R. Calculated arsenic BTVs for the east and west sides of the Agua Fria River for the IKHS background database are listed in Table 4.

The east-west classification was found to be the most useful way of identifying the BTVs to be used for cleaning up arsenic in soil around IKHS because different background levels of arsenic were found most strongly grouped on either side of the Agua Fria River. Figure 10 shows violin plots of updated IKHS background sample database on either side of the Agua River. These plots visually illustrate the differences in range and grouping of sample results on either side with nearly all samples on the west side below 50 mg/kg, and majority of samples on the east side ranging up to 100 mg/kg. This selection is justified by multiple lines of evidence, including the distinct chemical signatures of soil samples on each side of the river, the similarity in surface and subsurface concentrations of arsenic and other analytes by east-west side of the river, and the statistically significant difference between the two groupings. Because BTVs must justify site-wide cleanup goals protective of human health and the environment above background, BTVs had to be differentiated spatially. The most distinct and statistically defensible data grouping at IKHS was the east-west divide of the Agua Fria River.

Three different methods of BTV calculation were used to estimate appropriate arsenic BTVs on each site of the Agua Fria River. While these estimates differ substantially by location relative to the Agua Fria river, they also differ to a lesser extent among themselves within each data subgrouping. The mixed alluvial sources contributing to the soils on the east side of the river may be naturally higher in arsenic than the alluvium and residuum on the west side of the river. Figure 11 visually shows the grouping of the BTVs calculations on either side of Agua Fria River with the three BTV estimates on the east side clustered near 100 mg/kg while on the West side, they cluster closer to 50 mg/kg. Table 4 lists these BTV calculations for both sides and show that the three BTV estimates on the east side range from 97.6 mg/kg to 103 mg/kg with an average of 98.6 mg/kg, while on the West side, they range from 41.2 mg/kg to 52.7 mg/kg with an average of 47.5 mg/kg.

As the BTV estimates within each subgrouping vary in rank order as shown in Table 4 (e.g., the bootstrap-t BTV is the highest of the three on the West side, but the lowest of the three on the East side, etc.), use the arithmetic mean from the separate estimates for the final BTV is appropriate. The rationale for use of the average is that each of the methods may be slightly biased in one direction or the other, but the average should be more robust overall and closer to the actual BTV of the underlying arsenic background population, the vast majority of which has never been sampled or observed. Averaging the BTVs within each subgroup leads to final estimates of 98.6 mg/kg on the East side of the Agua Fria and 47.5 mg/kg on the West side.

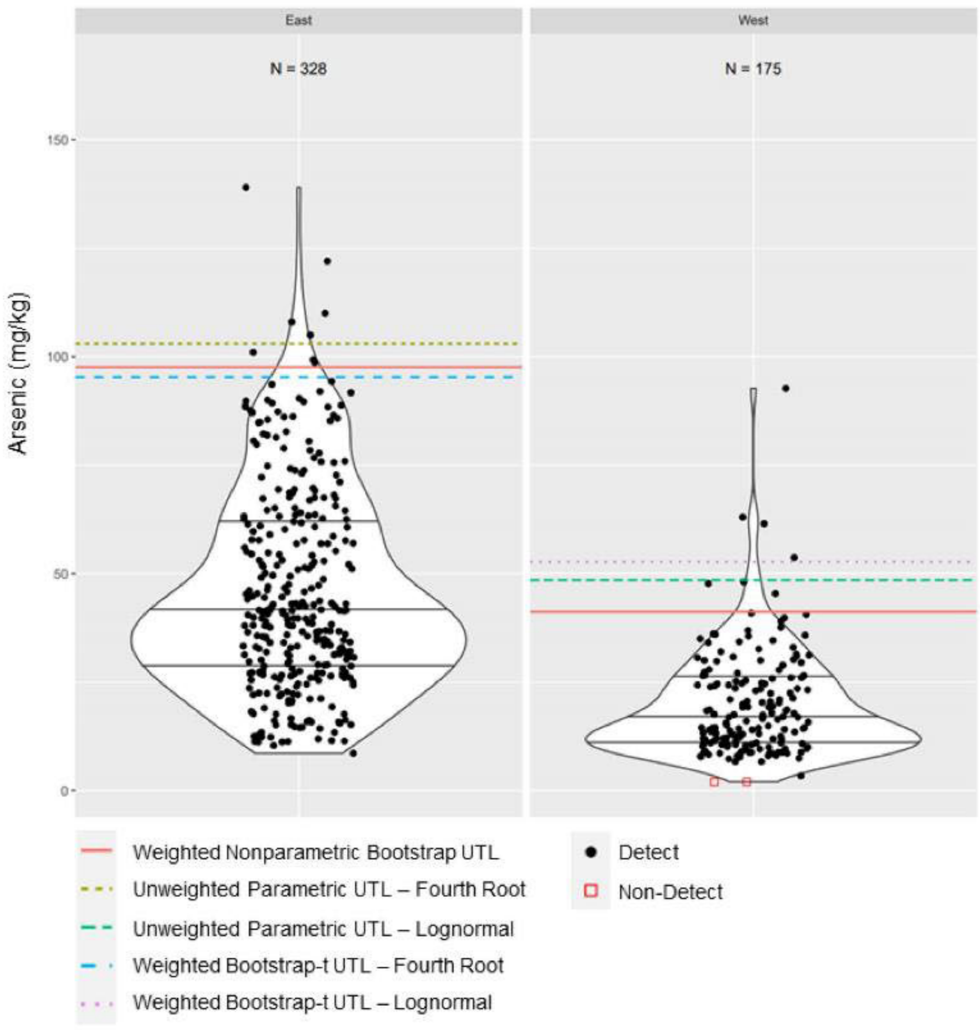
Table 4. Summary of BTV Calculations East and West of the Agua Fria River

Grouping	n	Model		As BTV (mg/kg)	Average (mg/kg)
East of the Agua Fria River	328	Weighted Nonparametric Bootstrap UTL		97.6	**98.6**
		Weighted Bootstrap-t UTL	Fourth Root	95.3	
		Weighted Parametric UTL	Fourth Root	103	
West of the Agua Fria River	175	Weighted Nonparametric Bootstrap UTL		41.2	**47.5**
		Weighted Bootstrap-t UTL	Lognormal	52.7	
		Weighted Parametric UTL	Lognormal	48.5	

Notes:
[1] Bolded value indicates the selected As BTV for each grouping.

As	Arsenic
BTV	Background threshold value
mg/kg	Milligrams per kilogram
n	Number of samples
UTL	Upper threshold limit

Refined BTV Calculations for Arsenic at IKHS



Notes:

IKHS	Iron King Humboldt Smelter
mg/kg	Milligrams per kilogram
N	Number of samples
UTL	Upper tolerance limit

Figure 10. Violin Plot of Updated IKHS Background Sample Database Grouped by Direction from the Agua Fria River

5.0 REFERENCES

Archaeological Consulting Services, Ltd. 2008. "A Cultural Resource and Historic Building Survey for a Remedial Investigation/Feasibility Study at the Iron King Mine-Humboldt Smelter Superfund Site, Dewey-Humboldt, Yavapai County, Arizona." November.

Arlinghaus, S.L. and J.J. Kerski. 2014. *Spatial Mathematics: Theory and Practice Through Mapping*. Boca Raton, FL: CRC Press.

Baddeley, A., E. Rubak, and R. Turner. 2016. *Spatial Point Patterns*. Boca Raton, FL: CRC Press.

CH2M Hill, Inc. 2016. "Remedial Investigation Report, Iron King Mine – Humboldt Smelter Superfund Site, Dewey-Humboldt, Yavapai County, Arizona." September.

Crumbling, D. 2021. "Tutorial: Using ProUCL to Manage Predicting Lab-Equivalent Values from XRF Data." August 16.

Ripley, B.D. 1981. *Spatial Statistics*. New York, NY: John Wiley & Sons, Inc.

U.S. Department of Agriculture (USDA) National Cooperative Soil Survey (NCSS). 2006. Balon Series. Established Soil Description. Arizona. Rev. GEW/YHH. May.

USDA NCSS. 2008. Lonti Series. Established Soil Description. Arizona and New Mexico. Rev. GEW/JEJ. December.

USDA National Resources Conservation Service (NRCS). 2022. "Web Soil Survey." Accessed May 2023. https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

U.S. Environmental Protection Agency (USEPA). 1992. "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities. Addendum to Interim Final Guidance." Office of Solid Waste and Emergency Response. EPA/600/R-92/128. July.

USEPA. 2002. "Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites." EPA 540/R-01-003. September.

USEPA. 2006. "Data Quality Assessment: Statistical Methods for Practitioners." EPA QA/G-9S. EPA/240/B-06/003. February.

USEPA. 2009. "Unified Guidance: Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities." EPA/530/R-09/007. March.

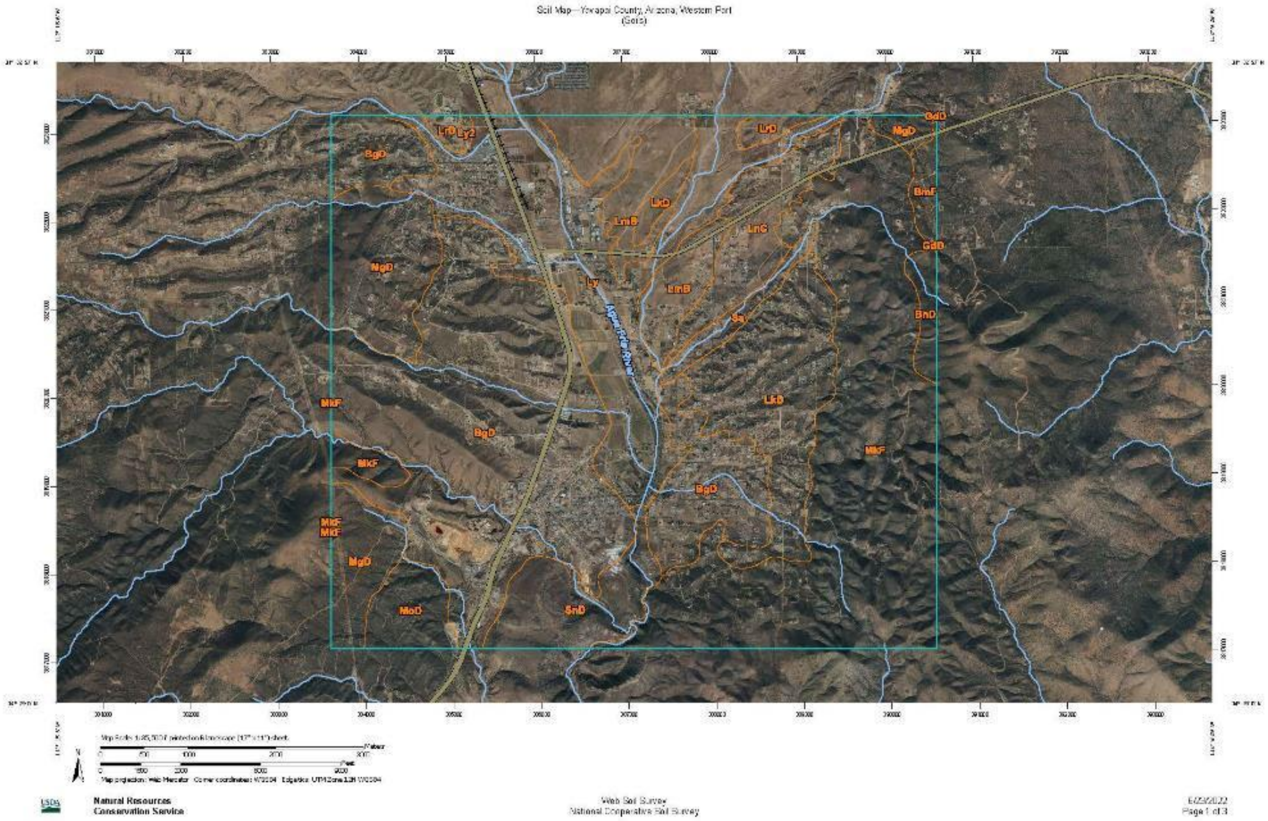
USEPA 2012. "Field Report and Preliminary Results, X-Ray Fluorescence (XRF) Soil Sampling, April 17-19, 2012, Iron King Mine – Humboldt Smelter Superfund Site, Humboldt, Arizona." April 25.

USEPA. 2015. "ProUCL Version 5.1 Technical Guide." Prepared by A. Singh and A.K. Singh. Office of Research and Development. EPA/600/R-07/041. October.

USEPA. 2022. "ProUCL Version 5.2 Technical Guide." Prepared by Neptune and Company, Inc. Office of Research and Development. June.

ATTACHMENT A

WEB SOIL SURVEY RESULTS AND SOIL SERIES DESCRIPTIONS


Soil Map—Yavapai County, Arizona, Western Part
(Soils)
BgD
NgD
MkF
MoD
SnD
LkB
LmB
LnC
GdD
BmF
BnD
Natural Resources
Conservation Service
Web Soil Survey
National Cooperative Soil Survey

Soil Map—Yavapai County, Arizona, Western Part
(Soils)

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:31,700.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Yavapai County, Arizona, Western Part
Survey Area Data: Version 14, Sep 16, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Nov 26, 2021—Dec 11, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BgD	Balon gravelly sandy clay loam, 5 to 30 percent slopes	2,949.0	28.4%
BmF	Barkerville cobbly sandy loam, 20 to 60 percent slopes	76.3	0.7%
BnD	Barkerville very stony sandy loam, 5 to 25 percent slopes	90.1	0.9%
GdD	Gaddes gravelly sandy loam, 3 to 25 percent slopes	2.5	0.0%
LkD	Lonti gravelly sandy loam, 15 to 30 percent slopes	825.2	8.0%
LmB	Lonti gravelly loam, 0 to 8 percent slopes	563.3	5.4%
LnC	Lonti cobbly loam, 0 to 15 percent slopes	376.0	3.6%
LrD	Lonti-Abra complex, 8 to 30 percent slopes	80.6	0.8%
Ly	Lynx soils	1,474.1	14.2%
Ly2	Lynx soils, eroded	11.1	0.1%
MgD	Moano gravelly loam, 0 to 30 percent slopes	818.8	7.9%
MkF	Moano very rocky loam, 15 to 60 percent slopes	2,383.1	23.0%
MoD	Moano extremely rocky loam, 15 to 30 percent slopes	204.9	2.0%
Sa	Sandy and Gravelly alluvial land	111.6	1.1%
SnD	Springerville-Cabezon complex, 3 to 30 percent slopes	399.6	3.9%
Totals for Area of Interest		**10,366.7**	**100.0%**

LOCATION BALON AZ

Established Series
Rev. GEW/YHH
05/2006

BALON SERIES

The Balon series consists of very deep, well drained soils that formed in mixed fan alluvium dominantly from schist, granite, basalt and related rocks. Balon soils are on fan terraces. Slopes are 2 to 25 percent. The mean annual precipitation is about 14 inches and the mean annual temperature is about 54 degrees F
TAXONOMIC CLASS: Fine-loamy, mixed, superactive, mesic Ustic Haplargids

TYPICAL PEDON: Balon gravelly sandy clay loam, grassland. (Colors are for dry soil unless otherwise noted.)

A--0 to 3 inches; dark grayish brown (10YR 4/2) gravelly sandy clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable, nonsticky and slightly plastic; few fine roots; many fine interstitial pores; moderately acid (pH 6.0); abrupt smooth boundary. (1 to 4 inches thick).

Bt1--3 to 7 inches; dark grayish brown (10YR 4/2) heavy clay loam, dark brown (7.5YR 3/2) moist; moderate fine subangular blocky structure; hard, friable, slightly sticky and plastic; common fine roots; common fine tubular pores; few thin clay films on ped faces and lining pores; 5 to 15 percent gravel; noneffervescent; neutral (pH 7.0); clear smooth boundary. (3 to 5 inches thick)

Bt2--7 to 15 inches; brown (7.5YR 5/4) gravelly clay loam, brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; very hard, friable, sticky and plastic; many fine roots; common fine tubular pores; common thin clay films on ped faces 25 percent gravel; noneffervescent; neutral (pH 7.0); clear wavy boundary. (7 to 12 inches thick)

BC1--15 to 23 inches; mottled brownish yellow (10YR 6/6), yellowish brown (10YR 5/4) and pale brown (10YR 6/3) gravelly sandy clay loam, mottled dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) and brown (10YR 5/3) moist; weak medium subangular structure; very hard, friable, sticky and plastic; common fine roots; common fine tubular; noneffervescent; slightly alkaline (pH 7.5); clear wavy boundary. (5 to 9 inches thick)

BC2--23 to 36 inches; light yellowish brown (10YR 6/4), yellowish brown (10YR 5/4) and pale brown (10YR 6/3) gravelly sandy loam, yellowish brown (10YR 5/4), brownish yellow (10YR 6/6) and dark yellowish brown (10YR 4/4) moist, mottles are many fine and medium faint and distinct; massive breaking to weak medium subangular blocky structure; very hard, friable, sticky and plastic; common fine medium and coarse roots; few fine and medium tubular and many fine interstitial pores; oriented clay occurs as bridges holding mineral grains together; few thin clay films on ped faces; noneffervescent; neutral (pH 7.2); clear wavy boundary. (8 to 15 inches thick)

C1--36 to 54 inches; mottled light yellowish brown (10YR 6/4), brownish yellow (10YR 6/6) and dark yellowish brown (10YR 4/4) gravelly sandy loam, dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/6), brownish yellow (10YR 6/6) and dark brown (10YR 3/3) moist; massive; hard, friable, slightly sticky and plastic; common fine roots; many fine interstitial pores; noneffervescent; neutral (pH 7.2); gradual wavy boundary. (12 to 20 inches thick)

C2--54 to 73 inches; very pale brown (10YR 8/4) gravelly sandy loam, yellowish brown (10YR 5/4) moist; massive; hard, friable, nonsticky and slightly plastic; few fine and medium roots; many fine interstitial pores;

noneffervescent; neutral (pH 7.2).

TYPE LOCATION: Yavapai County, Arizona. .7 mile west and .3 mile south of NE corner sec. 5, T.12N., R.1E., about 1/2 mile NE of Poland Junction Substation on south exposure of ridge.

RANGE IN CHARACTERISTICS:
Mean annual soil temperature: about 56 degrees F.

Soil Moisture: These soils are usually dry especially during the months of May, June, October and November. Ustic aridic moisture regime

A horizon
Hue: 10YR and 7.5YR
Value: 4 and 5 dry and 2 and 3 moist
Chroma: 2 to 4
Texture: sandy loam, gravelly sandy loam, gravelly sand clay loam and gravelly clay loam.
Reaction: 6.0 to 7.0

Bt horizons
Hue: 10YR and 7.5YR
Value: 4 to 6 dry and 3 to 5 moist
Chroma: 2 to 4
Texture: clay loam, clay, gravelly clay loam and gravelly clay.

BC horizons
Hue: 10YR through 5YR but are dominantly 7.5YR and 10YR
Value: 4 to 6 dry and 3 to 5 moist
Chroma: 3 to 6
Texture: averages less than 35 percent clay and is usually gravelly.
Structure: ranges from subangular blocky and angular blocky in the gravelly clay loam type to prismatic in the sandy loam type.

C horizons
Texture: gravelly loamy sand, gravelly sandy loam, gravelly loam, gravelly sandy clay loam and gravelly clay loam
Reaction: 6.5 to 8.0.

COMPETING SERIES: These are the Blancot (NM), Bowbac (WY), Buckle (NM), Cambria (WY), Chilerojo (NM), Cushman (WY), Decolney (WY), Doakum (NM), Forkwood (WY), Fort (CO), Gaddes (AZ), Gapbutte (AZ), Gapmesa (CO), Hagerman (NM), Hagerwest (NM), Hiland (WY), Mentmore (NM), Oelop (NM), Olney (CO), Palacid (NM), Penistaja (NM), Pokeman (WY), Potts (WY), Pugsley (WY), Quagwa (AZ), Redpen (NM), Spangler (WY), Sundance (CO), Tamarindo (NM), Teckla (WY) and Yenlo (CO) series.

Blancot and Mentmore soils have hues yellower than 10YR.

Bowbac, Cushman, Fattig, Flaco, Gaddes, Gapbutte, Gapmesa, Hagerman, Hagerwest, Pokeman, Progresso, Pugsley, Spangler, and Threetop soils have bedrock at depths of 20 to 40 inches.

Buckle soils have sola over 40 inches thick.

Cambria soils are dry in all parts of the moisture control section for at least 60 consecutive days and at least 90 cumulative days from July 15 to October 25.

Decolney soils have a MAST of 47 to 52 degrees F.

Forkwood soils are dry in all parts of the moisture control section for 60 consecutive days or more from July 15 to October 25.

Olney soils have a mean annual soil temperature greater than 52 degrees F., and are in a climatic setting that receives 3/4 of their precipitation between April and September and have a PE Index of about 20.

Oelop soils have a C horizon with hues redder than 7.5YR.

Palacid soils have less than 35 percent fine sand or coarser.

Penistaja soils typically have hue of 5YR or redder in the upper part of the B2t horizon.

Potts soils have less than 35 percent fine and coarser sand in the control section.

Quagwa soils have mean annual soil temperature of 54 to 57 degrees F.

Redpen soils have hue of 5YR or redder.

Sundance soils have lithic discontinuities formed from eolian sands on top of loess and the argillic horizon formed in part, in both materials.

Teckla soils have fragmental discontinuity below the Bt with over 35 percent rock fragments.

Yenlo soils have Ck horizons, hues 10YR and yellower, and MAST 47 to 52 degrees F.

In addition, the Bowbac, Cushman, Decolney, Fort, Hagerman, Olney, Pokeman, Potts, Pugsley, Spangler, Sundance and Tekla series are in LRR-G and are more moist in May and June.

GEOGRAPHIC SETTING: The Balon soils are at elevations of 4,000 to 5,000 feet on fan terraces. Slopes range from 2 to 25 percent. The regolith consists of mixed fan alluvium dominantly from schist, granite, basalt and related rocks. These soils are in a cool, semi-arid, continental climate, having a mean annual temperature of 50 degrees to 58 degrees F. The average annual precipitation ranges from 12 to 16 inches and occurs as thunderstorms in July through September and as rain and snow during the winter months. The frost-free period ranges from 144 and 223 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the Abra, Arp, Cordes, Lynx, Moano and Pastura in addition to the Lonti and Wineg series. Abra soils have a high lime content throughout and do not have an argillic horizon. Arp soils are redder, having hues of 5YR and 2.5YR and are fine-textured. Cordes soils are moderately coarse-textured and have a mollic epipedon. Lynx soils are in a fine-loamy family but are dark-colored and have a mollic epipedon. Moano soils have a lithic contact at shallow depths and are residual on schist. Pastura soils lack a Bt horizon and have a petrocalcic horizon at shallow depths.

DRAINAGE AND PERMEABILITY: Well-drained. Surface runoff ranges from slow to medium. Permeability is moderately slow to slow.

USE AND VEGETATION: Used mainly as rangeland. Native vegetation consists of oak brush, catclaw, Nolina, snakeweed and cacti with an understory of blue grama, sideoats grama, black grama and three-awns.

DISTRIBUTION AND EXTENT: Central and southern Yavapai Co., Arizona. These soils are moderately extensive. Approximately 26,000 acres have been mapped in the Western Yavapai Co. Soil Survey Area. MLRA 35.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Western Yavapai County Area, Yavapai County, Arizona, 1971.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric Epipedon - The zone from the surface of the soil to a depth of 3 inches (A horizon).

Argillic horizon - The zone from 3 to 15 inches (Bt horizons).

Classified according to Keys to Soil Taxonomy Ninth Edition, 2003.

National Cooperative Soil Survey
U.S.A.

LOCATION LONTI AZ+NM

Established Series
Rev. GEW/JEJ
12/2008

LONTI SERIES

The Lonti series consists of very deep, well drained soils that formed in old gravelly alluvium from mixed sources. These soils are on nearly level plains to steep alluvial fans. The mean annual precipitation is about 15 inches and the mean annual air temperature is about 54 degrees F.

TAXONOMIC CLASS: Fine, mixed, superactive, mesic Ustic Haplargids

TYPICAL PEDON: Lonti gravelly sandy loam - rangeland. (Colors are for dry soil unless otherwise noted.)

A--0 to 2 inches; grayish brown (10YR 5/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium and thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and fine vesicular pores; 25 percent gravel and few cobbles; noneffervescent; neutral (pH 6.9); clear wavy boundary. (1 to 5 inches thick)

Bt1--2 to 5 inches; dark brown (10YR 3/3) dry and moist gravelly sandy clay loam; moderate very fine and fine subangular blocky structure; hard, friable, sticky and plastic; many very fine and fine roots; many fine and very fine interstitial and common very fine and fine tubular pores; few thin clay films on peds; 20 percent gravel; noneffervescent; neutral (pH 6.6); clear wavy boundary. (2 to 6 inches thick)

Bt2--5 to 10 inches; reddish brown (5YR 4/3) gravelly clay, reddish brown (5YR 4/4) moist; weak fine and medium subangular blocky structure; very hard, firm, sticky and plastic; many very fine and fine roots; common fine interstitial pores; common thin clay films on peds; 25 percent gravel; noneffervescent; neutral (pH 6.6); clear smooth boundary. (5 to 14 inches thick)

Bt3--10 to 26 inches; reddish brown (5YR 4/4) gravelly clay, dark reddish brown (5YR 3/4) moist; moderate medium subangular blocky structure; very hard, firm, sticky and plastic; common fine and medium roots; common very fine and fine tubular and many fine interstitial pores; common moderately thick clay films on peds; 25 percent gravel; noneffervescent; moderately alkaline (pH 7.9); clear wavy boundary. (6 to 16 inches thick)

Bt4--26 to 45 inches; reddish brown (5YR 5/4) gravelly clay loam, reddish brown (5YR 4/4) moist; 25 percent of horizon consists of pockets of pink (5YR 7/4) gravelly clay loam, reddish brown (5YR 4/4) moist; similar to Bk1 horizon but noneffervescent; weak medium subangular blocky structure; very hard, firm, sticky and plastic; few fine and very fine roots; few very fine and fine tubular and common fine interstitial pores; common moderately thick clay films on peds and common pressure faces; 30 percent gravel; noneffervescent; moderately alkaline (pH 8.0); gradual wavy boundary. (4 to 20 inches thick)

Bk1--45 to 55 inches; pink (5YR 7/3) very gravelly sandy clay loam, yellowish red (5YR 5/6) moist; massive; very hard, firm, slightly sticky and plastic; few fine and very fine roots; few fine tubular and common fine interstitial pores; few pressure faces; 40 percent gravel; slightly effervescent; moderately alkaline (pH 8.0); gradual irregular boundary. (8 to 20 inches thick)

Bk2--55 to 68 inches; light reddish brown (5YR 6/4) extremely gravelly sandy clay loam, reddish brown (5YR 5/4) moist; massive; hard, friable, slightly sticky and plastic; few fine roots; common fine tubular and many interstitial pores; 60 percent gravel; noneffervescent to strongly effervescent; moderately alkaline (pH 8.0).

TYPE LOCATION: Yavapai County, Arizona; about 1 mile NW of the junction of the Rancho Moano and Williamson Valley roads; 1/2 mile west and 3/10 mile north of SE corner of sec. 3, T.15N., R.4W.

RANGE IN CHARACTERISTICS:

Soil moisture: Intermittently moist in some part of the soil moisture control section during July through September and December through March. Driest during May and June. Ustic aridic soil moisture regime.

Mean annual soil temperature: 54 degrees to 59 degrees F.

Thickness of the solum: 18 to 45 inches

Rock fragments: 5 to 35 percent by volume

Organic matter: more than 1 percent

A and upper B horizons
Hue: 5YR through 10YR but are dominantly 7.5YR or 10YR
Texture: A horizon is sandy loam, gravelly sandy loam, gravelly loam or cobbly loam
Reaction: slightly acid to neutral

Bt horizons
Hue: 5YR, 7.5YR
Value: 4 or 5 dry, 3 or 4 moist
Chroma: 3 through 6, dry or moist
Texture: clay loam, clay, gravelly heavy clay loam, gravelly clay
Structure: medium prismatic to weak fine and medium subangular blocky

Bk horizons
Hue: 5YR, 7.5YR, 10YR
Value: 5 through 8 dry
Chroma: 4 through 6, dry or moist
Texture: gravelly clay loam, gravelly sandy loam, gravelly loamy sand
Calcium carbonate: occurs as medium to large pockets but the horizon has less than 15 percent CaC03 equivalent.

COMPETING SERIES: These are the Mags (CO), Padilla (AZ), Servilleta (NM), Silver (NM), and Tobish (UT) series. Chafin soils have less than 5 percent rock fragments and are effervescent throughout the profile. Mags, Padilla and Silver soils have secondary carbonates in the argillic horizon. The Silver series attempts to reflect the effects of soil forming agents unique to the Great Plains. Servilleta and Tobish soils have bedrock at moderate depths.

GEOGRAPHIC SETTING: Lonti soils are on nearly level plains to steep alluvial fans. The soils are formed in old gravelly alluvium from granite, schist, sandstone, limestone, shale and basaltic materials. These soils are at elevations of 4,000 to 5,500 feet in a continental climate with an annual precipitation of 12 to 20 inches. The mean annual air temperature ranges from 52 degrees to 57 degrees F. The frost-free period is 140 to 200 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Abra, Cordes, Lynx, Pastura and Wineg soils and the competing Balon and Poley soils. Abra, Lynx and Cordes soils lack fine-textured argillic horizons. Pastura soils are shallow to an indurated calcic horizon. Wineg soils have a moderately fine-textured control section and a mollic epipedon.

DRAINAGE AND PERMEABILITY: Well-drained; medium to slow runoff; slow permeability.

USE AND VEGETATION: These soils are used mainly for livestock grazing and wildlife habitat. Small areas are irrigated. Vegetation is oakbrush, deerbrush and squaw bush with an understory of grama grasses, muhly grasses and squirreltail. At higher elevations some pinon pine and juniper occur. At lower elevations the grasses are dominant and include tobosa grass in addition to those mentioned above.

DISTRIBUTION AND EXTENT: Western Yavapai County Area, Yavapai County, Arizona. These soils are extensive. MLRA 38 & 39.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Western Yavapai County Area, Yavapai County, Arizona, 1971.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - The zone from 0 to 2 inches (A horizon)

Argillic horizon - The zone from 2 to 45 inches (Bt horizons)

Classified according to Soil Taxonomy, Second Edition, 1999; Keys to Soil Taxonomy, Tenth Edition, 2006.

The mean annual precipitation of 12 to 20" p.z. described in the GEOGRAPHIC SETTING section crosses two moisture regimes - Ustic aridic and Aridic ustic. The soil mapped in the Aridic ustic moisture regime (16 to 20" p.z.) would classify as Aridic Haplustalfs. When Western Yavapai County Area, Yavapai County, Arizona soil survey is updated, this series should be evaluated to decide which moisture regime is typical.

Update and revisions for the competing series section 2/08 DWD

National Cooperative Soil Survey
U.S.A.

LOCATION LYNX AZ+WY

Established Series
Rev. DRT-MSY-PDC
11/2006

LYNX SERIES

The Lynx series consists of deep, well drained soils that formed in mixed alluvium. Lynx soils are on flood plains and alluvial fans and have slopes of 0 to 8 percent. The mean annual precipitation is about 12 inches and the mean annual temperature is about 53 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, mesic Cumulic Haplustolls

TYPICAL PEDON: Lynx loam - rangeland. (Colors are for dry soil unless otherwise noted.)

A1--0 to 2 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium platy structure parting to moderate fine granular; soft, friable, slightly sticky and slightly plastic; many fine roots; many fine vesicular pores; neutral (pH 7.0); clear wavy boundary. (1 to 6 inches thick)

A2--2 to 14 inches; brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak thick platy structure; slightly hard, friable, slightly sticky and plastic; many fine and medium roots; many fine and medium tubular pores; neutral (pH 7.0); clear wavy boundary. (10 to 18 inches thick)

C--14 to 60 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; massive; slightly hard, friable, sticky and plastic; few fine and medium roots; many fine, medium and coarse tubular pores; 10 percent pebbles; common small stress surfaces; slightly alkaline (pH 7.5).

TYPE LOCATION: Yavapai County, Arizona; 250 feet north of the southwest corner, sec. 9, T. 12 N., R. 1 E.

RANGE IN CHARACTERISTICS:

Soil Moisture: Intermittently moist in some part of the soil moisture control section during July-September and December-February. The soil is driest during May and June. Ustic aridic moisture regime.

Rock Fragments: 0 to 15 percent pebbles

Organic Matter: Averages 1 percent or more in the surface; decreases irregularly with depth

Carbonates: Noncalcareous to depths of 40 inches or more

Reaction: Neutral to moderately alkaline

A horizon
Hue: 7.5YR, 10YR
Value: 2 to 5 dry, 3, 4 or 5 moist
Chroma: 2 or 3, dry or moist

C horizon
Hue: 7.5YR, 10YR
Value: 2 to 6 dry, 3, 4 or 5 moist
Chroma: 2, 3 or 4, dry or moist
Texture: Loam, silt loam, clay loam, sandy clay loam
Clay content: 18 to 35 percent

A Bw horizon may be present in some pedons.

COMPETING SERIES: These are the Bon (SD), Frazwell (), Manzano (NM), Maskell (NE), Mauricanyon (CO), Merrick (NE), Pack (UT), Shanta (NM), St. Onge (SD) and Umbarg (CO) series. Bon, Draper, Humbarger, Shanta, St. Onge and Umbarg soils are calcareous throughout. Draper and Pack soils have mottles at depths less than 40 inches. Frazwell soils have a stone line containing 40 to 55 percent rock fragments that overlies buried horizons. Manzano soils have Bw horizons and segregated lime in the lower control section. Maskell, Merrick and Mauricanyon soils are moist in the moisture control section during May and June.

GEOGRAPHIC SETTING: Lynx soils are on flood plains and alluvial fans and have slopes of 0 to 8 percent. These soils formed in alluvium from mixed sources. Elevations range from 3,500 to 6,900 feet. The mean annual precipitation ranges from 10 to 14 inches. The mean annual air temperature is 47 to 59 degrees F. The frost-free period is 120 to 180 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Abra, Arp, Balon, Deama, Dye, Gaddes, Lonti, Moano, Pastura, Showlow, and Wineg soils. Abra soils have a calcic horizon. Arp, Balon, Gaddes, Showlow, Lonti, and Wineg soils have an argillic horizon. Deama, Dye, and Moano soils have bedrock at depths less than 20 inches. Pastura soils have a petrocalcic horizon at depths less than 20 inches.

DRAINAGE AND PERMEABILITY: Well drained. Slow runoff. Moderately slow permeability.

USE AND VEGETATION: Lynx soils are used for grazing and irrigated cropland. The present vegetation is blue grama, sideoats grama, alkali sacaton, spike muhly, vine mesquite, rabbitbrush, tobosa, big galleta, fourwing saltbush, snakeweed, western wheatgrass, and muttongrass.

DISTRIBUTION AND EXTENT: North-central Arizona. This series is extensive. MLRA is 35, 39 & 61. Use in MLRA 61 should be discontinued.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Beaver Creek Area, Arizona, 1965.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon: The zone from the surface to a depth of 60 inches (A and C horizons).
The fact that this soil is in a 10 to 14 inch precipitation zone (Ustic aridic) and irrigation is required for cropland, it is doubtful that soil is moist long enough to meet the requirement for a Mollisol. Classification of this soil should be re-evaluated when the area is updated.

National Cooperative Soil Survey
U.S.A.

LOCATION MOANO AZ

Established Series
Rev. JEJ/GEW/YHH
11/2006

MOANO SERIES

The Moano series consists of very shallow and shallow, well drained soils that formed in residuum from phyllite or schist. Moano soils are on gently rolling to steep schist hills. Slopes are 8 to 60 percent. Mean annual precipitation is about 12 inches. Mean annual air temperature is about 53 degrees F.

TAXONOMIC CLASS: Loamy, mixed, superactive, nonacid, mesic Lithic Ustic Torriorthents

TYPICAL PEDON: Moano gravelly loam - grassland (Colors are for dry soil unless otherwise noted).

A--0 to 3 inches; brown (7.5YR 4/4) gravelly loam, dark brown (7.5YR 3/2) moist; moderate very fine and fine granular structure; soft, friable, slightly sticky and slightly plastic; common very fine and fine roots; many fine interstitial pores; noneffervescent; neutral (pH 7.2); clear irregular boundary. (2 to 4 inches thick).

C--3 to 9 inches; brown (7.5YR 4/4) gravelly heavy loam, brown (7.5YR 4/4) moist; massive; slightly hard, friable, slightly sticky and plastic; many fine and medium and few coarse roots; many fine interstitial pores; noneffervescent; moderately alkaline (pH 8.0); clear irregular boundary. (3 to 8 inches thick).

Cr--9 to 14 inches; olive (5Y 4/4) to olive brown (2.5Y 4/4) hard vertically oriented phyllite and schist bedrock with thin tongues of soil material in fractures (soil material is slightly heavier than in the B horizon); common fine roots in fractures; common thin clay coatings on rock faces; noneffervescent; moderately alkaline (pH 8.0); clear irregular boundary. (3 to 8 inches thick).

R--14 to 15 inches; pale yellow (2.5Y 7/4) extremely hard schist bedrock.

TYPE LOCATION: Yavapai County, Arizona. 2/10 mile E. and 1/ 10 mile S. of NW corner of Sec. 23, T12N, R1E, about 1 mile NE of Mayer, Arizona.

RANGE IN CHARACTERISTICS:

Depth to bedrock: 6 to +16 inches but may be 20 inches in some areas, due to variability in hardness of the parent rock.

Reaction: slightly acid to moderately alkaline due to the variability of the parent rock.

Mean annual soil temperature: 52 degrees to 58 degrees F.

Soil moisture: These soils are usually dry especially during the months of May, June, October and November. Ustic aridic moisture regime.

A horizon
Hue: 10YR and 7.5YR
Value: 4 and 5 dry and 3 and 4 moist
Chroma: 2 through 4
Texture: gravelly loam and very gravelly loam
Structure: weak platy to granular

C horizon
Hue: 10YR through 5YR
Value: 4 through 6 dry and 3 and 4 moist
Chroma: 4 through 6
Texture: gravelly loam and gravelly light clay loam Structure: usually massive or rock controlled but may range to weak subangular blocky
Gravel content: 15 to 35 percent by volume
Clay coatings may or may not be present in the C&R horizon.

COMPETING SERIES: This is the Moret (WY) series. Moret soils have a lithic contact of slate-like shale.

GEOGRAPHIC SETTING: The Moano soils are on gently rolling to steep schist hills with slopes ranging from 8 to 60 percent. These soils are formed in place on phyllite or schist bedrock and are at elevations of 4000 to 5500 feet in a semiarid continental climate. The average annual precipitation ranges from 10 to 14 inches and occurs mainly as rain in July, August and September and as rain and some snow in January and February. The mean annual temperature ranges from 50 degrees to 57 degrees F.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the Balon, Dandrea, Lynx and Showlow in addition to the Arp and Barkerville series. Balon soils have an argillic horizon. The Dandrea and Showlow soils are deep, have fine-textured control sections and argillic horizons. Lynx soils are deep and have a mollic epipedon.

DRAINAGE AND PERMEABILITY: Well-drained with medium runoff. Permeability of the soil is moderate.

USE AND VEGETATION: Used entirely as rangeland. Vegetation at higher elevations is oak brush, deerbrush, mountain mahogany, squawbush, manzanita and snakeweed with an understory of sideoats grama, blue grama, squirreltail, tridens, three-awns and annuals. Vegetation at lower elevations is black grama, sideoats grama, three-awns, tridens, squirreltail, snakeweed and annuals.

DISTRIBUTION AND EXTENT: Central Arizona in semiarid regions. The soil is extensive in central Yavapai County. MLRA 39.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Western Yavapai County Area, Yavapai County, Arizona, 1971. Name taken from Rancho Moano in Yavapai County, Arizona.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - The zone from 0 to 3 inches (A horizon)

Particle size control section - the zone from 0 to 9 inches (A and C horizons)

Entisol feature - The absence of diagnostic subsurface horizons

Lithic contact - The boundary at 14 inches (2R horizon)

Classification changed from Lithic subgroup to Lithic Ustic subgroup in 2006 to be consistent with the moisture regime.

Classified according to Keys to Soil Taxonomy Tenth Edition, 2006.

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TYPE LOCATION: Yavapai County, Arizona; about 1 mile NW of the junction of the Rancho Moano and Williamson Valley roads; 1/2 mile west and 3/10 mile north of SE corner of sec. 3, T.15N., R.4W.

RANGE IN CHARACTERISTICS:

Soil moisture: Intermittently moist in some part of the soil moisture control section during July through September and December through March. Driest during May and June. Ustic aridic soil moisture regime.

Mean annual soil temperature: 54 degrees to 59 degrees F.

Thickness of the solum: 18 to 45 inches

Rock fragments: 5 to 35 percent by volume

Organic matter: more than 1 percent

A and upper B horizons
Hue: 5YR through 10YR but are dominantly 7.5YR or 10YR
Texture: A horizon is sandy loam, gravelly sandy loam, gravelly loam or cobbly loam
Reaction: slightly acid to neutral

Bt horizons
Hue: 5YR, 7.5YR
Value: 4 or 5 dry, 3 or 4 moist
Chroma: 3 through 6, dry or moist
Texture: clay loam, clay, gravelly heavy clay loam, gravelly clay
Structure: medium prismatic to weak fine and medium subangular blocky

Bk horizons
Hue: 5YR, 7.5YR, 10YR
Value: 5 through 8 dry
Chroma: 4 through 6, dry or moist
Texture: gravelly clay loam, gravelly sandy loam, gravelly loamy sand
Calcium carbonate: occurs as medium to large pockets but the horizon has less than 15 percent CaC03 equivalent.

COMPETING SERIES: These are the Mags (CO), Padilla (AZ), Servilleta (NM), Silver (NM), and Tobish (UT) series. Chafin soils have less than 5 percent rock fragments and are effervescent throughout the profile. Mags, Padilla and Silver soils have secondary carbonates in the argillic horizon. The Silver series attempts to reflect the effects of soil forming agents unique to the Great Plains. Servilleta and Tobish soils have bedrock at moderate depths.

GEOGRAPHIC SETTING: Lonti soils are on nearly level plains to steep alluvial fans. The soils are formed in old gravelly alluvium from granite, schist, sandstone, limestone, shale and basaltic materials. These soils are at elevations of 4,000 to 5,500 feet in a continental climate with an annual precipitation of 12 to 20 inches. The mean annual air temperature ranges from 52 degrees to 57 degrees F. The frost-free period is 140 to 200 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Abra, Cordes, Lynx, Pastura and Wineg soils and the competing Balon and Poley soils. Abra, Lynx and Cordes soils lack fine-textured argillic horizons. Pastura soils are shallow to an indurated calcic horizon. Wineg soils have a moderately fine-textured control section and a mollic epipedon.

DRAINAGE AND PERMEABILITY: Well-drained; medium to slow runoff; slow permeability.

USE AND VEGETATION: These soils are used mainly for livestock grazing and wildlife habitat. Small areas are irrigated. Vegetation is oakbrush, deerbrush and squaw bush with an understory of grama grasses, muhly grasses and squirreltail. At higher elevations some pinon pine and juniper occur. At lower elevations the grasses are dominant and include tobosa grass in addition to those mentioned above.

DISTRIBUTION AND EXTENT: Western Yavapai County Area, Yavapai County, Arizona. These soils are extensive. MLRA 38 & 39.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Western Yavapai County Area, Yavapai County, Arizona, 1971.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - The zone from 0 to 2 inches (A horizon)

Argillic horizon - The zone from 2 to 45 inches (Bt horizons)

Classified according to Soil Taxonomy, Second Edition, 1999; Keys to Soil Taxonomy, Tenth Edition, 2006.

The mean annual precipitation of 12 to 20" p.z. described in the GEOGRAPHIC SETTING section crosses two moisture regimes - Ustic aridic and Aridic ustic. The soil mapped in the Aridic ustic moisture regime (16 to 20" p.z.) would classify as Aridic Haplustalfs. When Western Yavapai County Area, Yavapai County, Arizona soil survey is updated, this series should be evaluated to decide which moisture regime is typical.

Update and revisions for the competing series section 2/08 DWD

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LOCATION SPRINGERVILLE AZ+UT

Established Series
Rev. DRT/PDC
04/2007

SPRINGERVILLE SERIES

The Springerville series consists of deep, well drained soils that formed in alluvium from tuff, volcanic breccia and basalt. Springerville soils are on plateaus and mesas and have slopes of 0 to 10 percent. The mean annual precipitation is about 16 inches and the mean annual air temperature is about 51 degrees F.

TAXONOMIC CLASS: Fine, smectitic, mesic Aridic Haplusterts

TYPICAL PEDON: Springerville stony silty clay - woodland. (Colors are for dry soil unless otherwise noted.)

A1--0 to 1 inch; brown (7.5YR 4/2) stony silty clay, dark brown (7.5YR 3/2) moist; strong very fine granular structure; hard, friable, very sticky and very plastic; few fine roots; many fine irregular pores; 25 percent stones; slightly alkaline (pH 7.5); abrupt smooth boundary. (1 to 2 inches thick)

A2--1 to 4 inches; brown (7.5YR 4/2) stony silty clay, dark brown (7.5YR 3/2) moist; strong medium and fine subangular blocky structure parting to moderate fine granular; very hard, firm, very sticky and very plastic; many fine roots; common very fine and fine tubular and irregular pores; 25 percent stones; slightly alkaline (pH 7.6); clear wavy boundary. (3 to 6 inches thick)

Ass1--4 to 9 inches; brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; moderate medium and fine angular blocky and subangular blocky structure; extremely hard, very firm, very sticky and very plastic; many fine roots; few fine and very fine tubular pores; common irregular pores; common medium slickensides; slightly effervescent; slightly alkaline (pH 7.7); gradual wavy boundary. (5 to 10 inches thick)

Ass2--9 to 15 inches; brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; moderate medium and fine angular blocky and subangular blocky structure; extremely hard, very firm, very sticky and very plastic; many fine roots; common fine tubular and irregular pores; common medium slickensides; 10 percent gravel; slightly effervescent; slightly alkaline (pH 7.7); gradual wavy boundary. (4 to 12 inches thick)

ACss--15 to 25 inches; brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; massive; extremely hard, very firm, very sticky and very plastic; many fine and very fine roots; few very fine tubular pores; many medium slickensides; few black concretions; few fine calcium carbonate nodules; slightly effervescent; slightly alkaline (pH 7.7); gradual wavy boundary. (7 to 15 inches thick)

Css1--25 to 35 inches; brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; massive; extremely hard, very firm, very sticky and very plastic; few fine roots; few pores; many intersecting slickensides; few fine calcium carbonate nodules; few stones; slightly effervescent; slightly alkaline (pH 7.7); gradual wavy boundary. (6 to 15 inches thick)

Css2--35 to 42 inches; brown (7.5YR 4/2) stony silty clay, dark brown (7.5YR 3/2) moist; massive; extremely hard, very firm, very sticky and very plastic; many intersecting slickensides; common fine calcium carbonate nodules and few soft calcium carbonate accumulations; 25 percent stones; slightly effervescent; slightly alkaline (pH 7.7); abrupt irregular boundary. (3 to 10 inches thick)

2R--42 inches; basalt.

TYPE LOCATION: Yavapai County, Arizona; 50 feet west of the center of U.S. Highway 89 at a point 0.6 miles south of Milepost 350, 14.8 miles south of the junction of U.S. Highway 66 and 89; near the center of section 20, T. 19 N., R. 1 W.

RANGE IN CHARACTERISTICS:

Soil Moisture: Intermittently moist in some part of the soil moisture control section during July-September and December-February. Driest during May and June. Aridic ustic soil moisture regime.

Rock Fragments: 5 to 40 percent gravel, cobble and stones

Soil Temperature: 47 to 59 degrees F.

Organic matter: More than 1 percent in the surface

Cracking: Deep, wide cracks are open more than 210 days cumulative

Reaction: Slightly or moderately alkaline

Depth to bedrock: 40 to 60 inches

A and Ass horizons
Hue: 5YR, 7.5YR, 10YR
Value: 3, 4 or 5 dry, 2, 3 or 4 moist
Chroma: 2, 3 or 4, dry or moist

Css, Bss and Bk horizons
Hue: 5YR, 7.5YR, 10YR
Value: 3, 4 or 5 dry, 2, 3 or 4 moist
Chroma: 2 through 6, dry or moist
Texture: Clay, silty clay, clay loam
Calcium carbonate equivalent: less than 15 percent

COMPETING SERIES: These are the Albers (AZ), Antelopeflat (CO), Arboles (C), Dominquez (CO), Ritoazul (CO), and Sideshow (CO) series. Albers soils are very deep. Antelopeflat have accumulations of gypsum in the profile. Arboles soils formed in parent material derived from shale. Dominquez soils have hue of 5YR or 2.5YR. Ritoazul soils are moderately deep to shale and have accumulations of gypsum in the profile. Sideshow soils are effervescent at 10 inches, contain less than 5 percent calcium carbonates equivalents and do not have 5YR hue.

GEOGRAPHIC SETTING: Springerville soils are on plateaus and mesas and have slopes of 0 to 10 percent. These soils formed in alluvium from tuff, volcanic breccia and basalt. Elevations range from 4,200 to 7,500 feet. The mean annual precipitation ranges from 14 to 18 inches. The mean annual air temperature is 45 to 57 degrees F. The frost-free period is 120 to 180 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cabezon, Showlow, Tajo and Thunderbird soils. These soils do not have intersecting slickensides.

DRAINAGE AND PERMEABILITY: Well drained; slow runoff; very slow permeability.

USE AND VEGETATION: Springerville soils are used for livestock grazing, fuelwood production and wildlife habitat. The present vegetation is blue grama, sideoats grama, snakeweed, juniper and pinon pine.

DISTRIBUTION AND EXTENT: Northern Arizona. This series is extensive. MLRAs 35 & 39.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Navajo County (Holbrook - Show Low Area), Arizona; 1961.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - The zone from 0 to 15 inches (A1, A2, Ass1, Ass2 horizons)

Intersecting slickensides - The zone from 25 to 42 inches (Css1, Css2 horizons)

Lithic contact - The boundary at 42 inches (2R horizon)

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ATTACHMENT B

IKHS BACKGROUND SOIL ARSENIC DATABASE

Sample Name	Easting	Northing	Sample Date	Analytical Method	Arsenic (mg/kg)	Soil Unit	Direction from Agua Fria River
HS-47	596602.348	1265297.914	1/27/2004	Lab	63.0	Moano	West
HS-47	596602.348	1265297.914	1/27/2004	Lab	53.7	Moano	West
OFS-200-1	607719.623	1271048.932	5/7/2010	Lab	16.6	Moano	East
OFS-200-1	607719.623	1271048.932	5/7/2010	Lab	15.8	Moano	East
OFS-200-2	607711.608	1270988.910	5/7/2010	Lab	12.7	Moano	East
OFS-200-3	607657.372	1270989.074	5/7/2010	Lab	22.4	Moano	East
OFS-200-4	607603.137	1270989.239	5/7/2010	Lab	31.4	Moano	East
OFS-200-5	607545.096	1271026.170	5/7/2010	Lab	22.1	Moano	East
OFS-200-6	607518.183	1271093.576	5/7/2010	Lab	32.1	Moano	East
OFS-200-7	607549.384	1271148.433	5/7/2010	Lab	20.8	Moano	East
OFS-200-8	607592.278	1271183.967	5/7/2010	Lab	21.8	Moano	East
OFS-200-9	607665.809	1271188.111	5/7/2010	Lab	26.0	Moano	East
XRF-003	611591.676	1274420.453	1/10/2012	XRF	34.3	Lonti	East
XRF-003	611591.676	1274420.453	1/10/2012	XRF	29.0	Lonti	East
XRF-003	611591.676	1274420.453	1/10/2012	XRF	23.7	Lonti	East
XRF-004	612916.958	1274334.721	1/10/2012	XRF	28.1	Moano	East
XRF-004	612916.958	1274334.721	1/10/2012	XRF	27.1	Moano	East
XRF-004	612916.958	1274334.721	1/10/2012	XRF	26.0	Moano	East
XRF-006	613171.015	1273694.045	1/10/2012	XRF	13.4	Moano	East
XRF-006	613171.015	1273694.045	1/10/2012	XRF	12.4	Moano	East
XRF-006	613171.015	1273694.045	1/10/2012	XRF	11.5	Moano	East
XRF-008	614308.365	1273118.035	1/10/2012	XRF	38.3	Moano	East
XRF-008	614308.365	1273118.035	1/10/2012	XRF	37.6	Moano	East
XRF-008	614308.365	1273118.035	1/10/2012	XRF	36.8	Moano	East
XRF-011	615031.757	1272888.894	1/10/2012	XRF	15.9	Moano	East
XRF-011	615031.757	1272888.894	1/10/2012	XRF	15.2	Moano	East
XRF-011	615031.757	1272888.894	1/10/2012	XRF	14.6	Moano	East
XRF-013	615630.488	1272841.361	1/10/2012	XRF	11.4	Moano	East
XRF-013	615630.488	1272841.361	1/10/2012	XRF	11.3	Moano	East
XRF-013	615630.488	1272841.361	1/10/2012	XRF	11.2	Moano	East
XRF-016	615596.101	1273329.154	1/10/2012	XRF	30.1	Moano	East
XRF-016	615596.101	1273329.154	1/10/2012	XRF	28.7	Moano	East
XRF-016	615596.101	1273329.154	1/10/2012	XRF	27.2	Moano	East
XRF-018	616154.731	1272682.911	1/10/2012	XRF	21.1	Moano	East
XRF-018	616154.731	1272682.911	1/10/2012	XRF	20.2	Moano	East
XRF-018	616154.731	1272682.911	1/10/2012	XRF	19.3	Moano	East
XRF-020	616439.027	1272822.292	1/10/2012	XRF	46.1	Moano	East
XRF-020	616439.027	1272822.292	1/10/2012	XRF	45.8	Moano	East
XRF-020	616439.027	1272822.292	1/10/2012	XRF	45.4	Moano	East
XRF-022	611175.683	1274456.524	1/10/2012	XRF	30.7	Lonti	East
XRF-022	611175.683	1274456.524	1/10/2012	XRF	26.4	Lonti	East
XRF-022	611175.683	1274456.524	1/10/2012	XRF	22.1	Lonti	East
XRF-024	610909.913	1274369.655	1/10/2012	XRF	41.6	Lonti	East
XRF-024	610909.913	1274369.655	1/10/2012	XRF	35.5	Lonti	East
XRF-024	610909.913	1274369.655	1/10/2012	XRF	29.3	Lonti	East
XRF-025	609814.492	1274441.253	1/10/2012	XRF	40.8	Balon	East
XRF-025	609814.492	1274441.253	1/10/2012	XRF	37.8	Balon	East
XRF-025	609814.492	1274441.253	1/10/2012	XRF	34.8	Balon	East
XRF-026	608615.067	1274386.163	1/10/2012	XRF	44.6	Balon	East
XRF-026	608615.067	1274386.163	1/10/2012	XRF	43.0	Balon	East
XRF-026	608615.067	1274386.163	1/10/2012	XRF	41.5	Balon	East
XRF-036	608641.259	1272593.527	1/10/2012	XRF	90.4	Moano	East
XRF-036	608641.259	1272593.527	1/10/2012	XRF	88.4	Moano	East
XRF-036	608641.259	1272593.527	1/10/2012	XRF	86.5	Moano	East
XRF-038	609557.194	1272872.552	1/10/2012	XRF	65.1	Lonti	East
XRF-038	609557.194	1272872.552	1/10/2012	XRF	61.4	Lonti	East
XRF-038	609557.194	1272872.552	1/10/2012	XRF	57.7	Lonti	East
XRF-039	611142.429	1272585.977	1/10/2012	XRF	87.6	Moano	East
XRF-039	611142.429	1272585.977	1/10/2012	XRF	82.7	Moano	East
XRF-039	611142.429	1272585.977	1/10/2012	XRF	77.8	Moano	East
XRF-041	598496.277	1280046.663	1/10/2012	XRF	13.0	Balon	West
XRF-041	598496.277	1280046.663	1/10/2012	XRF	12.5	Balon	West
XRF-041	598496.277	1280046.663	1/10/2012	XRF	12.0	Balon	West
XRF-042	597930.988	1280492.426	1/10/2012	XRF	31.4	Balon	West
XRF-042	597930.988	1280492.426	1/10/2012	XRF	31.0	Balon	West
XRF-042	597930.988	1280492.426	1/10/2012	XRF	30.6	Balon	West
XRF-043	597138.472	1280741.926	1/10/2012	XRF	19.2	Moano	West
XRF-043	597138.472	1280741.926	1/10/2012	XRF	17.6	Moano	West
XRF-043	597138.472	1280741.926	1/10/2012	XRF	16.0	Moano	West
XRF-044	596519.478	1281080.691	1/10/2012	Lab	30.0	Moano	West
XRF-044	596519.478	1281080.691	1/10/2012	XRF	29.5	Moano	West
XRF-044	596519.478	1281080.691	1/10/2012	XRF	27.1	Moano	West
XRF-044	596519.478	1281080.691	1/10/2012	XRF	24.8	Moano	West
XRF-045	595731.618	1281589.544	1/10/2012	XRF	21.0	Moano	West
XRF-045	595731.618	1281589.544	1/10/2012	XRF	19.2	Moano	West
XRF-045	595731.618	1281589.544	1/10/2012	XRF	17.4	Moano	West
XRF-046	595387.467	1281959.334	1/10/2012	Lab	10.0	Moano	West
XRF-046	595387.467	1281959.334	1/10/2012	XRF	8.8	Moano	West
XRF-046	595387.467	1281959.334	1/10/2012	XRF	8.8	Moano	West
XRF-046	595387.467	1281959.334	1/10/2012	XRF	8.8	Moano	West
XRF-047	594235.633	1282402.149	1/10/2012	XRF	34.3	Moano	West
XRF-047	594235.633	1282402.149	1/10/2012	XRF	32.0	Moano	West
XRF-047	594235.633	1282402.149	1/10/2012	XRF	29.8	Moano	West
XRF-048	598485.582	1279946.887	1/10/2012	XRF	11.0	Balon	West
XRF-048	598485.582	1279946.887	1/10/2012	XRF	10.0	Balon	West
XRF-048	598485.582	1279946.887	1/10/2012	XRF	9.0	Balon	West
XRF-050	599875.650	1285014.082	1/10/2012	XRF	11.5	Balon	West
XRF-050	599875.650	1285014.082	1/10/2012	XRF	11.0	Balon	West
XRF-050	599875.650	1285014.082	1/10/2012	XRF	10.6	Balon	West
XRF-051	600602.962	1285241.203	1/10/2012	XRF	NA	Lynx	West
XRF-051	600602.962	1285241.203	1/10/2012	Lab	7.7	Lynx	West
XRF-051	600602.962	1285241.203	1/10/2012	XRF	6.7	Lynx	West

Lab Bulk soil sample analyzed in a lab setting
XRF Sample measured in-field by XRF

Sample Name	Easting	Northing	Sample Date	Analytical Method	Arsenic (mg/kg)	Soil Unit	Direction from Agua Fria River
XRF-051	600602.962	1285241.203	1/10/2012	XRF	6.7	Lynx	West
XRF-053	601039.691	1279558.492	1/10/2012	XRF	14.3	Balon	West
XRF-053	601039.691	1279558.492	1/10/2012	XRF	13.3	Balon	West
XRF-053	601039.691	1279558.492	1/10/2012	XRF	12.3	Balon	West
XRF-054	608496.367	1274231.241	1/11/2012	XRF	63.5	Balon	East
XRF-054	608496.367	1274231.241	1/11/2012	XRF	54.8	Balon	East
XRF-054	608496.367	1274231.241	1/11/2012	XRF	46.2	Balon	East
XRF-056	608397.537	1275038.418	1/11/2012	XRF	62.7	Balon	East
XRF-056	608397.537	1275038.418	1/11/2012	XRF	56.9	Balon	East
XRF-056	608397.537	1275038.418	1/11/2012	XRF	51.1	Balon	East
XRF-058	608382.402	1274980.476	1/11/2012	XRF	71.1	Balon	East
XRF-058	608382.402	1274980.476	1/11/2012	XRF	68.1	Balon	East
XRF-058	608382.402	1274980.476	1/11/2012	XRF	65.1	Balon	East
XRF-059	608542.842	1275691.095	1/11/2012	XRF	67.6	Balon	East
XRF-059	608542.842	1275691.095	1/11/2012	XRF	61.0	Balon	East
XRF-059	608542.842	1275691.095	1/11/2012	XRF	54.5	Balon	East
XRF-060	608014.348	1275790.351	1/11/2012	XRF	44.8	Balon	East
XRF-060	608014.348	1275790.351	1/11/2012	XRF	38.3	Balon	East
XRF-060	608014.348	1275790.351	1/11/2012	XRF	31.9	Balon	East
XRF-061	607214.876	1275921.600	1/11/2012	XRF	55.1	Balon	East
XRF-061	607214.876	1275921.600	1/11/2012	XRF	48.7	Balon	East
XRF-061	607214.876	1275921.600	1/11/2012	XRF	42.4	Balon	East
XRF-063	607213.810	1276894.120	1/11/2012	Lab	56.0	Lynx	East
XRF-063	607213.810	1276894.120	1/11/2012	XRF	54.2	Lynx	East
XRF-063	607213.810	1276894.120	1/11/2012	XRF	53.1	Lynx	East
XRF-063	607213.810	1276894.120	1/11/2012	XRF	52.0	Lynx	East
XRF-064	608674.270	1276362.133	1/11/2012	XRF	35.2	Balon	East
XRF-064	608674.270	1276362.133	1/11/2012	XRF	33.3	Balon	East
XRF-064	608674.270	1276362.133	1/11/2012	XRF	31.5	Balon	East
XRF-065	610087.444	1276403.111	1/11/2012	XRF	31.6	Balon	East
XRF-065	610087.444	1276403.111	1/11/2012	XRF	30.2	Balon	East
XRF-065	610087.444	1276403.111	1/11/2012	XRF	28.9	Balon	East
XRF-066	608430.754	1276214.713	1/11/2012	XRF	43.2	Balon	East
XRF-066	608430.754	1276214.713	1/11/2012	XRF	38.0	Balon	East
XRF-066	608430.754	1276214.713	1/11/2012	XRF	32.9	Balon	East
XRF-067	608449.834	1276867.815	1/11/2012	XRF	98.6	Balon	East
XRF-067	608449.834	1276867.815	1/11/2012	XRF	89.6	Balon	East
XRF-067	608449.834	1276867.815	1/11/2012	XRF	80.6	Balon	East
XRF-069	607228.535	1277880.093	1/11/2012	XRF	68.6	Balon	East
XRF-069	607228.535	1277880.093	1/11/2012	XRF	63.2	Balon	East
XRF-069	607228.535	1277880.093	1/11/2012	XRF	57.8	Balon	East
XRF-071	608553.658	1278453.827	1/11/2012	XRF	63.3	Lonti	East
XRF-071	608553.658	1278453.827	1/11/2012	XRF	61.7	Lonti	East
XRF-071	608553.658	1278453.827	1/11/2012	XRF	60.2	Lonti	East
XRF-072	609764.449	1278270.537	1/11/2012	XRF	89.8	Lonti	East
XRF-072	609764.449	1278270.537	1/11/2012	XRF	89.3	Lonti	East
XRF-072	609764.449	1278270.537	1/11/2012	XRF	88.8	Lonti	East
XRF-074	612428.071	1278363.736	1/11/2012	XRF	55.2	Lonti	East
XRF-074	612428.071	1278363.736	1/11/2012	XRF	52.1	Lonti	East
XRF-074	612428.071	1278363.736	1/11/2012	XRF	49.1	Lonti	East
XRF-075	611587.539	1278397.411	1/11/2012	XRF	84.9	Lonti	East
XRF-075	611587.539	1278397.411	1/11/2012	XRF	81.9	Lonti	East
XRF-075	611587.539	1278397.411	1/11/2012	XRF	78.9	Lonti	East
XRF-077	612444.881	1278577.191	1/11/2012	XRF	306.0	Lonti	East
XRF-077	612444.881	1278577.191	1/11/2012	XRF	302.0	Lonti	East
XRF-077	612444.881	1278577.191	1/11/2012	XRF	299.0	Lonti	East
XRF-079	612720.332	1278894.020	1/11/2012	XRF	1120.0	Lonti	East
XRF-079	612720.332	1278894.020	1/11/2012	XRF	1100.0	Lonti	East
XRF-079	612720.332	1278894.020	1/11/2012	XRF	1080.0	Lonti	East
XRF-079	612720.332	1278894.020	1/11/2012	Lab	1000.0	Lonti	East
XRF-081	612746.640	1278892.895	1/11/2012	XRF	41.5	Lonti	East
XRF-081	612746.640	1278892.895	1/11/2012	XRF	39.0	Lonti	East
XRF-081	612746.640	1278892.895	1/11/2012	XRF	36.5	Lonti	East
XRF-082	610358.813	1278398.743	1/11/2012	XRF	79.8	Lonti	East
XRF-082	610358.813	1278398.743	1/11/2012	XRF	72.2	Lonti	East
XRF-082	610358.813	1278398.743	1/11/2012	XRF	64.6	Lonti	East
XRF-084	608573.431	1279759.629	1/11/2012	XRF	49.4	Lonti	East
XRF-084	608573.431	1279759.629	1/11/2012	XRF	41.7	Lonti	East
XRF-084	608573.431	1279759.629	1/11/2012	Lab	36.0	Lonti	East
XRF-084	608573.431	1279759.629	1/11/2012	XRF	34.7	Lonti	East
XRF-084	608573.431	1279759.629	1/11/2012	XRF	33.0	Lonti	East
XRF-084	608573.431	1279759.629	1/11/2012	XRF	31.3	Lonti	East
XRF-086	610457.050	1280068.178	1/11/2012	XRF	38.0	Lonti	East
XRF-086	610457.050	1280068.178	1/11/2012	XRF	38.0	Lonti	East
XRF-086	610457.050	1280068.178	1/11/2012	XRF	38.0	Lonti	East
XRF-088	612158.251	1280542.570	1/11/2012	XRF	40.7	Lonti	East
XRF-088	612158.251	1280542.570	1/11/2012	XRF	36.9	Lonti	East
XRF-088	612158.251	1280542.570	1/11/2012	XRF	33.1	Lonti	East
XRF-090	607251.382	1279680.118	1/11/2012	XRF	46.6	Sandy and Gravelly alluvial land	East
XRF-090	607251.382	1279680.118	1/11/2012	XRF	41.6	Sandy and Gravelly alluvial land	East
XRF-090	607251.382	1279680.118	1/11/2012	XRF	36.7	Sandy and Gravelly alluvial land	East
XRF-092	606416.224	1278981.426	1/11/2012	XRF	42.9	Lynx	East
XRF-092	606416.224	1278981.426	1/11/2012	XRF	41.6	Lynx	East
XRF-092	606416.224	1278981.426	1/11/2012	XRF	40.4	Lynx	East
XRF-093	607256.493	1280390.854	1/11/2012	XRF	50.9	Sandy and Gravelly alluvial land	East
XRF-093	607256.493	1280390.854	1/11/2012	XRF	47.0	Sandy and Gravelly alluvial land	East
XRF-093	607256.493	1280390.854	1/11/2012	XRF	43.1	Sandy and Gravelly alluvial land	East
XRF-094	606620.033	1281758.051	1/11/2012	XRF	39.4	Lonti	East
XRF-094	606620.033	1281758.051	1/11/2012	XRF	34.2	Lonti	East
XRF-094	606620.033	1281758.051	1/11/2012	XRF	29.0	Lonti	East
XRF-096	608612.842	1282457.363	1/11/2012	XRF	43.0	Lonti	East
XRF-096	608612.842	1282457.363	1/11/2012	XRF	40.5	Lonti	East

Sample Name	Easting	Northing	Sample Date	Analytical Method	Arsenic (mg/kg)	Soil Unit	Direction from Agua Fria River
XRF-096	608612.842	1282457.363	1/11/2012	XRF	38.1	Lonti	East
XRF-098	608539.433	1283532.285	1/11/2012	XRF	38.5	Lonti	East
XRF-098	608539.433	1283532.285	1/11/2012	XRF	35.6	Lonti	East
XRF-098	608539.433	1283532.285	1/11/2012	XRF	32.7	Lonti	East
XRF-099	608533.618	1283539.014	1/11/2012	XRF	34.1	Lonti	East
XRF-099	608533.618	1283539.014	1/11/2012	XRF	29.8	Lonti	East
XRF-099	608533.618	1283539.014	1/11/2012	XRF	25.5	Lonti	East
XRF-100	605074.648	1284765.934	1/11/2012	XRF	59.7	Lonti	East
XRF-100	605074.648	1284765.934	1/11/2012	XRF	51.9	Lonti	East
XRF-100	605074.648	1284765.934	1/11/2012	XRF	44.1	Lonti	East
XRF-101	606029.984	1286183.571	1/11/2012	XRF	24.0	Lonti	East
XRF-101	606029.984	1286183.571	1/11/2012	XRF	22.2	Lonti	East
XRF-101	606029.984	1286183.571	1/11/2012	XRF	20.3	Lonti	East
XRF-102	611141.447	1285973.748	1/11/2012	XRF	30.7	Lonti	East
XRF-102	611141.447	1285973.748	1/11/2012	XRF	28.7	Lonti	East
XRF-102	611141.447	1285973.748	1/11/2012	XRF	26.7	Lonti	East
XRF-103	611122.691	1285934.813	1/11/2012	XRF	27.1	Lonti	East
XRF-103	611122.691	1285934.813	1/11/2012	XRF	27.0	Lonti	East
XRF-103	611122.691	1285934.813	1/11/2012	XRF	26.9	Lonti	East
XRF-104	612007.254	1284991.037	1/11/2012	XRF	24.3	Moano	East
XRF-104	612007.254	1284991.037	1/11/2012	XRF	22.5	Moano	East
XRF-104	612007.254	1284991.037	1/11/2012	XRF	20.7	Moano	East
XRF-106	610290.458	1283492.241	1/11/2012	XRF	39.7	Lonti	East
XRF-106	610290.458	1283492.241	1/11/2012	XRF	36.6	Lonti	East
XRF-106	610290.458	1283492.241	1/11/2012	XRF	33.5	Lonti	East
XRF-108	610428.597	1282975.014	1/11/2012	XRF	35.7	Sandy and Gravelly alluvial land	East
XRF-108	610428.597	1282975.014	1/11/2012	XRF	33.5	Sandy and Gravelly alluvial land	East
XRF-108	610428.597	1282975.014	1/11/2012	XRF	31.3	Sandy and Gravelly alluvial land	East
XRF-109	610432.991	1282953.781	1/11/2012	XRF	85.8	Sandy and Gravelly alluvial land	East
XRF-109	610432.991	1282953.781	1/11/2012	XRF	69.1	Sandy and Gravelly alluvial land	East
XRF-109	610432.991	1282953.781	1/11/2012	XRF	52.7	Sandy and Gravelly alluvial land	East
XRF-110	610485.765	1281425.905	1/11/2012	XRF	60.8	Lonti	East
XRF-110	610485.765	1281425.905	1/11/2012	XRF	56.9	Lonti	East
XRF-110	610485.765	1281425.905	1/11/2012	XRF	52.9	Lonti	East
XRF-112	608979.439	1281215.129	1/11/2012	XRF	43.4	Sandy and Gravelly alluvial land	East
XRF-112	608979.439	1281215.129	1/11/2012	XRF	42.5	Sandy and Gravelly alluvial land	East
XRF-112	608979.439	1281215.129	1/11/2012	XRF	41.6	Sandy and Gravelly alluvial land	East
XRF-114	613383.308	1280181.161	1/11/2012	XRF	34.5	Moano	East
XRF-114	613383.308	1280181.161	1/11/2012	XRF	33.3	Moano	East
XRF-114	613383.308	1280181.161	1/11/2012	XRF	32.1	Moano	East
XRF-115	612086.378	1281820.308	1/11/2012	XRF	28.1	Lonti	East
XRF-115	612086.378	1281820.308	1/11/2012	XRF	27.0	Lonti	East
XRF-115	612086.378	1281820.308	1/11/2012	XRF	26.0	Lonti	East
BKG-411	599259.290	1284978.684	1/21/2012	Lab	19.9	Balon	West
BKG-411	599259.290	1284978.684	1/21/2012	Lab	14.3	Balon	West
BKG-412	599283.364	1284988.245	1/21/2012	Lab	18.4	Balon	West
BKG-412	599283.364	1284988.245	1/21/2012	Lab	15.8	Balon	West
BKG-413	599310.329	1284978.766	1/21/2012	Lab	14.4	Balon	West
BKG-414	599342.802	1284996.261	1/21/2012	Lab	16.4	Balon	West
BKG-415	599336.900	1284945.365	1/21/2012	Lab	20.2	Balon	West
BKG-416	599304.985	1284944.082	1/21/2012	Lab	18.6	Balon	West
BKG-417	599329.462	1284926.637	1/21/2012	Lab	17.9	Balon	West
BKG-418	599386.562	1284921.328	1/21/2012	Lab	22.4	Balon	West
BKG-419	599387.329	1284984.451	1/21/2012	Lab	20.6	Balon	West
BKG-420	599365.216	1285018.349	1/21/2012	Lab	13.8	Balon	West
BKG-611	597109.193	1281636.152	1/22/2012	Lab	11.0	Moano	West
BKG-611	597109.193	1281636.152	1/22/2012	Lab	10.8	Moano	West
BKG-612	597161.064	1281609.721	1/22/2012	Lab	11.9	Moano	West
BKG-613	597284.026	1281541.716	1/22/2012	Lab	10.3	Moano	West
BKG-651	611112.104	1285972.871	1/22/2012	Lab	26.5	Lonti	East
BKG-651	611112.104	1285972.871	1/22/2012	Lab	25.4	Lonti	East
BKG-652	610984.040	1285930.025	1/22/2012	Lab	26.6	Lonti	East
BKG-653	610896.431	1285864.947	1/22/2012	Lab	63.2	Lonti	East
BKG-653	610896.431	1285864.947	1/22/2012	Lab	40.0	Lonti	East
BKG-551	612891.160	1274461.538	1/23/2012	Lab	16.2	Moano	East
BKG-551	612891.160	1274461.538	1/23/2012	Lab	16.1	Moano	East
BKG-552	612876.100	1274494.123	1/23/2012	Lab	17.7	Moano	East
BKG-552	612876.100	1274494.123	1/23/2012	Lab	17.6	Moano	East
BKG-553	612800.702	1274518.774	1/23/2012	Lab	10.4	Moano	East
BKG-554	612816.195	1274477.278	1/23/2012	Lab	14.3	Moano	East
BKG-555	612798.712	1274426.319	1/23/2012	Lab	13.4	Moano	East
BKG-556	612752.486	1274426.126	1/23/2012	Lab	11.2	Moano	East
BKG-557	612779.025	1274508.079	1/23/2012	Lab	8.6	Moano	East
BKG-558	612763.033	1274392.704	1/23/2012	Lab	12.5	Moano	East
BKG-559	612760.500	1274466.846	1/23/2012	Lab	21.2	Moano	East
BKG-560	612785.698	1274488.667	1/23/2012	Lab	12.3	Moano	East
BKG-431	600684.692	1281861.911	1/24/2012	Lab	15.1	Balon	West
BKG-431	600684.692	1281861.911	1/24/2012	Lab	14.5	Balon	West
BKG-432	600643.124	1281900.845	1/24/2012	Lab	23.9	Balon	West
BKG-432	600643.124	1281900.845	1/24/2012	Lab	23.2	Balon	West
BKG-433	600590.920	1281809.884	1/24/2012	Lab	13.2	Balon	West
BKG-434	600610.884	1281831.008	1/24/2012	Lab	17.0	Balon	West
BKG-435	600669.622	1281766.532	1/24/2012	Lab	16.6	Balon	West
BKG-436	600538.310	1281791.067	1/24/2012	Lab	24.3	Balon	West
BKG-437	600477.432	1281832.455	1/24/2012	Lab	13.9	Balon	West
BKG-438	600431.988	1281766.637	1/24/2012	Lab	23.5	Balon	West
BKG-439	600381.310	1281826.401	1/24/2012	Lab	8.6	Balon	West
BKG-440	600366.046	1281767.456	1/24/2012	Lab	7.9	Balon	West
BKG-461	606129.626	1282750.437	1/24/2012	Lab	69.4	Lonti	East
BKG-461	606129.626	1282750.437	1/24/2012	Lab	56.9	Lonti	East
BKG-462	606073.553	1282724.987	1/24/2012	Lab	62.6	Lonti	East
BKG-462	606073.553	1282724.987	1/24/2012	Lab	51.4	Lonti	East

Sample Name	Easting	Northing	Sample Date	Analytical Method	Arsenic (mg/kg)	Soil Unit	Direction from Agua Fria River
BKG-463	606033.377	1282714.673	1/24/2012	Lab	60.7	Lonti	East
BKG-464	606007.164	1282678.077	1/24/2012	Lab	62.5	Lonti	East
BKG-465	606016.765	1282631.676	1/24/2012	Lab	57.7	Lonti	East
BKG-466	606033.048	1282587.713	1/24/2012	Lab	67.5	Lonti	East
BKG-467	605962.870	1282559.658	1/24/2012	Lab	67.5	Lonti	East
BKG-468	605989.038	1282507.623	1/24/2012	Lab	74.2	Lonti	East
BKG-469	605954.233	1282452.018	1/24/2012	Lab	68.6	Lonti	East
BKG-470	605981.102	1282404.477	1/24/2012	Lab	57.0	Lonti	East
BKG-621	603679.665	1283770.820	1/24/2012	Lab	14.5	Lynx	West
BKG-621	603679.665	1283770.820	1/24/2012	Lab	14.5	Lynx	West
BKG-622	603631.506	1283818.697	1/24/2012	Lab	13.0	Lynx	West
BKG-623	603599.587	1283887.452	1/24/2012	Lab	13.2	Lynx	West
BKG-623	603599.587	1283887.452	1/24/2012	Lab	12.6	Lynx	West
BKG-481	609152.349	1283485.482	1/26/2012	Lab	35.9	Lonti	East
BKG-481	609152.349	1283485.482	1/26/2012	Lab	29.7	Lonti	East
BKG-482	609048.193	1283620.317	1/26/2012	Lab	32.6	Lonti	East
BKG-482	609048.193	1283620.317	1/26/2012	Lab	31.1	Lonti	East
BKG-483	608947.179	1283565.270	1/26/2012	Lab	27.5	Lonti	East
BKG-484	608883.676	1283533.459	1/26/2012	Lab	26.2	Lonti	East
BKG-485	608834.996	1283571.337	1/26/2012	Lab	27.3	Lonti	East
BKG-486	608807.169	1283539.564	1/26/2012	Lab	31.1	Lonti	East
BKG-487	608776.655	1283583.122	1/26/2012	Lab	26.4	Lonti	East
BKG-488	608733.453	1283596.803	1/26/2012	Lab	24.6	Lonti	East
BKG-489	608706.769	1283535.191	1/26/2012	Lab	25.6	Lonti	East
BKG-490	608661.274	1283563.379	1/26/2012	Lab	26.0	Lonti	East
BKG-491	609039.678	1277010.634	1/26/2012	Lab	81.4	Balon	East
BKG-491	609039.678	1277010.634	1/26/2012	Lab	75.9	Balon	East
BKG-492	609037.006	1276979.414	1/26/2012	Lab	85.5	Balon	East
BKG-492	609037.006	1276979.414	1/26/2012	Lab	80.5	Balon	East
BKG-493	608973.788	1276912.262	1/26/2012	Lab	84.8	Balon	East
BKG-494	609091.543	1277032.994	1/26/2012	Lab	110.0	Balon	East
BKG-495	609014.911	1276942.444	1/26/2012	Lab	72.7	Balon	East
BKG-496	608942.974	1276863.838	1/26/2012	Lab	88.4	Balon	East
BKG-497	608975.843	1276845.868	1/26/2012	Lab	421.0	Balon	East
BKG-498	609041.929	1276899.826	1/26/2012	Lab	122.0	Balon	East
BKG-499	609093.141	1276900.267	1/26/2012	Lab	94.3	Balon	East
BKG-500	609004.823	1276956.099	1/26/2012	Lab	91.7	Balon	East
BKG-541	611280.860	1278323.348	1/26/2012	Lab	69.4	Lonti	East
BKG-541	611280.860	1278323.348	1/26/2012	Lab	67.3	Lonti	East
BKG-542	611205.884	1278280.684	1/26/2012	Lab	108.0	Lonti	East
BKG-542	611205.884	1278280.684	1/26/2012	Lab	49.6	Lonti	East
BKG-543	611242.401	1278241.210	1/26/2012	Lab	75.6	Lonti	East
BKG-544	611241.547	1278168.860	1/26/2012	Lab	73.8	Lonti	East
BKG-545	611320.505	1278185.351	1/26/2012	Lab	75.8	Lonti	East
BKG-546	611423.577	1278249.103	1/26/2012	Lab	78.4	Lonti	East
BKG-547	611437.863	1278300.617	1/26/2012	Lab	86.1	Lonti	East
BKG-548	611491.057	1278254.682	1/26/2012	Lab	139.0	Lonti	East
BKG-549	611529.124	1278208.473	1/26/2012	Lab	74.8	Lonti	East
BKG-550	611360.762	1278301.752	1/26/2012	Lab	87.3	Lonti	East
XRF-077	612444.881	1278577.191	1/26/2012	XRF	283.0	Lonti	East
XRF-077	612444.881	1278577.191	1/26/2012	XRF	272.0	Lonti	East
XRF-079	612720.332	1278894.020	1/26/2012	XRF	956.0	Lonti	East
XRF-079	612720.332	1278894.020	1/26/2012	XRF	914.0	Lonti	East
XRF-047	594235.633	1282402.149	1/27/2012	XRF	37.6	Moano	West
XRF-047	594235.633	1282402.149	1/27/2012	XRF	24.6	Moano	West
XRF-067	608449.834	1276867.815	1/27/2012	XRF	101.0	Balon	East
XRF-067	608449.834	1276867.815	1/27/2012	XRF	88.7	Balon	East
XRF-075	611587.539	1278397.411	1/27/2012	XRF	105.0	Lonti	East
XRF-075	611587.539	1278397.411	1/27/2012	XRF	92.0	Lonti	East
XRF-086	610457.050	1280068.178	1/27/2012	XRF	39.7	Lonti	East
XRF-086	610457.050	1280068.178	1/27/2012	XRF	35.5	Lonti	East
XRF-088	612158.251	1280542.570	1/27/2012	XRF	47.5	Lonti	East
XRF-088	612158.251	1280542.570	1/27/2012	XRF	36.7	Lonti	East
XRF-026	608615.067	1274386.163	1/31/2012	XRF	39.7	Balon	East
XRF-026	608615.067	1274386.163	1/31/2012	XRF	34.4	Balon	East
XRF-039	611142.429	1272585.977	1/31/2012	XRF	76.7	Moano	East
XRF-039	611142.429	1272585.977	1/31/2012	XRF	73.8	Moano	East
XRF-041	598496.277	1280046.663	1/31/2012	XRF	19.3	Balon	West
XRF-041	598496.277	1280046.663	1/31/2012	XRF	14.1	Balon	West
XRF-044	596519.478	1281080.691	1/31/2012	XRF	32.6	Moano	West
XRF-044	596519.478	1281080.691	1/31/2012	XRF	27.8	Moano	West
XRF-045	595731.618	1281589.544	1/31/2012	XRF	26.5	Moano	West
XRF-045	595731.618	1281589.544	1/31/2012	XRF	18.6	Moano	West
XRF-046	595387.467	1281959.334	1/31/2012	XRF	8.6	Moano	West
XRF-046	595387.467	1281959.334	1/31/2012	XRF	7.3	Moano	West
XRF-047	594235.633	1282402.149	1/31/2012	XRF	36.9	Moano	West
XRF-047	594235.633	1282402.149	1/31/2012	XRF	35.8	Moano	West
XRF-050	599875.650	1285014.082	1/31/2012	XRF	13.6	Balon	West
XRF-050	599875.650	1285014.082	1/31/2012	XRF	11.0	Balon	West
XRF-051	600602.962	1285241.203	1/31/2012	XRF	NA	Lynx	West
XRF-051	600602.962	1285241.203	1/31/2012	XRF	10.3	Lynx	West
XRF-053	601039.691	1279558.492	1/31/2012	XRF	11.8	Balon	West
XRF-053	601039.691	1279558.492	1/31/2012	XRF	9.6	Balon	West
XRF-056	608397.537	1275038.418	1/31/2012	XRF	69.7	Balon	East
XRF-056	608397.537	1275038.418	1/31/2012	XRF	58.6	Balon	East
XRF-063	607213.810	1276894.120	1/31/2012	XRF	59.0	Lynx	East
XRF-063	607213.810	1276894.120	1/31/2012	XRF	54.4	Lynx	East
XRF-064	608674.270	1276362.133	1/31/2012	XRF	35.2	Balon	East
XRF-064	608674.270	1276362.133	1/31/2012	XRF	26.9	Balon	East
XRF-067	608449.834	1276867.815	1/31/2012	XRF	99.3	Balon	East
XRF-067	608449.834	1276867.815	1/31/2012	XRF	93.6	Balon	East
XRF-071	608553.658	1278453.827	1/31/2012	XRF	64.0	Lonti	East

Sample Name	Easting	Northing	Sample Date	Analytical Method	Arsenic (mg/kg)	Soil Unit	Direction from Agua Fria River
XRF-071	608553.658	1278453.827	1/31/2012	XRF	62.0	Lonti	East
XRF-079	612720.332	1278894.020	1/31/2012	XRF	1110.0	Lonti	East
XRF-079	612720.332	1278894.020	1/31/2012	XRF	1050.0	Lonti	East
XRF-084	608573.431	1279759.629	1/31/2012	XRF	39.6	Lonti	East
XRF-084	608573.431	1279759.629	1/31/2012	XRF	36.5	Lonti	East
XRF-211	594939.606	1270888.944	4/17/2012	XRF	92.7	Moano	West
XRF-239	609832.287	1274159.809	4/18/2012	XRF	40.8	Balon	East
XRF-241	609837.053	1273428.331	4/18/2012	XRF	51.9	Balon	East
XRF-243	610778.029	1271596.142	4/18/2012	XRF	64.5	Moano	East
XRF-245	609676.309	1271137.963	4/18/2012	Lab	20.0	Moano	East
XRF-245	609676.309	1271137.963	4/18/2012	XRF	22.8	Moano	East
XRF-247	608899.470	1269603.808	4/18/2012	XRF	53.1	Moano	East
XRF-249	608823.952	1273067.047	4/18/2012	XRF	34.1	Lonti	East
XRF-251	600452.696	1273445.912	4/18/2012	XRF	51.1	Moano	East
XRF-297	604003.721	1278551.159	4/19/2012	XRF	23.6	Balon	West
XRF-299	603545.470	1280526.137	4/19/2012	Lab	14.0	Balon	West
XRF-299	603545.470	1280526.137	4/19/2012	XRF	12.0	Balon	West
XRF-301	602748.713	1284380.384	4/19/2012	XRF	14.9	Lynx	West
XRF-303	603572.638	1286440.458	4/19/2012	XRF	22.3	Lynx	East
XRF-305	607477.665	1288393.145	4/19/2012	XRF	38.7	Lonti	East
XRF-307	601929.643	1279091.638	4/19/2012	XRF	19.4	Balon	West
XRF-309	598853.816	1278742.153	4/19/2012	XRF	47.7	Balon	West
XRF-315	598002.253	1279200.254	4/19/2012	XRF	24.3	Balon	West
XRF-317	597292.837	1279552.357	4/19/2012	XRF	39.8	Balon	West
XRF-317	597292.837	1279552.357	4/19/2012	Lab	39.0	Balon	West
XRF-319	594466.818	1279927.389	4/19/2012	XRF	14.4	Balon	West
XRF-321	593204.308	1279732.387	4/19/2012	XRF	16.9	Balon	West
XRF-337	592799.530	1281121.408	4/19/2012	XRF	14.0	Balon	West
XRF-339	591894.967	1278229.289	4/19/2012	XRF	8.8	Moano	West
XRF-339	591894.967	1278229.289	4/19/2012	Lab	8.0	Moano	West
XRF-341	591842.140	1278198.544	4/19/2012	XRF	18.4	Moano	West
BKG-511	611138.728	1268625.496	5/14/2012	Lab	51.6	Moano	East
BKG-511	611138.728	1268625.496	5/14/2012	Lab	44.5	Moano	East
BKG-512	611122.441	1268558.909	5/14/2012	Lab	18.2	Moano	East
BKG-512	611122.441	1268558.909	5/14/2012	Lab	15.2	Moano	East
BKG-513	611129.249	1268528.348	5/14/2012	Lab	30.5	Moano	East
BKG-514	611200.432	1268490.908	5/14/2012	Lab	27.2	Moano	East
BKG-515	611230.461	1268547.489	5/14/2012	Lab	15.5	Moano	East
BKG-516	611276.420	1268540.413	5/14/2012	Lab	14.7	Moano	East
BKG-517	611271.984	1268595.956	5/14/2012	Lab	14.5	Moano	East
BKG-518	611359.389	1268610.972	5/14/2012	Lab	15.8	Moano	East
BKG-519	611279.055	1268655.629	5/14/2012	Lab	11.3	Moano	East
BKG-520	611217.055	1268680.798	5/14/2012	Lab	11.9	Moano	East
BKG-561	615761.173	1279135.164	5/29/2012	Lab	50.1	Moano	East
BKG-561	615761.173	1279135.164	5/29/2012	Lab	47.3	Moano	East
BKG-562	615731.362	1279158.847	5/29/2012	Lab	24.5	Moano	East
BKG-562	615731.362	1279158.847	5/29/2012	Lab	23.6	Moano	East
BKG-563	615694.545	1279142.290	5/29/2012	Lab	27.1	Moano	East
BKG-564	615699.053	1279110.348	5/29/2012	Lab	35.4	Moano	East
BKG-565	615692.036	1279065.944	5/29/2012	Lab	34.9	Moano	East
BKG-566	615648.339	1279054.959	5/29/2012	Lab	27.7	Moano	East
BKG-567	615655.403	1279116.022	5/29/2012	Lab	16.3	Moano	East
BKG-568	615639.404	1279147.995	5/29/2012	Lab	15.1	Moano	East
BKG-569	615641.783	1279177.142	5/29/2012	Lab	19.0	Moano	East
BKG-570	615639.565	1279206.301	5/29/2012	Lab	17.6	Moano	East
BKG-571	592618.693	1275362.527	5/29/2012	Lab	31.2	Moano	West
BKG-571	592618.693	1275362.527	5/29/2012	Lab	24.1	Moano	West
BKG-572	592705.943	1275335.843	5/29/2012	Lab	35.0	Moano	West
BKG-572	592705.943	1275335.843	5/29/2012	Lab	34.6	Moano	West
BKG-573	592703.595	1275321.969	5/29/2012	Lab	40.9	Moano	West
BKG-574	592682.982	1275342.065	5/29/2012	Lab	36.1	Moano	West
BKG-575	592754.504	1275418.967	5/29/2012	Lab	30.2	Moano	West
BKG-576	592717.929	1275476.013	5/29/2012	Lab	24.6	Balon	West
BKG-577	592791.577	1275503.519	5/29/2012	Lab	28.9	Balon	West
BKG-578	592885.780	1275493.470	5/29/2012	Lab	30.8	Balon	West
BKG-579	592886.127	1275592.034	5/29/2012	Lab	26.6	Balon	West
BKG-579	592886.127	1275592.034	5/29/2012	Lab	26.0	Balon	West
BKG-580	592934.443	1275605.747	5/29/2012	Lab	25.8	Balon	West
BKG-580	592934.443	1275605.747	5/29/2012	Lab	25.4	Balon	West
BKG-581	607973.878	1287172.005	5/29/2012	Lab	73.1	Lynx	East
BKG-581	607973.878	1287172.005	5/29/2012	Lab	46.7	Lynx	East
BKG-582	607895.643	1287133.371	5/29/2012	Lab	87.1	Lynx	East
BKG-582	607895.643	1287133.371	5/29/2012	Lab	85.2	Lynx	East
BKG-583	607877.040	1287059.850	5/29/2012	Lab	67.3	Lynx	East
BKG-584	607890.678	1287011.220	5/29/2012	Lab	90.0	Lynx	East
BKG-585	607915.842	1286975.050	5/29/2012	Lab	63.6	Lynx	East
BKG-586	607927.209	1286934.757	5/29/2012	Lab	66.9	Lynx	East
BKG-587	607922.479	1286890.347	5/29/2012	Lab	57.6	Lynx	East
BKG-588	607924.600	1286832.034	5/29/2012	Lab	82.2	Lynx	East
BKG-589	607880.790	1286780.802	5/29/2012	Lab	65.6	Lynx	East
BKG-590	607853.072	1286732.298	5/29/2012	Lab	86.2	Lynx	East
BKG-441	594167.193	1285083.149	6/20/2012	Lab	9.0	Moano	West
BKG-441	594167.193	1285083.149	6/20/2012	Lab	8.8	Moano	West
BKG-442	594162.424	1285033.188	6/20/2012	Lab	12.2	Moano	West
BKG-442	594162.424	1285033.188	6/20/2012	Lab	11.5	Moano	West
BKG-443	594127.842	1284999.990	6/20/2012	Lab	61.5	Moano	West
BKG-444	594079.632	1285012.653	6/20/2012	Lab	8.1	Moano	West
BKG-445	594084.160	1284993.201	6/20/2012	Lab	10.1	Moano	West
BKG-446	594033.542	1284973.942	6/20/2012	Lab	12.0	Moano	West
BKG-447	594003.608	1284955.999	6/20/2012	Lab	11.5	Moano	West
BKG-448	593987.698	1285006.031	6/20/2012	Lab	10.6	Moano	West
BKG-449	593997.000	1285037.928	6/20/2012	Lab	11.8	Moano	West

Sample Name	Easting	Northing	Sample Date	Analytical Method	Arsenic (mg/kg)	Soil Unit	Direction from Agua Fria River
BKG-450	594010.850	1285055.927	6/20/2012	Lab	10.6	Moano	West
BKG-451	606879.719	1280246.624	6/20/2012	Lab	41.6	Lonti	East
BKG-451	606879.719	1280246.624	6/20/2012	Lab	41.0	Lonti	East
BKG-452	606840.549	1280213.427	6/20/2012	Lab	42.3	Lonti	East
BKG-452	606840.549	1280213.427	6/20/2012	Lab	41.4	Lonti	East
BKG-453	606867.974	1280163.366	6/20/2012	Lab	45.3	Lonti	East
BKG-454	606815.139	1280170.469	6/20/2012	Lab	39.9	Lonti	East
BKG-455	606766.819	1280151.161	6/20/2012	Lab	42.6	Lonti	East
BKG-456	606787.327	1280094.201	6/20/2012	Lab	41.3	Lonti	East
BKG-457	606720.648	1280083.299	6/20/2012	Lab	42.8	Lonti	East
BKG-458	606745.864	1280062.398	6/20/2012	Lab	43.7	Lonti	East
BKG-459	606821.706	1280063.554	6/20/2012	Lab	42.1	Lonti	East
BKG-460	606840.180	1280092.651	6/20/2012	Lab	41.4	Lonti	East
BKG-521	593482.120	1272499.721	6/20/2012	Lab	9.1	Moano	West
BKG-521	593482.120	1272499.721	6/20/2012	Lab	8.3	Moano	West
BKG-522	593466.116	1272524.765	6/20/2012	Lab	8.5	Moano	West
BKG-522	593466.116	1272524.765	6/20/2012	Lab	7.9	Moano	West
BKG-523	593445.511	1272548.437	6/20/2012	Lab	3.4	Moano	West
BKG-524	593427.247	1272584.595	6/20/2012	Lab	8.8	Moano	West
BKG-525	593404.105	1272540.253	6/20/2012	Lab	8.6	Moano	West
BKG-526	593404.017	1272515.265	6/20/2012	Lab	12.0	Moano	West
BKG-527	593380.958	1272494.522	6/20/2012	Lab	9.7	Moano	West
BKG-528	593373.906	1272450.123	6/20/2012	Lab	12.7	Moano	West
BKG-529	593422.111	1272430.519	6/20/2012	Lab	8.6	Moano	West
BKG-530	593429.216	1272490.188	6/20/2012	Lab	7.8	Moano	West
XRF-913	601769.996	1279201.761	5/23/2013	XRF	24.7	Balon	West
XRF-913	601769.996	1279201.761	5/23/2013	XRF	23.4	Balon	West
XRF-915	600573.823	1279644.445	5/23/2013	XRF	13.5	Balon	West
XRF-915	600573.823	1279644.445	5/23/2013	XRF	13.1	Balon	West
XRF-917	600068.777	1281116.754	5/23/2013	XRF	23.0	Balon	West
XRF-917	600068.777	1281116.754	5/23/2013	XRF	22.5	Balon	West
XRF-919	597858.701	1280419.583	5/23/2013	XRF	20.5	Balon	West
XRF-919	597858.701	1280419.583	5/23/2013	XRF	17.5	Balon	West
XRF-921	597250.681	1280690.917	5/23/2013	XRF	21.0	Moano	West
XRF-921	597250.681	1280690.917	5/23/2013	XRF	16.9	Moano	West
XRF-923	597764.817	1279725.988	5/23/2013	XRF	9.6	Balon	West
XRF-923	597764.817	1279725.988	5/23/2013	XRF	7.5	Balon	West
XRF-925	596669.766	1280001.076	5/23/2013	XRF	21.3	Balon	West
XRF-925	596669.766	1280001.076	5/23/2013	XRF	20.3	Balon	West
XRF-897	601037.046	1278505.427	5/28/2013	XRF	48.1	Balon	West
XRF-897	601037.046	1278505.427	5/28/2013	XRF	40.6	Balon	West
XRF-901	600647.221	1278588.968	5/28/2013	XRF	45.4	Balon	West
XRF-901	600647.221	1278588.968	5/28/2013	XRF	36.0	Balon	West
XRF-911	600207.764	1278877.470	5/28/2013	XRF	17.8	Balon	West
XRF-911	600207.764	1278877.470	5/28/2013	XRF	15.6	Balon	West
XRF-927	595933.219	1280133.496	5/28/2013	XRF	34.1	Balon	West
XRF-927	595933.219	1280133.496	5/28/2013	XRF	30.0	Balon	West
XRF-929	594986.434	1280082.230	5/28/2013	XRF	35.6	Balon	West
XRF-929	594986.434	1280082.230	5/28/2013	XRF	33.0	Balon	West
XRF-929	594986.434	1280082.230	5/28/2013	XRF	10.5	Balon	West
XRF-929	594986.434	1280082.230	5/28/2013	XRF	8.5	Balon	West
XRF-967	603822.504	1279202.524	5/28/2013	XRF	27.3	Balon	West
XRF-967	603822.504	1279202.524	5/28/2013	XRF	26.0	Balon	West
XRF-969	603701.522	1279466.661	5/28/2013	XRF	27.9	Balon	West
XRF-969	603701.522	1279466.661	5/28/2013	XRF	26.5	Balon	West
XRF-969	603701.522	1279466.661	5/28/2013	XRF	25.2	Balon	West
XRF-969	603701.522	1279466.661	5/28/2013	XRF	19.3	Balon	West

ATTACHMENT B

IKHS BACKGROUND SOIL ARSENIC DATABASE

ATTACHMENT C

NEPTUNE AND COMPANY TECHNICAL MEMORANDUM

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TECHNICAL MEMORANDUM

From: John Carson, Tracy Schifeling

To: Jeffrey Dhont, R9

CC: Felicia Barnes, EPA ORD
Terry Burton, EPA ORD
Polona Carson, Neptune
Kevin Bricknell, TetraTech
Kirk Cameron, TetraTech

Date: June 9, 2023

RE: Findings of Neptune review of IKHS soil background issues

Review

Neptune was asked to review CH2MHill's "Soil Background Study Report" (Appendix E) and Tetra Tech's Technical Memorandum on the subject "Refined Background Threshold Value (BTV) Calculations for Arsenic at the Iron King-Humboldt Smelter Superfund Site". Tetra Tech provided the full RI soil sample database for our review.

Upon review of the documents and data, over the course of several meetings and in response to issues that arose in those meetings, we presented several issues and analyses to the EPA.

Issues

Issue 1. Concerns about the background dataset used by CH2MHill and Tetra Tech, which only included the maximum value of arsenic measured at each location

The background dataset used by Tetra Tech in their technical memorandum included the surface arsenic measurements at 269 locations (surface measurement meaning the sample began at 0 feet). The dataset originated from CH2MHill. However, we found that in the full RI soil database, about half of these locations had multiple surface samples of arsenic. At most but not all of these locations, Tetra Tech's dataset only had the maximum measurement of arsenic. We were concerned that this approach of taking only the maximum value would inflate the background threshold value.

Neptune proposed a new background dataset, including the same set of 269 locations, and including all surface arsenic measurements for each location. This dataset has 542 surface samples of arsenic.

In some analyses below we also consider sub-surface samples at these locations to compare the ratio of surface and sub-surface measurements, but the sub-surface samples are not included in the background dataset. This is consistent with Tetra Tech's previous analysis as well as discussed CH2MHill's report.

Issue 2. Handling of outliers in background dataset

We wanted to revisit how outliers were handled in the background dataset. We found that the highest value of arsenic in the background dataset was from a sample whose name contained the phrase "different rock". This sample had an ending depth of 0 feet. Given the name "different rock" and the ending depth of 0 feet, we suspected that this sample might have been an XRF sample of a rock, not a soil sample. An XRF reading of a rock would not be valid for assessment of either background or human exposure.

There were 25 samples with an ending depth of 0 feet, and so we proposed removing these 25 samples that had an ending depth of 0 feet.

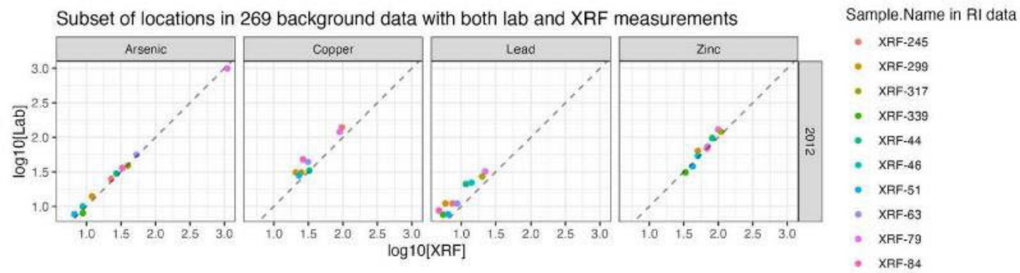
There were 3 additional locations that were identified as having possible outlier measurements. Tetra Tech ran their analysis with and without these 3 locations, and these outlier samples did tend to increase the BTV when they were included in the calculation.

Although we might prefer to have a better understanding of why these samples had such high levels of arsenic, we are comfortable removing them from the BTV calculation. We assume they are not representative of the background.

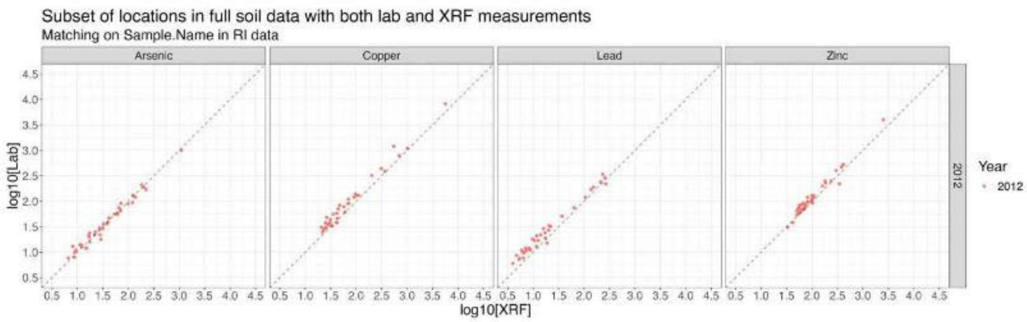
Issue 3. Concern about combining XRF and lab samples

The background samples from 2012 and 2013 include both XRF and lab samples, and we wanted to investigate whether these two sample types were comparable. We plotted paired samples and determined that including the XRF samples would not add bias to the analysis. The XRF samples provide many more locations than just the lab samples, and we think the additional locations will help the analysis overall.

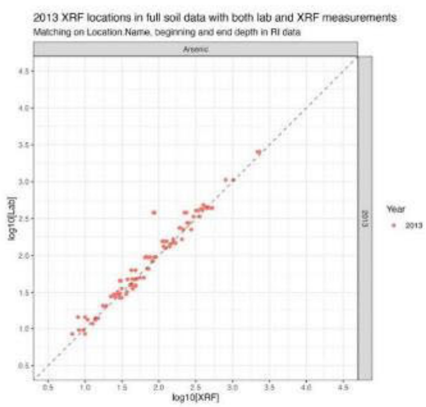
The paired lab/XRF samples from 2012 were easy to create because the "Sample.Name" field matched exactly between lab and XRF samples. The plot below shows the 10 background locations that have both lab and XRF samples in 2012. In particular, note that the arsenic plot shows very little bias between the XRF and lab measurements, making us feel confident in the XRF data transformation.



This plot below shows all paired samples from 2012, background and non-background.



The lab/XRF samples from 2013 were not given the exact same "Sample.Name" in the database, so we attempted to create paired samples by matching samples on "Location.Name" and beginning and ending sample depth. While we could not recreate CH2MHill's plots exactly, we did not see evidence of bias between the XRF and lab data so we feel comfortable including both lab and XRF samples in the background data.



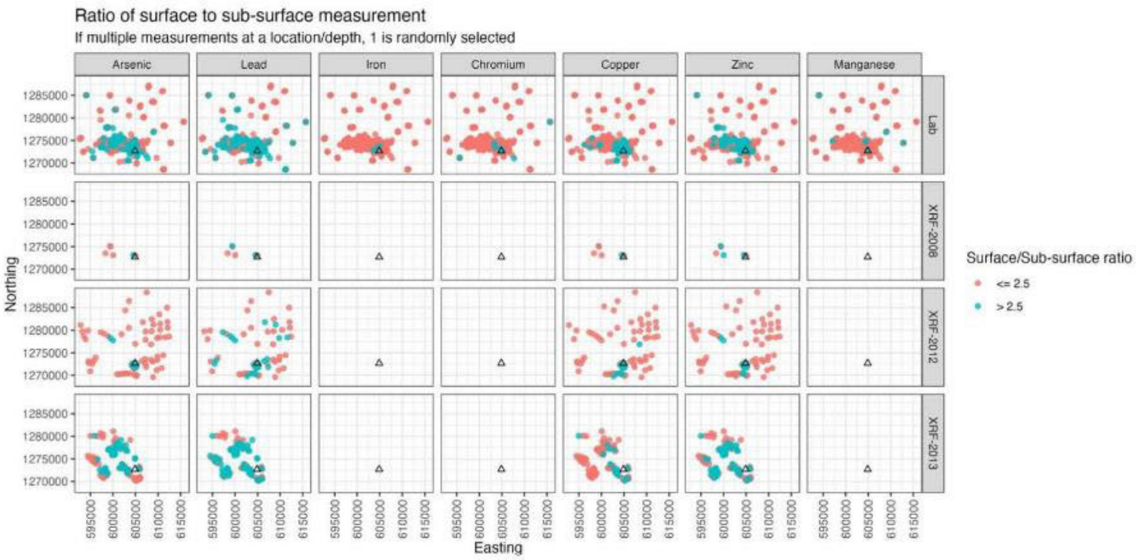
Issue 4. Concern about arsenic volatility and the background boundary

The Humboldt smelter stack emissions are a significant potential source of contamination. Since arsenic is a semivolatile metal, we requested more information about the wind patterns at the Iron King site. We were concerned that there might be aerial deposits of arsenic farther from the site.

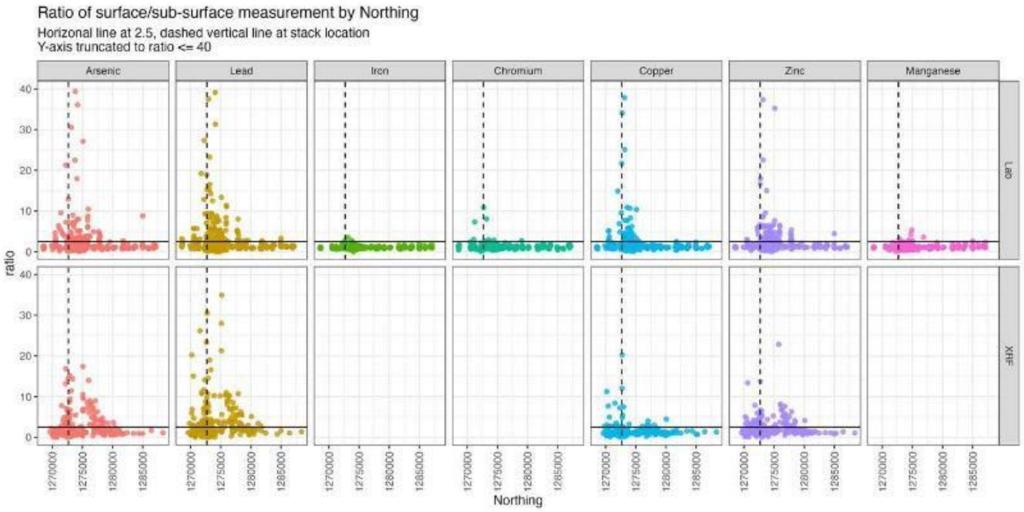
Upon reviewing the wind roses from the Remedial Investigation, we could see that the wind direction varies and changes direction over the course of the year, so there was not a clear direction where we would expect to see aerial deposits of arsenic.

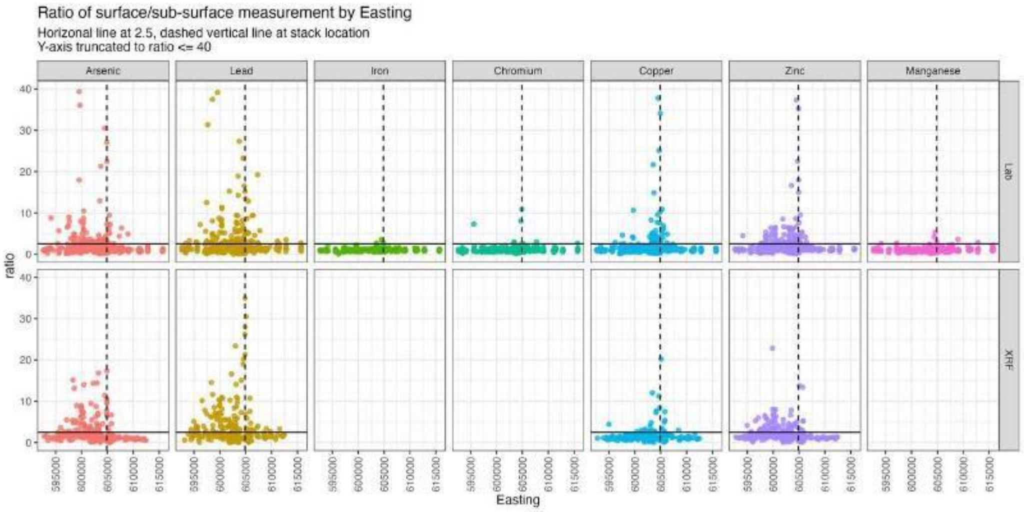
Additionally, we compared surface and subsurface samples (samples with beginning depth > 0 feet) to help us understand if there was evidence of aerial deposits or simply differences in geology.

Following a similar analysis in CH2MHill's Appendix E, we looked at the ratio of surface to sub-surface measurements at each location. Similar to CH2MHill, we see that the ratio is greater than 2.5 mostly close to the site.

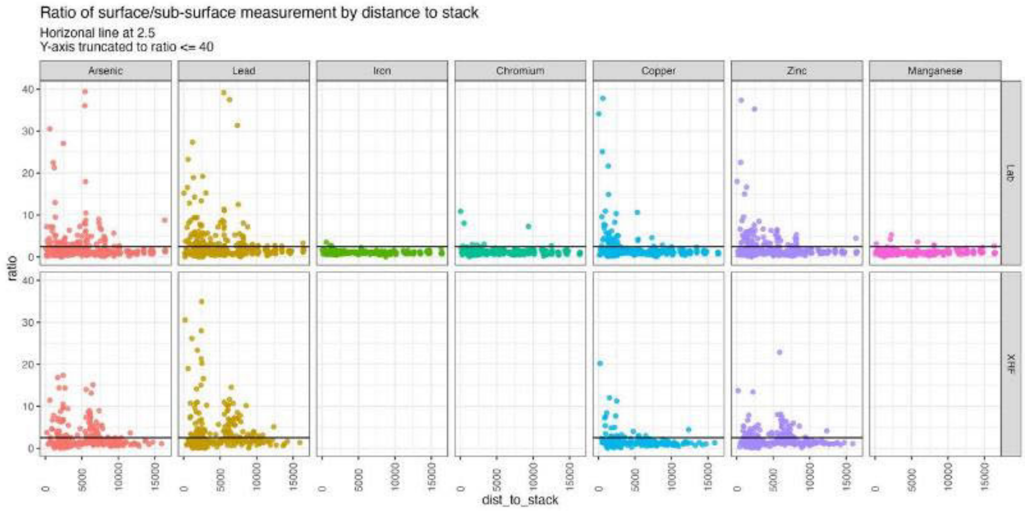


We plotted these surface/sub-surface ratios by Northing, by Easting, and by distance to the smelter stack.


Ratio of surface/sub-surface measurement by Northing
Horizonal line at 2.5, dashed vertical line at stack location
Y-axis truncated to ratio <= 40
Arsenic
Lead
Iron
Chromium
Copper
Zinc
Manganese
Lab
XRF
ratio
Northing

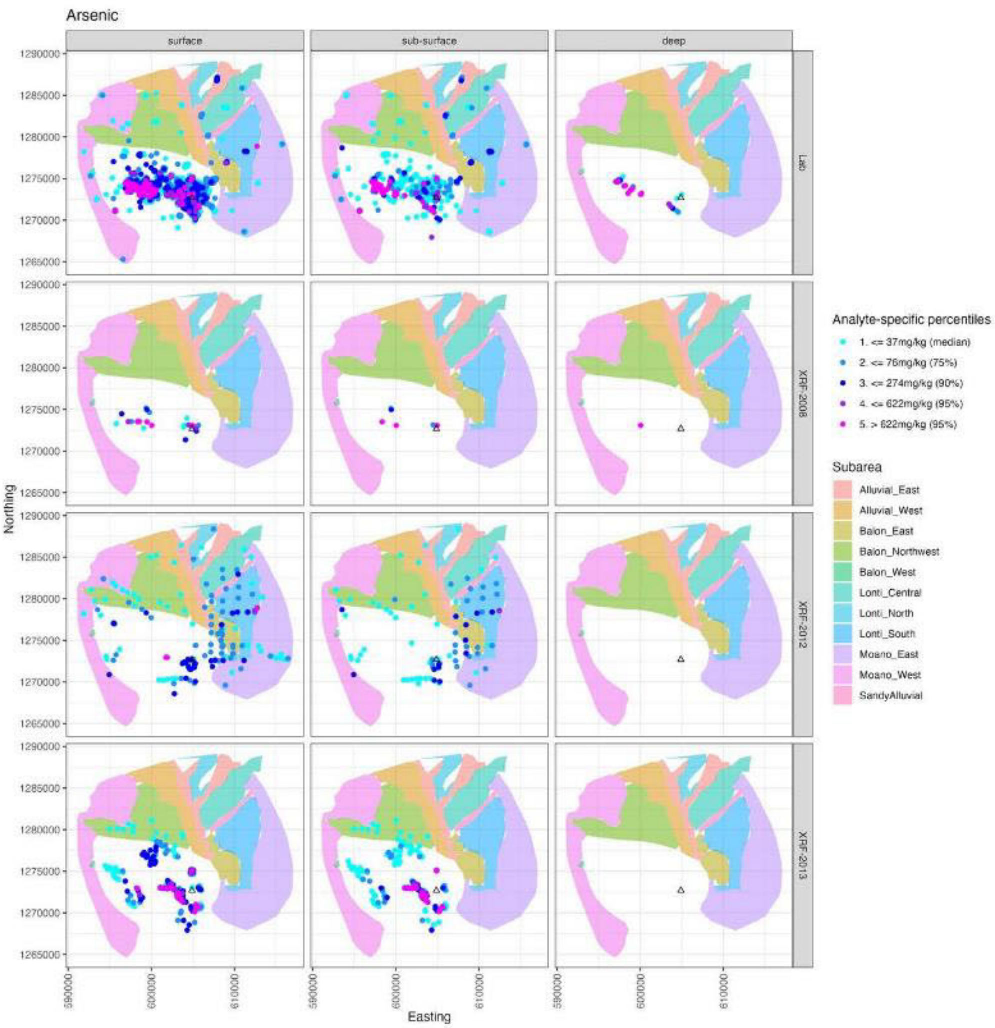

Ratio of surface/sub-surface measurement by Easting
Horizonal line at 2.5, dashed vertical line at stack location
Y-axis truncated to ratio <= 40
Arsenic
Lead
Iron
Chromium
Copper
Zinc
Manganese
Lab
XRF
ratio
Easting

5



We also looked at the arsenic measurements overlaid on the different geologies. We could see some higher levels of arsenic on the east side of the river, and these higher levels were present both in surface samples and sub-surface samples, leading us to believe the high levels of arsenic resulted from the geology rather than aerial deposition from the site.

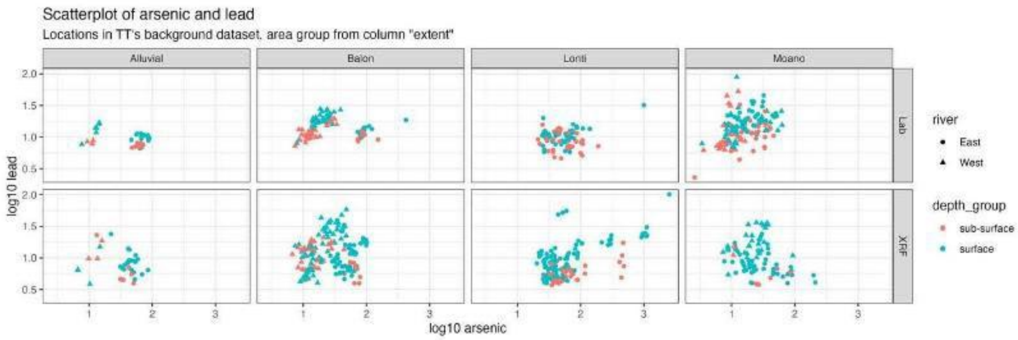
In this plot, "surface" means the sample had starting depth of 0 feet. If the sample had starting depth greater than 0 feet but less that or equal to 5 feet, we consider it "sub-surface". Greater than 5 feet, we consider it a "deep" sample. The triangle in these plots represents the smelter stack.

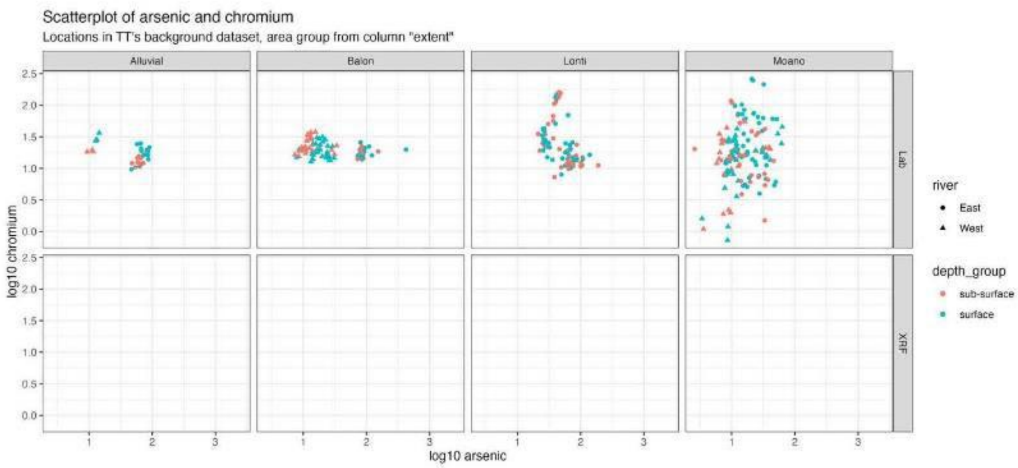


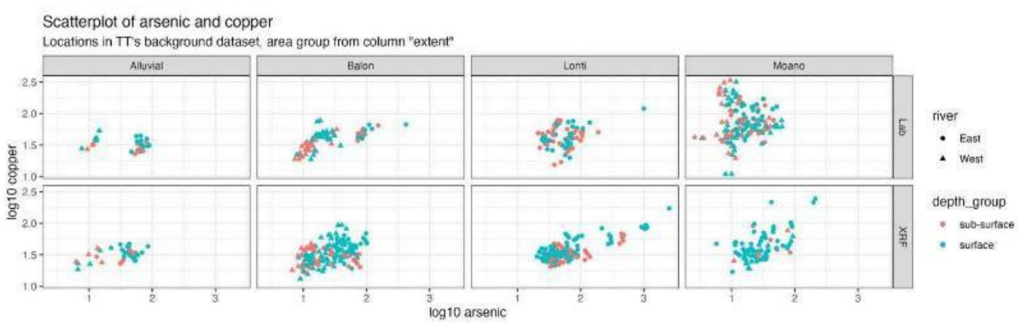
Plots of other metals are included in the appendix.

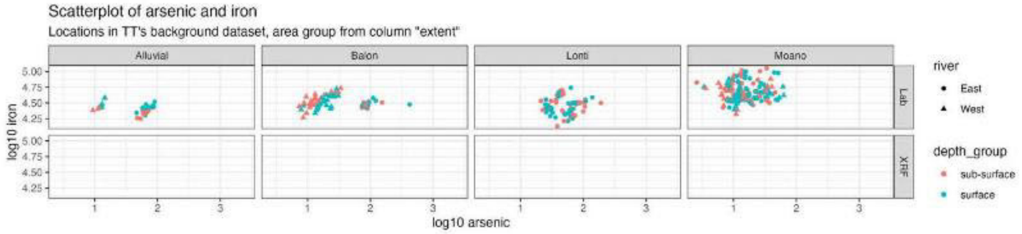
Additionally, we plotted the relationship between arsenic and other metals at the background locations. For these plots we included both surface (the 542 samples included in the background dataset) and sub-surface samples (additional 273 samples with sampling beginning depth > 0 feet). The plots show log-scale concentrations of arsenic versus another metal, are faceted by soil type and type of measurement (lab or XRF), and use symbols to indicate whether the locations are east or west of the Agua Fria River and color to indicate whether the samples are surface or subsurface.

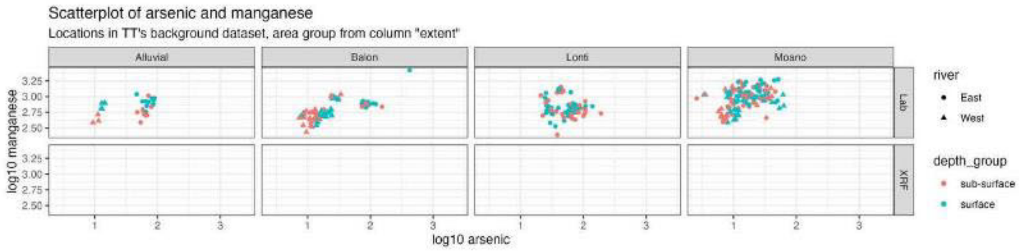
From these plots, we see a clear difference between the east and west locations, and not as much of a difference between surface and sub-surface samples. If there were significant aerial deposition of arsenic, we would expect to see a difference between the surface and sub-surface measurements of arsenic and between the relationship of arsenic to other heavy metal concentrations that could be attributed to sample depth. In fact, we see neither.

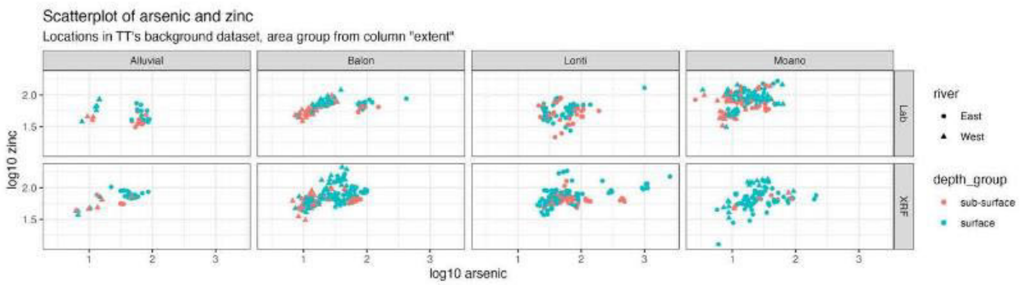












From these various ways of looking at the data, Neptune concluded that there was no evidence of significant aerial deposit of arsenic, and therefore that the background/site impact boundary defined by CH2MHill was reasonable.

Issue 5. Discussing whether the background should be divided between east and west of the river

The log-log plots above showed us that there were clear differences in the soil samples between the east and west sides of the river. The data supports separating the background by east and west, and we have enough data on both the east and west to calculate separate BTVs.

Issue 6. Location weights

Tetra Tech proposed using Voronoi tessellation weights (proportional to the areas of Voronoi polygons around the sampling locations) to take into account the spatial locations of each sample. Although this is a valid statistical approach, in this specific situation we found that some locations with high levels of arsenic were also give very large weights, and this was leading to counter-intuitive conclusions in the analysis.

In the typical sampling situation, high sample results trigger additional sampling around them in order to spatially define hot spots. This results in biased sampling and can be identified by plotting concentration against the area of Voronoi polygons, where it shows up as a decreasing trend with higher concentrations being associated with smaller Voronoi polygon areas. Smaller Voronoi polygon areas indicates higher sampling intensity, which is often associated with hot spot delineation. Plots of IKHS background data showing concentration against Voronoi tessellation weights shows an increasing trend rather than a decreasing trend, which is unusual.

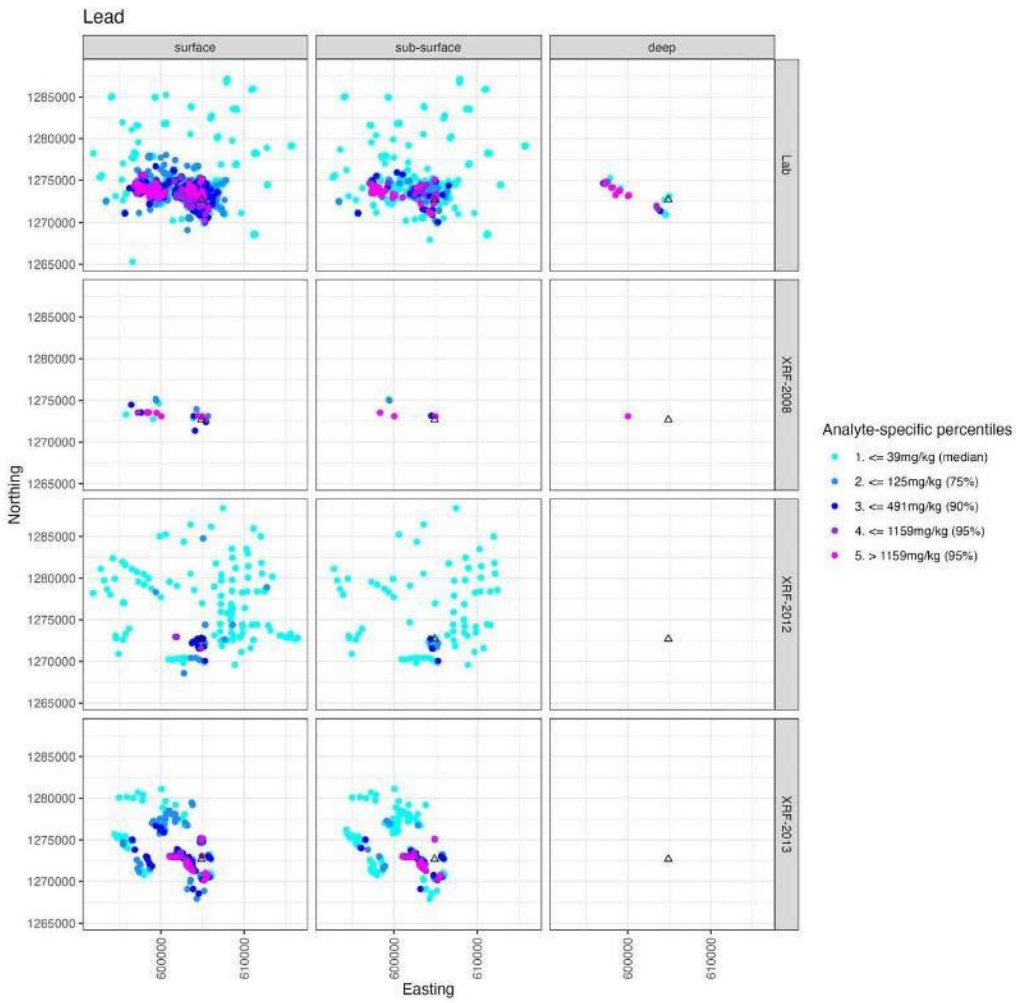
Neptune decided that we prefer equal weighting for each location with weights to account for replicate sampling. For locations with 1 sample, the weight of the sample should be 1. For locations with k samples, each sample result should be given weight 1/k.

Discussion

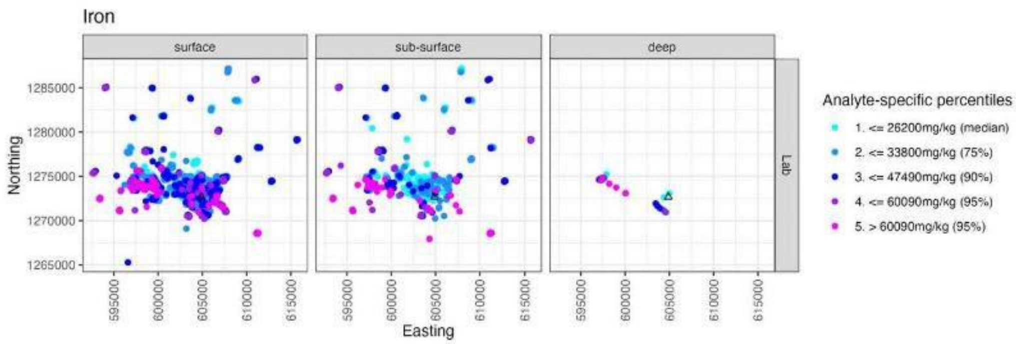
Our additional analysis described above makes us feel confident in CH2MHill's transformation of the XRF data as well as the background boundary they defined. The background dataset in the BTV calculation now includes all surface samples at background locations, rather than just the maximum value. Our analysis also helped point out that a separate background for east and west sides of the river would be more appropriate than one overall background. We also believe that equal weighting of each location produces a better outcome than using Voronoi weights in this situation.

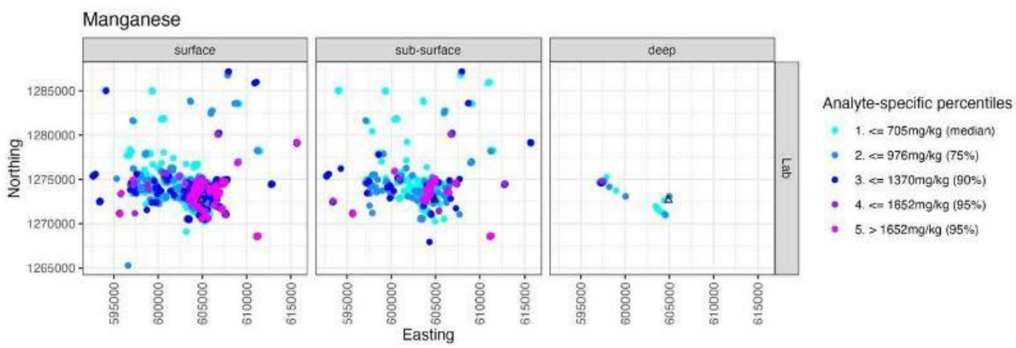
Appendix

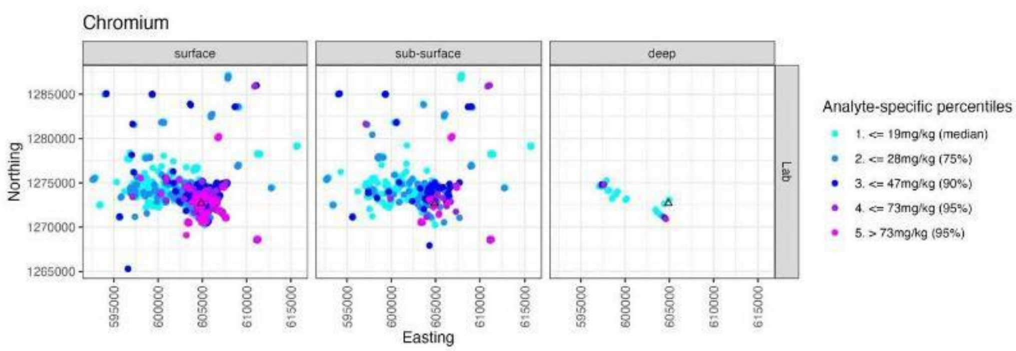
Although our analysis was focused on arsenic, we also plotted levels of lead, iron, chromium, copper, zinc, and manganese. Additional plots are presented below.

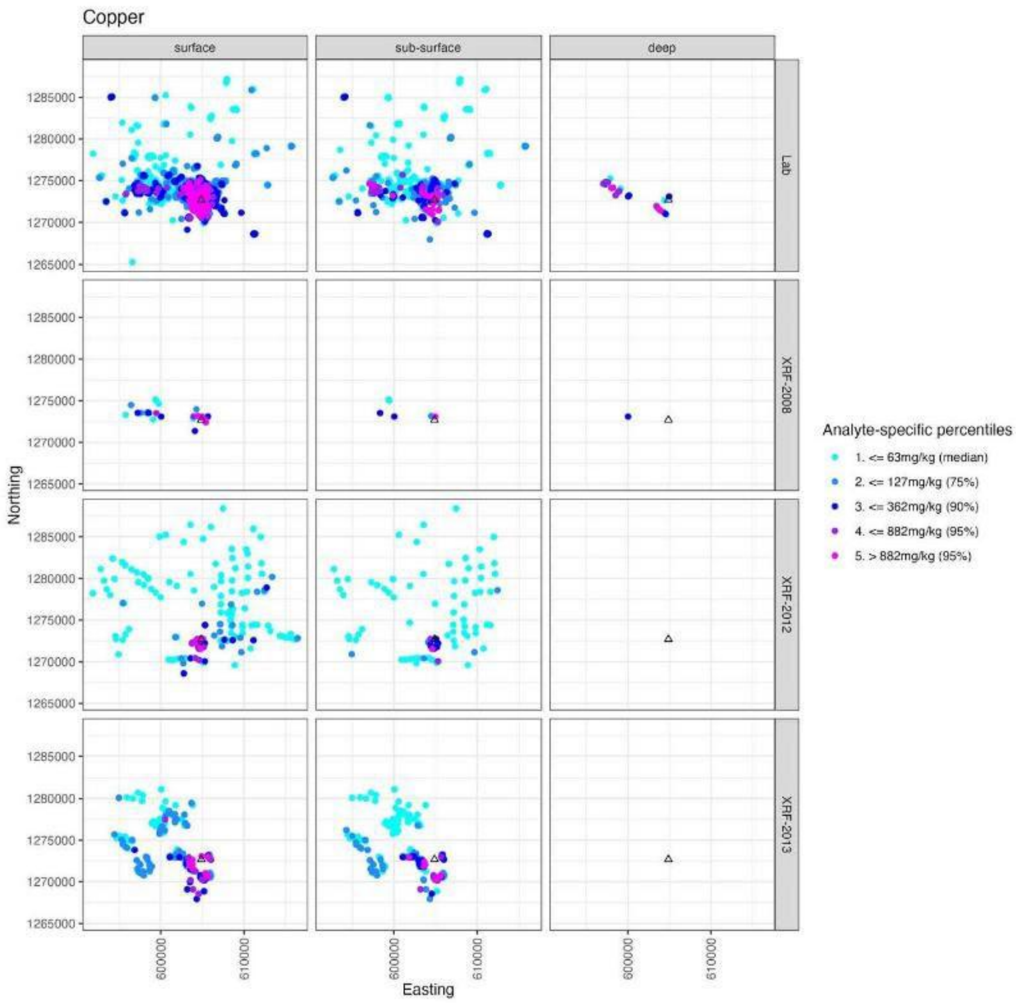


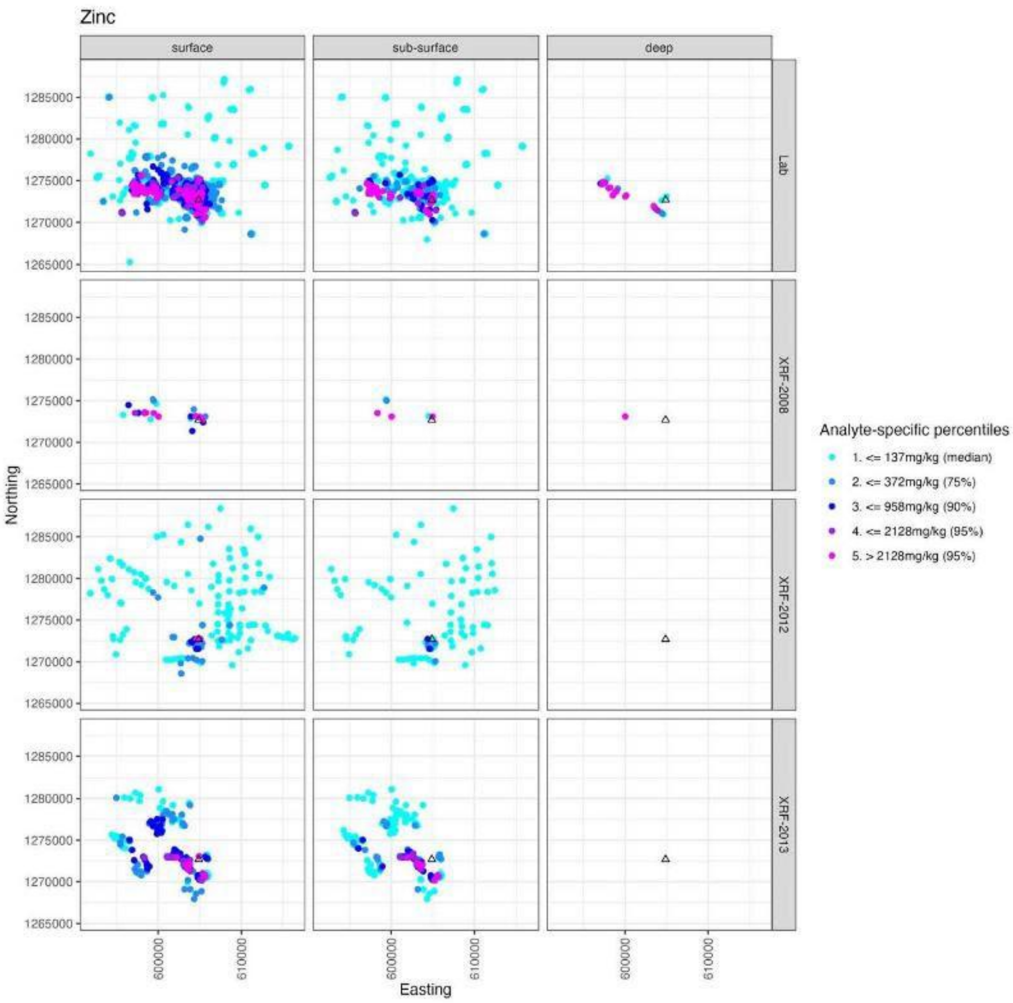
11


Iron
surface
sub-surface
deep
Lab
Northing
Easting
Analyte-specific percentiles
1. <= 26200mg/kg (median)
2. <= 33800mg/kg (75%)
3. <= 47490mg/kg (90%)
4. <= 60090mg/kg (95%)
5. > 60090mg/kg (95%)


Manganese
surface
sub-surface
deep
Lab
Northing
Easting
Analyte-specific percentiles
1. <= 705mg/kg (median)
2. <= 976mg/kg (75%)
3. <= 1370mg/kg (90%)
4. <= 1652mg/kg (95%)
5. > 1652mg/kg (95%)


Chromium
surface
sub-surface
deep
Lab
Northing
Easting
Analyte-specific percentiles
1. <= 19mg/kg (median)
2. <= 28mg/kg (75%)
3. <= 47mg/kg (90%)
4. <= 73mg/kg (95%)
5. > 73mg/kg (95%)


Copper
surface
sub-surface
deep
Lab
XRF-2008
XRF-2012
XRF-2013
Northing
Easting
1285000
1280000
1275000
1270000
1265000
600000
610000
Analyte-specific percentiles
1. <= 63mg/kg (median)
2. <= 127mg/kg (75%)
3. <= 362mg/kg (90%)
4. <= 882mg/kg (95%)
5. > 882mg/kg (95%)


Zinc
surface
sub-surface
deep
Lab
XRF-2008
XRF-2012
XRF-2013
Northing
Easting
1285000
1280000
1275000
1270000
1265000
600000
610000
Analyte-specific percentiles
1. <= 137mg/kg (median)
2. <= 372mg/kg (75%)
3. <= 958mg/kg (90%)
4. <= 2128mg/kg (95%)
5. > 2128mg/kg (95%)