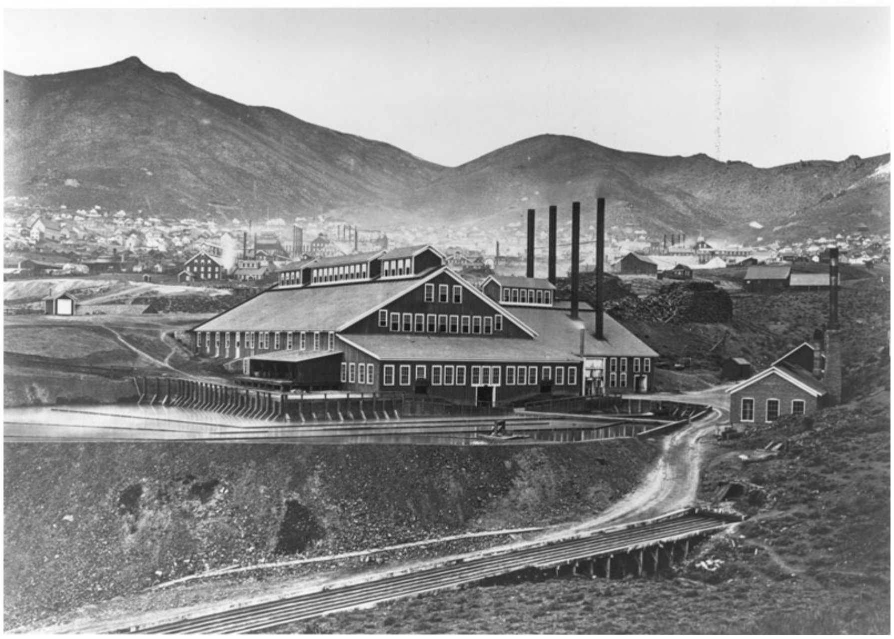
EXPLANATION OF SIGNIFICANT DIFFERENCES

CARSON RIVER MERCURY SITE

Washoe, Carson City, Storey, Lyon, and Churchill Counties, Nevada
NVD980813646



U.S. Environmental Protection Agency
Region 9
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Carson River Mercury Site
Explanation of Significant Differences

Introduction and Statement of Purpose

The purpose of this Explanation of Significant Differences (ESD) for the March 30, 1995 Record of Decision (ROD) for Operable Unit 1 (OU1) of the Carson River Mercury Site (CRMS) is to address issues that have arisen as a result of the continuing implementation and management of the remedy selected in the ROD. The issues addressed by this ESD are:

- The CRMS boundaries need to be better defined to assure that the remedy protects public health by focusing on areas of concern.
- Cleanup levels for two of the three contaminants of concern, lead and arsenic, have changed since the ROD was signed.

EPA uses an ESD to document a significant change to the ROD for a Superfund site. A significant change is defined as "a change to a component of a remedy that does not fundamentally alter the overall cleanup approach."[1] In the case of the CRMS ROD for OU1, the overall cleanup and the goal of the remediation -- to protect public health, specifically children, from exposure to the contaminants of concern in residential settings -- is not being altered. The manner in which the remedy is implemented is being refined and improved. The site definition is being revised to be contamination-based, rather than geographic, and the cleanup levels for two of the contaminants of concern, arsenic and lead, are being updated to better protect public health. Detailed discussions of the issues and the proposed modifications follow in the body of this document.

The U.S. Environmental Protection Agency (EPA) is the lead agency for the Record of Decision for OU1 of the Carson River Mercury Site. The Nevada Department of Conservation and Natural Resources Division of Environmental Protection (NDEP) is the support agency for OU1 of the CRMS. This ESD is completed pursuant to §117(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, and §300.425(c)(2)(1) of the National Contingency Plan. This ESD will become part of the Administrative Record for the CRMS as required by §300.825(a)(2) of the National Contingency Plan.

The Administrative Record is available for review at the following locations:

U. S. EPA Superfund Records Center
95 Hawthorne Street, Suite 403 S
San Francisco, California 94105
Hours: Monday - Friday 8 a.m. - 5 p.m.

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[1] A Guide To Preparing Superfund Proposed Plans, Records of Decision, And Other Remedy Selection Decision Documents, EPA 540-R-98-031, OSWER 9200.1-23P, July 1999

Nevada Division of Environmental Protection
Bureau of Corrective Actions
901 South Stewart Street, Suite 4001
Carson City, Nevada 89701

Site History, Contamination, and Selected Remedy

The Carson River Mercury Site is a legacy of the Nevada Comstock mining era of the late 1800s, when mercury was imported to the area for the processing of gold and silver ore. Ore mined from the Comstock Lode was transported to mill sites, where it was crushed and mixed with mercury to amalgamate the precious metals. The mills were located in Virginia City, Silver City, Gold Hill, Dayton, Six Mile Canyon, Gold Canyon, Sevenmile Canyon, Washoe Valley, and adjacent to the Carson River between New Empire and Dayton. During the mining era, an estimated 14,000,000 pounds of mercury were discharged into the Carson River drainage, primarily in the form of mercury-contaminated tailings. The CRMS includes mercury-contaminated soils and tailings at former mill sites, mercury contamination in drainages adjacent to the mill sites, and mercury contamination in sediments, fish and wildlife over a more than 70 mile length of the Carson River, beginning near Carson City, Nevada and extending downstream through the Lahontan Reservoir and the Lahontan Valley to the River's terminus in the Carson Desert.

High levels of mercury in sediment and water of the Carson River were reported by the United States Geological Survey (USGS) in the early 1970's. Since then, numerous studies have documented the presence of mercury and methylmercury in sediments, soil, water, and wildlife. A 2009 USGS Scientific Investigations Report of mercury concentrations in the United States found that total mercury in bed sediment in the Carson River exceeded the Probable Effects Concentration of 1,060 nanograms per gram (ng/g) and a composite sample of smallmouth bass from the Carson River at Dayton had the highest mercury concentration reported for fish in the study, 1.95 micrograms per gram (μg/g) wet weight. This level significantly exceeds the EPA human-health criterion for fish of 0.3 μg/g.[2] The same USGS study found maximum methylmercury levels in United States streams of 4.11 nanograms per liter (ng/L). In 2006, a water sample from the bottom of Lahontan Reservoir contained 40.2 ng/L methylmercury. Elevated methylmercury levels in fish have prompted the Nevada State Health Division to issue health advisories that recommend no consumption of any fish from the Carson River from Dayton to the Lahontan Dam and all waters of the Lahontan Valley, and no consumption of white bass from Big and Little Washoe Lakes.

The Carson River Mercury Site was listed on the Superfund National Priorities List (NPL) on August 30, 1990, and remains the only Nevada site on the NPL. At the time of listing, the CRMS was described as portions of the Carson drainage and Washoe Valley in Northwestern Nevada which are affected by mercury released from milling operations during the Comstock Lode. The subsequent ROD stated that:

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[2] Scudder, B.C., Chasar, L.C., Wentz, D.A., Bauch, N.J., Brigham, M.E., Moran, P.W., and Krabbenhoft, D.P., 2009, Mercury in fish, bed sediment, and water from streams across the United States, 1998–2005: U.S. Geological Survey Scientific Investigations Report 2009–5109, 74 p.

> The current definition of the CRMS study area is as follows: sediments in an approximately 70-mile stretch of the Carson River beginning near Carson City, Nevada and extending downstream though the Lahontan Reservoir to the terminal wetlands in the Carson Desert (Stillwater National Wildlife Refuge and Carson Lake); tailings piles, sediments and soil in Gold Canyon, Sixmile Canyon, and Sevenmile Canyon; and sediments and soil in Washoe Valley."[3]

The ROD also noted that ". . . EPA is unable to clearly delineate the exact boundaries of the Superfund site . . ." because the site potentially included all areas where mercury contamination from Comstock tailings had come to reside, and it is impossible to sample an area of that size with sufficient density to provide definitive characterization.

For EPA management purposes, the site is divided into two Operable Units (OU): OU1 consists of the mill sites and those areas where tailings have contaminated surface soil and drainages (generally the source areas), and OU2 is the Carson River itself, including sediments and biota (generally the depositional/ecological areas). This ESD only addresses OU1. OU2 is in the Remedial Investigation/Feasibility Study phase of the Superfund process and EPA has not selected a remedy for OU2.

In 1994, Region 9 released the Human Health Risk Assessment and Remedial Investigation Report (HHRA/RI), Carson River Mercury Site. Data gathered in support of the Remedial Investigation included over 1000 soil samples collected at 131 historic mill sites, and samples of sediment, air, groundwater, surface water, and biota. The HHRA/RI identified mercury, arsenic, and lead as contaminants of concern for the CRMS. All three metals occur naturally in ore from the Comstock Lode, but arsenic and lead were concentrated in the milling process, and the addition of mercury as an amalgam greatly exceeded the levels naturally present in the ore. Based on the Human Health Risk Assessment, EPA established a site-specific cleanup level of 80 milligrams per kilogram (mg/kg) mercury in residential soils. The level was designed to be protective of a child, age 1 to 6, who would come into contact with mercury-contaminated soils, and was based on the oral reference dose for inorganic mercury. The level takes into account the species of mercury found in the soils at the CRMS and the bioavailability of those species.

On March 30, 1995, Region 9 signed a Record of Decision (ROD) selecting a cleanup remedy for OU1 (Attachment 1). The objective of the remedial action was to "reduce human health risks by reducing direct exposure to surface soils containing mercury at concentrations equal to or greater than 80 milligrams per kilogram (mg/kg) in residential areas." The ROD also determined that the cleanup level for arsenic that was specified in the Nevada Contaminated Soil and Groundwater Remediation Policy was pertinent and would be followed. The Nevada standard for arsenic from the Policy was 80 mg/kg. As EPA did not have a reference dose for lead, and there was no standard in the Nevada Policy, no cleanup level was established for lead in soil.

At the time the ROD was signed, six residential areas were identified as exceeding the mercury cleanup criteria, based on the sampling conducted during the Remedial Investigation. "No Action" was selected as the remedial action for one of the areas, but for the remaining five areas, the remedy anticipated "[E]xcavation of approximately 5000 cubic yards of contaminated soils,

[3] EPA Record of Decision, 1995

disposal at a RCRA municipal and/or hazardous waste landfill, and restoration of properties. In the event that subsurface soil (greater than or equal to 2 feet below ground surface) is impacted and is not addressed, then this alternative may also include institutional controls." To address areas not identified as exceeding the cleanup criteria and not residential at the time of the ROD, the remedy also included "[I]mplementation of institutional controls to ensure that any residential development in present open land use areas known or suspected to be impacted by mercury includes characterizing mercury levels in surface soils, and if necessary, addressing impacted soils. These institutional controls will be referred to as the 'Long-term Sampling and Response Plan."'

Cleanup of the five areas identified by EPA took place between August 4, 1998 and December 15, 1999. Over 9,087 cubic yards of mercury-contaminated soil was removed. The majority of the soil was disposed of at the Lockwood Landfill in Sparks, Nevada, but discovery of the foundation of an historic mill building at one of the areas required a larger excavation and transport of highly contaminated soils to treatment and disposal facilities in Pennsylvania.

EPA and the NDEP then drafted the institutional control, the Long-term Sampling and Response Plan (LTSRP). The LTSRP has operated as a draft, living, document and is in the process of being formally adopted by the agencies. The LTSRP is administered by NDEP and is applied to residential properties within the general CRMS site boundary. According to the ROD, the LTSRP applicability area includes:

- Sixmile Canyon - Refers to the tributary of the Carson River that begins near Virginia City in the Virginia mountain range and meets the Carson River approximately five miles east of Dayton. The segment of concern is the canyon which begins just below Virginia City and extends to the mouth of the canyon just above the alluvial fan.
- Alluvial Fan - Refers to the alluvial fan below the mouth of Sixmile Canyon. The fluvial channels extending across the fan from the mouth of Sixmile Canyon to the Carson River confluence are the areas of concern.
- Brunswick Canyon - Refers to the Carson River flood plain between New Empire (the Mexican Mill) and Dayton.
- Carson River Flood Plain Above Lahontan Dam - Refers to the Carson River flood plain extending between Dayton and Lahontan Reservoir.
- Carson River Flood Plain Below Lahontan Dam - Refers to the flood plain of the South Branch of the Carson River beginning below Lahontan Dam and extending to Carson Lake.

The ROD anticipated that the NDEP Bureau of Corrective Actions (BCA) would be notified of development within the general CRMS site boundary by the NDEP Bureau of Water Pollution Control (BWPC) for developments of five homes or more, and by the county planning departments for smaller developments. Much of OU1 is in Lyon County, but Washoe, Storey, and Churchill Counties and Carson City are also affected. From 1995 to 2012, approximately 45 development proposals were reviewed by BCA pursuant to the LTSRP. Of those, 28 required sampling and 2 required remediation.

Due to changes in the National Pollution Discharge Elimination System (NPDES) requirements for Construction General Permits (CGP) under the Phase II Storm Water Rule that was promulgated on December 8, 1999, the NDEP BWPC CGP now applies to projects disturbing at least one acre, or that will disturb less than one (1) acre but are part of a larger common plan for development or sale that will ultimately disturb one (1) or more acres. Therefore, a notification to the NDEP BCA of potential disturbance of sites smaller than five homes or five acres, but greater than or equal to one acre, originates from the NDEP BWPC. However, notification of new home construction or other surface disturbance of less than one acre must still be initiated by the county planning departments.

Basis for the Explanation of Significant Differences

- Issue 1: The CRMS boundaries are not well defined to focus on the areas of concern.

This issue was identified in the Second Five-Year Review Report for the site, which was completed in 2008. The review noted that "there is no clear method for determining whether a property is within or outside of the CRMS."[4] This issue primarily affects the success of the LTSRP as a continuing public health protection. If the purpose of the LTSRP is to protect the public from exposures to CRMS contaminants, then knowledge of the location of those contaminants is central to effective implementation of the institutional control.

The very nature of the CRMS makes contaminant location difficult. Rather than a conventional industrial facility, the CRMS is composed of historic locations, some more than 150 years old and many no longer visible, and the areas where contamination from those locations has come to rest. Since EPA conducted its initial mill site identification and investigation effort, an additional 100^{+} mill sites have been identified from the historical records.

The issue of site definition is acknowledged in the ROD, which states:

> » 1.1 SITE DEFINITION
> The Carson River Mercury Site (CRMS) consists of the portions of the Carson drainage and Washoe Valley in Northwestern Nevada which are affected by mercury released from milling operations during the Comstock Lode. The exact boundaries of the affected area were not defined as part of this remedial investigation because knowledge of these boundaries were considered to have little or no influence on the findings of the risk assessment.
>
> The current definition of the CRMS study area is as follows: sediments in an approximately 70-mile stretch of the Carson River beginning near Carson City, Nevada and extending downstream through the Lahontan Reservoir to the terminal wetlands in the Carson Desert (Stillwater National Wildlife Refuge and Carson Lake); tailing piles, sediments and soil in Gold Canyon, Sixmile Canyon, and Sevenmile Canyon; and sediments and soil in Washoe Valley.

[4] Second Five-Year Review Report for Carson River Mercury Site, Cities of Dayton and Silver City, Lyon County, Nevada, September 30, 2008

Other site descriptions in the ROD follow:

- 6.4 AREAS OF DEPOSITION AND ACCUMULATION
  Areas of deposition and accumulation refers to areas where mercury imported to the region is presently deposited and potentially accumulating as a result of the fate and transport mechanisms discussed in the preceding section. For the purpose of characterizing and assessing human exposure at the CRMS, areas of deposition and accumulation were broken out and assessed separately. These areas and how they were defined for the remedial investigation are as follows:
  Millsites/Tailing Piles: refers to the locations of the historic millsites and all associated features (i.e., tailing piles, tailing ponds, flumes, etc.) which are recognized as the original point sources of mercury in the drainage;
  Tributaries: refers to the tributaries which drain the Virginia Mountain Range into the Carson basin and Washoe Valley (i.e., Six Mile Canyon, Gold Canyon, etc.);
  Alluvial Fan: refers to the alluvial fan below the mouth of Sixmile Canyon;
  Flood Plain: refers to the Carson River floodplain beginning above New Empire and extending to the terminal wetlands;
  Carson River: refers to the main channel of the Carson River beginning above New Empire and extending to the terminal wetlands;
  Lahontan Reservoir: refers to Lahontan Reservoir which has a surface area of approximately 4,856 acres (EPA, 1977);
  Carson Lake: refers to Carson Lake which occupies approximately 5,600 acres (Hoffman et.al, 1990);
  Stillwater Wildlife Management Area: refers to the Stillwater Wildlife management area which occupies approximately 9,600 acres during an average water year (Hoffman et.al, 1990);
  Indian Lakes: refers to the Indian Lakes recreation area which have a total surface area of approximately 549 acres during an average water year (Tuttle, 1992); and
  Washoe Lake: refers to the combined area of Little and Big Washoe Lake which have a combined area of approximately 5,100 acres during a normal water year (Washoe County, 1992).

- 9.1 DESCRIPTION OF REMEDIATION ALTERNATIVES
  The Long-term Sampling and Response Plan will set forth specific sampling guidelines for characterizing mercury levels in surface soils and for addressing impacted areas. The areas where any residential development will be subject to the guidelines prescribed in this plan are generally described as follows:
  Sixmile Canyon - Refers to the tributary of the Carson River that begins near Virginia City in the Virginia mountain range and meets the Carson River approximately five miles east of Dayton. The segment of concern is the canyon which begins just below Virginia City and extends to the mouth of the canyon just above the alluvial fan.
  Alluvial Fan - Refers to the alluvial fan below the mouth of Sixmile Canyon. The fluvial channels extending across the fan from the mouth of Sixmile Canyon to the Carson River confluence are the areas of concern.
  Brunswick Canyon - Refers to the Carson River flood plain between New Empire (the Mexican Mill) and Dayton.

Carson River Flood Plain Above Lahontan Dam - Refers to the Carson River flood plain extending between Dayton and Lahontan Reservoir.

Carson River Flood Plain Below Lahontan Dam - Refers to the flood plain of the South Branch of the Carson River beginning below Lahontan Dam and extending to Carson Lake.

In instances where residential development is proposed within these defined areas, [the] Nevada Division of Environmental Protection (NDEP) will provide the interested parties with the Long-term Sampling and Response Plan Guidelines. The guidelines will provide specific instructions for sampling an area to assess mercury levels in surface soils, instructions for interpreting and reporting results, instructions for follow-up sampling, and instructions for addressing impacted areas.

» 10.0 SELECTED REMEDY

Implementation of institutional controls to ensure that any residential development in present open land use areas known or suspected to be impacted by mercury includes characterizing mercury levels in surface soils and, if necessary, addressing impacted soils. These institutional controls will be referred to as the "Long-term Sampling and Response Plan."

The consistent thread through all the descriptions of the site in the ROD is that it includes those areas where Comstock mining era contaminants of concern have come to reside. At the time the ROD was signed, the technology did not exist to display data in a manner that could identify the contaminated areas on a property by property scale. With the improvements in Geographic Information System (GIS) technology, it is now possible to record and display sample locations and analytical results with an accuracy that permits delineation of a site based on the distribution of contaminants.

EPA generally defines a Superfund site to be "…that portion of a facility [site] that includes the location of a release (or releases) of hazardous substances and wherever hazardous substances have come to be located. As such the extent of a site is not limited by property boundaries, and does not include clean areas within a facility's property boundaries."[5] The Agency also recognizes that "[T]he extent and nature of a release becomes more refined as information…is gathered….NPL site boundaries will vary over time. Throughout the life of the project, information may develop that results in finding more contamination than was previously thought to be present. Conversely, as remedial action is implemented, site boundaries may contract."[6]

When EPA conducted the Remedial Investigation for the CRMS in the early 1990's, the Agency identified, sampled, and mapped 131 mill sites in OU1. Out of this effort, six areas were found to be both residential and have mercury in soil above the 80 mg/kg cleanup level, and five were remediated as described above.

[5] Clarifying the Definition of "Site" Under the National Priorities List, Quick Reference Fact Sheet, U.S. EPA, EPA/540/F-95/033 OSWER-9320.2-10FS, May 1996.

[6] Ibid

The sampling data from sites which were not identified for remedial action in 1995 because their mercury levels were below 80 mg/kg or they were not being used for residential purposes, was not subsequently managed in a way that could assist EPA and NDEP to determine which areas could be subject to the LTSRP in the future (mercury, arsenic, and lead above cleanup standards but not residential in 1995) and those areas which could be excluded from future CRMS consideration (contaminants below cleanup levels). The LTSRP was simply applied on a general geographic basis to development along the flood plain of the Carson River and in a wedge-shaped area starting at Virginia City and running down Gold and Sixmile Canyons to the flood plain, consistent with the site description contained in Section 9.1 of the ROD.

The institutional control did not provide protection for public health from residential development in CRMS areas associated with Washoe Lake, even though it was recognized as an area with contaminants of concern. Conversely, the geographic nature of the LTSRP applicability area included upland properties which were not impacted by the historic mill sites. The inconsistency caused by the various general geographic site definitions in the ROD hampers the protectiveness and effectiveness of CRMS management and public health protections and is not consistent with the manner in which EPA defines a "site".

- Issue 2: Cleanup levels for two of the three contaminants of concern, lead and arsenic, have changed since the ROD was signed.

Contaminants of concern for the CRMS were determined in the EPA 1994 HHRA/RI to be mercury, arsenic, and lead. Although mercury occurs naturally in the Carson River basin, the background levels are overwhelmed by the amount of mercury imported into the Comstock to process ore. Arsenic and lead are naturally occurring trace metals in the area that were concentrated in the ore milling process.

The HHRA evaluated the cancer and non-cancer health risks from exposure to CRMS contaminants by various exposure pathways. For OU1, exposure by incidental soil ingestion was found to be the pathway of potential concern for mercury, arsenic, and lead. Using toxicity information and CRMS concentration data for each compound, the cancer and non-cancer risks were then estimated. The risk assessment concluded that cancer risks from exposures to the contaminants of concern at OU1 were not significant. However, the non-cancer health risks for children under the age of six, living on or adjacent to contaminated areas and incidentally ingesting mercury or arsenic from soil, were found to be at levels that EPA considered to be potentially adverse i.e., Hazard Index (HI) >1 (Table 1). Because of the nature of the health effects of lead, the risk for residential exposure to lead in the soils of the CRMS was calculated separately using levels found in soils in the Dayton area. The calculation determined that lead in soils should not present a significant health threat. Exposures from recreational land use were not significant for any contaminant.

Table 1: Estimated Hazard Indices (HI) for Individuals Living On or Adjacent to Impacted Areas[1]			
Exposure Pathway	**Contaminant**	**Typical Estimate[2]**	**High-end Estimate[3]**
Soil Ingestion[4]	Mercury	0.09	2.80
	Arsenic	0.05	1.23
Dust and/or Vapor Inhalation	Mercury	0.10	0.38
	Arsenic	0.002	0.007
Consumption of Domestic Produce	Mercury	0.40	0.80
Hazard Index		0.64	5.22

[1]A HI >1 indicates that the associated exposure scenario has the potential to result in adverse noncancer health effects. The HI is the sum of individual Hazard Quotients.
[2]Typical Hazard Quotient estimate is for an adult.
[3] High-end Hazard Quotient estimate is for a young child (<6 years).
[4] Chronic daily intake (CDI) was estimated based on mercury levels measured in surface soil at the MS004 sample area in Dayton

To protect children from exposure to the contaminants of concern from residential exposures, the 1995 ROD established the site-specific 80 mg/kg cleanup standard for mercury in soil, and also adopted the Nevada Contaminated Soil and Groundwater Remediation Policy, June 25, 1992, arsenic standard of 80 mg/kg. Because neither EPA nor the State of Nevada had a cleanup level for lead, none was specified in the ROD.[7]

Section 121(d) of CERCLA requires that remedial actions selected for Superfund sites comply with “legally applicable or relevant and appropriate standard[s], requirement[s], criteria, or limitation[s].” The highest tier of cleanup standards are those promulgated under Federal or, with certain conditions, State law that are “applicable or relevant and appropriate” (ARAR) to a particular site, contaminant, or remedial action. As such, ARARs can be chemical-specific, location-specific, and/or action-specific requirements.

At the time the ROD was signed, there were no federal or state laws concerning mercury, arsenic and lead cleanup levels that were considered to be ARARs for the cleanup of OU1. However, there were standards from the next tier of requirements, termed “To Be Considered” standards, which were determined to be germane to the CRMS cleanup. The Nevada Contaminated Soil and Groundwater Remediation Policy was determined to be appropriate for the arsenic standard and that cleanup level was selected in the ROD. For mercury, the section of the Policy that states that site specific cleanup levels may be used at a site if they were developed using a scientifically valid risk assessment was used. The Nevada Contaminated Soil and Groundwater Remediation Policy cited in the ROD is no longer in effect. Cleanup levels for soil in Nevada are now governed by Nevada Administrative Code (NAC) 445A.2272.

[7] Please see ROD for discussion of lead level

Description of the Significant Differences

- Issue 1: The CRMS boundaries are not well defined to focus on the areas of concern.

The global definition of the CRMS contained in Section 1.1 of the ROD remains applicable: “The Carson River Mercury Site (CRMS) consists of the portions of the Carson drainage and Washoe Valley in Northwestern Nevada which are affected by mercury released from milling operations during the Comstock Lode.” The more specific, geographical description in Section 9.1 of the ROD of the area subject to the LTSRP was based on the belief that the sampling conducted during the Remedial Investigation had identified all the areas with mercury above the cleanup level, both residential and non- residential. The area of the CRMS subject to the LTSRP was described geographically in the ROD based on the data collected in the Remedial Investigation.

As time has passed and CRMS land uses have changed and more information has become available, it has become apparent that there are areas which were not identified in the original scope and description of the LTSRP applicability area which should be included if the institutional control is to be effective in protecting the public from residential exposures to CRMS contaminants. The definition of the areas to which the LTSRP applies needs to be based on the locations of contaminants, driven by sampling data, not simply a general geographic description. The contamination-zone based site definition and description in ROD Sections 1.1 and 10.0 make sense when the purpose of the LTSRP is considered; the geographic description in Section 9.1 does not. A contamination-zone based definition is also more consistent with the Superfund program’s general definition of “site” referenced above.

A contamination-zone based definition of the CRMS means that the site is defined by data. The data need to be organized and communicated in a way that is useful for site managers and the public. To that end, NDEP has digitized CRMS sampling data and has prepared a GIS-platformed management map of the CRMS. The map uses historical records of mill site locations, watershed and drainage information, and data from EPA and LTSRP sampling to more specifically identify the areas where CRMS-related contaminants are found or are likely to be located, and includes several contamination zones to account for possible transport from the original mill site locations. The contamination zones, termed by NDEP as “risk zones”, include the sediments above the ordinary and permanent high water mark of the Carson River and its tributaries to assure that the areas which may be developed adjacent to the river or tributaries are included in the public health protections provided by the LTSRP.

The map is designed to change over time as additional data more closely profile and define the areas with and without elevated levels of contaminants of concern, and contaminated properties are remediated pursuant to the LTSRP. This will assure that the CRMS site definition remains aligned with the public health risk and with EPA’s definition of “site” as “…the location of a release.” The current version of the CRMS map is available on the NDEP website at http://ndep.nv.gov/bca/carsonriver/criverwhatsnew.htm.

To further refine the map, EPA and NDEP will conduct additional sampling of OU1 of the CRMS. NDEP is currently reviewing an archeological survey of the expanded list of mill site locations to assure that the OU1 work complies with the requirements of the National Historic Preservation Act and that historic features are protected. After the survey, samples of soil and tailings will be collected and analyzed for contaminants of concern. The site boundaries will be adjusted as the sample results indicate.

- Issue 2: Cleanup levels for two of the three contaminants of concern, lead and arsenic, have changed since the ROD was signed.

The Nevada Contaminated Soil and Groundwater Remediation Policy is no longer in effect. The cleanup levels for soils in Nevada are now governed by the Nevada Administrative Code (NAC):

> NAC 445A.2272 Contamination of soil: Establishment of action levels. **(**NRS 445A.425**)**
>
> 1. For the purposes of NAC 445A.22695 to 445A.2271, inclusive, the action level for soil must be established at the following levels:
>
> (a) The background concentration or volume of a hazardous substance, hazardous waste or a regulated substance set forth in:
>
> (1) The permit issued to the owner or operator by the Division; or
>
> (2) A study approved by the Division.
>
> (b) The presence of a hazardous substance, hazardous waste or a regulated substance in the soil at an appropriate level of concentration that is based on the protection of the waters of the State, public health and safety for all identified routes of exposure and the environment. The appropriate level of concentration must be determined by the Division using the Integrated Risk Information System, adopted by the Environmental Protection Agency, as it existed on October 3, 1996, or any other equivalent method or peer-reviewed source of information chosen by the Division.
>
> 2. Except as otherwise provided in this subsection, if more than one action level for soil may be established using the criteria set forth in paragraph (b) of subsection 1, the most restrictive action level must be used. In no case may the action level be more restrictive than the background concentration of the hazardous substance, hazardous waste or regulated substance.
>
> 3. The State Environmental Commission hereby adopts by reference the Integrated Risk Information System, adopted by the Environmental Protection Agency, as it existed on October 3, 1996.[8]

The EPA Integrated Risk Information System is used to derive the Agency's Regional Screening Levels (RSLs). RSLs are used by Superfund site decision makers to help determine whether levels of contamination found at a site may warrant further investigation or site cleanup. RSLs are used by NDEP for the same purpose, consistent with Nevada Administrative Code 445A.2272, as the successor to the Nevada Contaminated Soil and Groundwater Remediation Policy. RSLs are guidance, not promulgated standards.

The EPA RSL level for arsenic in residential soil is currently 0.61 mg/kg, based on the carcinogenicity of arsenic, and assuming that 60% of the arsenic is bioavailable. The geology of Nevada is such that arsenic occurs naturally in soil at levels far exceeding the RSL. A 1981

[8] Added to NAC by Environmental Comm'n, eff. 10-3-96; A by R189-08, 8-25-2009

United States Geological Study (USGS) Open File Report recorded arsenic values in Nevada soils of 2.9 to 24.0 mg/kg, and data from Tidball et al, cited in the EPA Human Health Risk Assessment and Remedial Investigation Report, found an arithmetic mean for arsenic in soil of 13.14 mg/kg.[9,10] To establish a meaningful and protective level for arsenic in soils of the CRMS, both natural levels and the effect that the milling process had on concentrating arsenic must be considered. As a matter of policy, EPA does not establish cleanup goals below natural background levels. NDEP statistically evaluated arsenic data from the almost 400 soil samples reported in Tidball, et al. The NDEP Position Paper detailing the evaluation is attached to this ESD (Attachment 2). Based on the analysis, NDEP concluded that "…32 mg/kg represents an appropriate and conservative generic screening/action level for arsenic in surface soils within the Carson River drainage basin." This level is based on an analysis using normal probability plots to identify a naturally occurring background population for arsenic. The 95th percentile of this background population of arsenic concentrations was selected as the background screening level for the Carson River basin. This determination of a naturally occurring background concentration meets the requirements of NAC 445A.2272(1)(a)(2). EPA concurs with the NDEP evaluation and recognizes the cleanup level of 32 mg/kg arsenic as a site-specific ARAR for the CRMS.

Unlike arsenic, concentrations of lead in Nevada soils are not naturally elevated. Lead levels in Nevada soils reported in the 1981 USGS paper ranged from <10 mg/kg to 70 mg/kg and the mean reported in the data from Tidball et al was 17.2mg/kg.[11] The NDEP estimated a background screening level of approximately 22 mg/kg for lead using the Tidball et al. data set. The EPA Office of Solid Waste and Emergency Response (OSWER) has utilized a risk reduction goal of limiting exposure to soil lead levels such that children would have no more than 5% risk of exceeding a blood lead level of 10 micrograms per deciliter (µg/dL). Until EPA revises this policy, that risk reduction goal is appropriate to support Superfund site cleanup decisions. The OSWER Directive on risk assessment and cleanup of lead in residential soil recommends that soil lead levels less than 400 mg/kg are generally safe for residential use.[12] That level has been incorporated into the EPA RSLs, and EPA considers the level to be an appropriate and protective "to be considered" requirement for the CRMS. The level of 400 mg/kg is therefore adopted as the cleanup level for lead in residential soil in the CRMS.

The presence of elevated levels of arsenic and lead at a residential location, in the absence of mercury above natural background levels, shall not solely make that location subject to the management provisions of the CRMS. Because such large quantities of mercury were introduced into the native ore in the milling process, it serves as the sentinel compound for Comstock-related contamination. In the absence of mercury above typical background levels, elevated levels of arsenic and lead found at a residential location cannot be assumed to be CRMS-related. The arsenic and lead levels may just reflect natural background. Therefore, a background level

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[9] Boerngen, Josephine G., and Shacklette, Hansford T. Chemical Analyses of Soils and Other Surficial Materials of the Conterminous United States: Denver, Colorado: U.S. Geological Survey Open-File Report 81-197; 1981.
[10] Tidball, R.R., Briggs, P.H., Stewart, K.C., Vaughn, R.B., and Welsch, E.P., 1991, Analytical data for soil and well core samples from the Carson River basin, Lyon and Churchill Counties, Nevada, U.S. Geological Survey Open-File Report 91-584A.
[11] Ibid.
[12] Memorandum: OSWER Directive: Revised Interim Soil Lead Guidance For CERCLA Sites AND RCRA Corrective Action Facilities, EPA OSWER Directive #9355.4-12, August 1994

for mercury in soils in the CRMS has been established as a threshold to indicate the presence of contaminated materials. If mercury is present above the background level, then further analysis will be conducted to determine whether the property has been affected by CRMS-related contamination.

NDEP analyzed studies of the Carson River basin to determine typical mercury background levels (Attachment 3). Based on the analysis of data from the Tidball study and from sampling recently conducted by Comstock Mining, Inc. in support of their mineral exploration and extraction activities in Gold Canyon, NDEP concluded that "Data from the Tidball study (Tidball et al., 1991, n = 397) and the recent background study conducted by Comstock (Comstock Mining, 2012, n = 56), suggest that concentrations of mercury in soil that exceed 1 mg/kg are unlikely to represent background conditions in non-mineralized areas."[13] EPA concurs with this analysis and has determined that 1.0 mg/kg mercury in soils and tailings is the appropriate threshold level which EPA and NDEP will reference as a screening level to begin to determine that a sample location may be impacted by Comstock Lode milling activities.

If an area is identified with levels of arsenic or lead above the cleanup levels in the absence of mercury above background concentrations, and the area is determined not to be CRMS-related, EPA and NDEP will consult regarding the best path forward to assure that any public health or environmental risks associated with the area are addressed.

Table 2. Summary of Soil ARAR/TBC Changes

Contaminants of Concern	1995 ROD ARARs/TBCs (mg/kg)	Current (mg/kg)	ARARs /TBCs Changed?
Mercury	80	80	No change
Arsenic	80	32	More stringent
Lead	--	400	More stringent

Support Agency Comments

The Nevada Division of Environmental Protection concurs with this ESD. The NDEP letter confirming its agreement is incorporated as Attachment 4 of this document.

Statutory Determinations

The modifications to the remedy for the Carson River Mercury site satisfy the requirements of CERCLA §121.

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[13] Evaluation of Metals Data from Tidball et al. (1991): Arsenic, Lead and Mercury. Mary A. Siders, Ph.D. NDEP, BCA, June 29, 2012

Public Participation Compliance

Section 300.435 Remedial design/remedial action, operation and maintenance, subsection (c)(2)(i) of the National Contingency Plan states:

> (c) *Community relations...*
> (2) After the adoption of the ROD, if the remedial action or enforcement action taken, or the settlement or consent decree entered into, differs significantly from the remedy selected in the ROD with respect to scope, performance, or cost, the lead agency shall consult with the support agency, as appropriate, and shall either:
> (i) Publish an explanation of significant differences when the differences in the remedial or enforcement action, settlement, or consent decree significantly change but do not fundamentally alter the remedy selected in the ROD with respect to scope, performance, or cost. To issue an explanation of significant differences, the lead agency shall:
> (A) Make the explanation of significant differences and supporting information available to the public in the administrative record established under §300.815 and the information repository; and
> (B) Publish a notice that briefly summarizes the explanation of significant differences, including the reasons for such differences, in a major local newspaper of general circulation.

Because community involvement activities for the CRMS have been limited since the remedial action in 1999, it is appropriate to do a more robust community involvement program than that required by the National Contingency Plan. Therefore, in addition to publishing notice of the ESD in the Virginia City News, the Dayton Courier, the Nevada Appeal, the Mason Valley News, and the Reno Gazette-Journal, the Region will issue a Fact Sheet to residents in the OU1 area to apprise them of the changes being made pursuant to this ESD. The Region and NDEP will also meet with local officials, and hold open houses and community meetings, as deemed appropriate, to inform residents of the CRMS of the changes.

This ESD is approved by:

Michael Montgomery
Assistant Director
Superfund Division
EPA Region 9

9/27/13
Date

Attachment 1

EPA Superfund Record of Decision
March 30, 1995

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EPA/ROD/R09-95/134
1995

EPA Superfund
Record of Decision:

CARSON RIVER MERCURY SITE
EPA ID: NVD980813646
OU 01
DAYTON, NV
03/30/1995

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IX

75 Hawthorne Street

San Francisco, CA 94105-3901

AR0189

RECORD OF DECISION

CARSON RIVER MERCURY SITE, WEST CENTRAL NEVADA

OPERABLE UNIT 1: SURFACE SOIL

March 30, 1995

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PART 1. DECLARATION

SITE NAME AND LOCATION

Carson River Mercury Site
Lyon, Storey and Churchill County, Nevada

STATEMENT AND PURPOSE

This Record of Decision ("ROD") presents the selected remedial action for Operable Unit 1 ("OU-1") of the Carson River Mercury Site (" CRMS") which is located in Lyon, Storey and Churchill Counties, Nevada. This document was developed in accordance with Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ("CERCLA") as amended by the Superfund Amendments and Reauthorization Act of 1986 ("SARA"), 42 U.S.C. Section 9601 et seq., and in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan, 40 C. F. R. Section 300 et seq., ("NCP"). This decision is based on the administrative record for this operable unit.

In a letter to EPA dated March 29, 1995, the State of Nevada, through the Nevada Division of Environmental Protection (NDEP) concurred with the selected remedy for this operable unit of the CRMS.

ASSESSMENT OF THE SITE

Actual or threatened release of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

The remedial action objective for OU-1 of the CRMS is to reduce human health risks by reducing direct exposure to surface soils containing mercury at concentrations equal to or greater than 80 milligrams per kilogram (mg/kg) in residential areas. There are six areas which are considered actionable based on this cleanup objective: five residential yards and one ditch ("Dayton Ditch").

The selected remedy for the five residential yards is to excavate contaminated surface soil (estimated to go to a depth of approximately 2 feet below ground surface), dispose of the soil at a RCRA municipal landfill if the soils do not exceed the TCLP standards, and restore the excavated areas. Approximately 5000 cubic yards of soil will be excavated and disposed of as part of this response action. If it is determined that all or part of the excavated soil exceeds the TCLP standards, then the excavated soil will either be treated and disposed of at a RCRA municipal landfill or disposed of at a RCRA hazardous waste landfill. Which of these sub-alternatives that will be used will depend on which sub-alternative is found to be more cost effective and the logistics of implementing each sub-alternative.

The selected remedy for the Dayton Ditch is no action. EPA selected no action for the Dayton Ditch because the health risks for this area are not great enough to warrant response actions such as capping or excavation and the State of Nevada and the community expressed opposition to institutional controls (i.e., restricting access with a fence). Although EPA has selected no action for the Dayton Ditch, additional samples will be collected from the ditch during the remedial design to further evaluate the level of impact. In the event that EPA determines that some form of remediation is warranted, then EPA will document this remedy selection in an "Explanation of Significant Differences (ESD) or ROD amendment, or the area will be addressed as part of OU-2.

The response actions for the residential yards address the incidental soil ingestion exposure pathway which was found to be of potential concern for populations near impacted areas. Also found to be an exposure pathway of potential concern is consumption of fish or waterfowl from the Carson River system. However, this remedial action is not attempting to address this pathway. Operable unit 2 of the remedial investigation and feasibility study ("RI/FS") will evaluate methods to reduce mercury concentrations in fish and waterfowl.

The major components of the selected remedy include:

- Excavation of approximately 5000 cubic yards of contaminated soils, disposal at a RCRA municipal and/or hazardous waste landfill, and restoration of properties. In the event that subsurface soil (greater than or equal to 2 feet below ground surface) is impacted and is not addressed, then this alternative may also include institutional controls; and

- Implementation of institutional controls to ensure that any residential development in present open land use areas known or suspected to be impacted by mercury includes characterizing mercury levels in surface soils and, if necessary, addressing impacted soils. These institutional controls will be referred to as the "Long-term Sampling and Response Plan."

This remedial action addresses a principal risk at the CRMS by removing contaminants from surface soil, thereby significantly reducing the toxicity, mobility or volume of hazardous substances in surface soil. This remedial action will reduce the possibility of human contact with mercury and thereby reduce the human health risks.

STATUTORY DECLARATION

The selected remedy is protective of human health and the environment, complies with federal State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. However, because treatment of soils may not occur, this remedy may not satisfy the statutory preference for treatment as a principal element of the remedy. Because this remedy will result in hazardous substances remaining on-site above health-based levels, a five-year review, pursuant to CERCLA Section 121, 42 U.S.C. Section 9621, will be conducted at least once every five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

Keith Takata 3-30-95

Keith Takata — Date
Deputy director,
Hazardous Waste Management Division

PART 2. DECISION SUMMARY

This Decision Summary provides an overview of the problems posed by the Carson River Mercury Site ("CRMS" or the "Site"), the alternatives considered for addressing those problems which are within the scope of operable unit ("OU-1"), and presents the analysis of the remediation alternatives. This Decision Summary also provides the rationale for the remedy selection and describes how the selected remedy satisfies the statutory requirements.

1.0 SITE DESCRIPTION

1.1 SITE DEFINITION

The Carson River Mercury Site (CRMS) consists of the portions of the Carson drainage and Washoe Valley in Northwestern Nevada which are affected by mercury released from milling operations during the Comstock Lode. The exact boundaries of the affected area were not defined as part of this remedial investigation because knowledge of these boundaries were considered to have little or no influence on the findings of the risk assessment.

The current definition of the CRMS study area is as follows: sediments in an approximately 70-mile stretch of the Carson River beginning near Carson City, Nevada and extending downstream through the Lahontan Reservoir to the terminal wetlands in the Carson Desert (Stillwater National Wildlife Refuge and Carson Lake); tailing piles, sediments and soil in Gold Canyon, Sixmile Canyon, and Sevenmile Canyon; and sediments and soil in Washoe Valley (Figure 1).

This Record of Decision ("ROD") calls for remedial action in Dayton and Silver City, Nevada. Both Dayton and Silver City are located in Lyon County.

1.2 SITE PHYSIOGRAPHY

The Carson River drainage basin drains approximately 3,980 square miles in east-central California and west- central Nevada. The Carson River heads in the eastern Sierra Nevada mountains south of Lake Tahoe and generally flows northeastward and eastward to the Carson Sink (Figure 1). The Carson River flows through a series of generally separate alluvial valleys from the headwaters area to the Carson Sink. In downstream order, the alluvial valleys passed by the river include Carson Valley, Eagle Valley, Dayton Plains, Stagecoach Valley, Churchill Valley, and Carson Desert (Figure 2). Between New Empire and Dayton the river flows through a narrow, high-gradient stretch along which large ore-processing mills were situated during the late 1800s. The flow of the river is interrupted west of Fallon by Lahontan Reservoir, which was constructed in 1915 as part of the Newlands Irrigation Project. Below Lahontan Dam, flow is routed through a complex network of ditches, drains, and canals of the Newlands Irrigation Project. Irrigation return flow eventually discharges to Carson Lake, the Stillwater Wildlife Refuge, and/ or the Carson Sink.

Stream flow in the Carson River above Lahontan Reservoir is highly seasonal. The major source of water for the Carson River is the winter snowpack in the Sierra Nevada mountains. Base flow is reached in late summer (August, September, and October) and flow then increases slightly through the fall and winter (November through March), until the snowmelt season starts in early spring. Maximum annual flow typically occurs in April, May and June.

The areal extent of water bodies and wetlands in the Carson Basin is highly variable, both seasonally and from year to year. This is especially true in the Carson Desert. For example, between July 1984 and February 1985, following three unusually wet years, the water surface area of the Carson Sink was approximately 200,000 acres (Rowe and Hoffman, in press), yet by April 1988 (during a second consecutive drought year) the sink was dry (Hoffman, 1988).

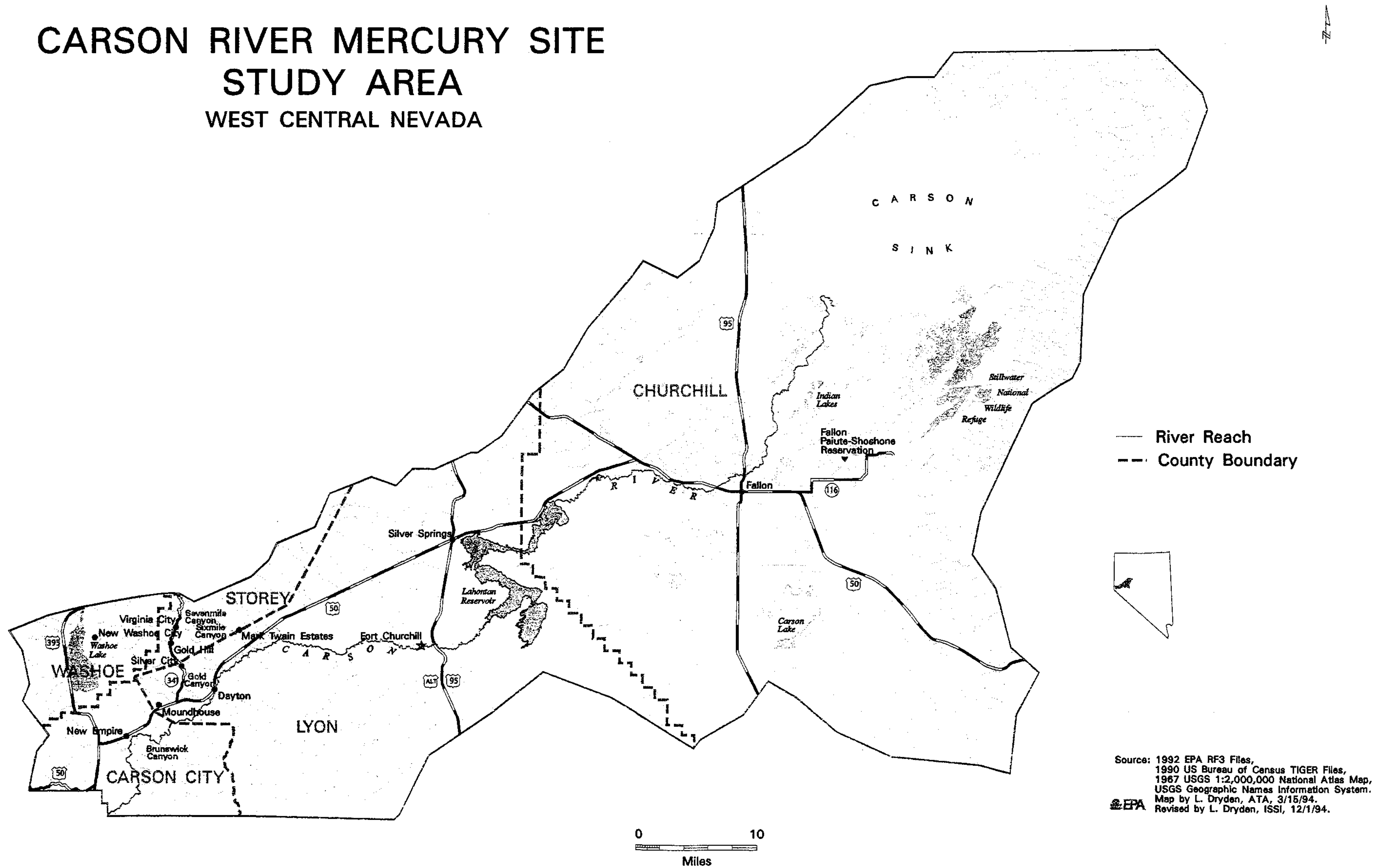

CARSON RIVER MERCURY SITE
STUDY AREA
WEST CENTRAL NEVADA
CARSON SINK
CHURCHILL
Indian Lakes
Stillwater National Wildlife Refuge
Fallon Paiute-Shoshone Reservation
Fallon
RIVER
Silver Springs
Lahontan Reservoir
STOREY
Virginia City
Sevenmile Canyon
Sixmile Canyon
New Washoe City
Washoe Lake
Gold Hill
Silver City
Mark Twain Estates
Fort Churchill
CARSON
WASHOE
Gold Canyon
Dayton
Moundhouse
New Empire
Brunswick Canyon
CARSON CITY
LYON
Carson Lake
River Reach
County Boundary
Source: 1992 EPA RF3 Files,
1990 US Bureau of Census TIGER Files,
1967 USGS 1:2,000,000 National Atlas Map,
USGS Geographic Names Information System.
Map by L. Dryden, ATA, 3/15/94.
Revised by L. Dryden, ISSI, 12/1/94.
EPA
0
10
Miles

FIGURE 1

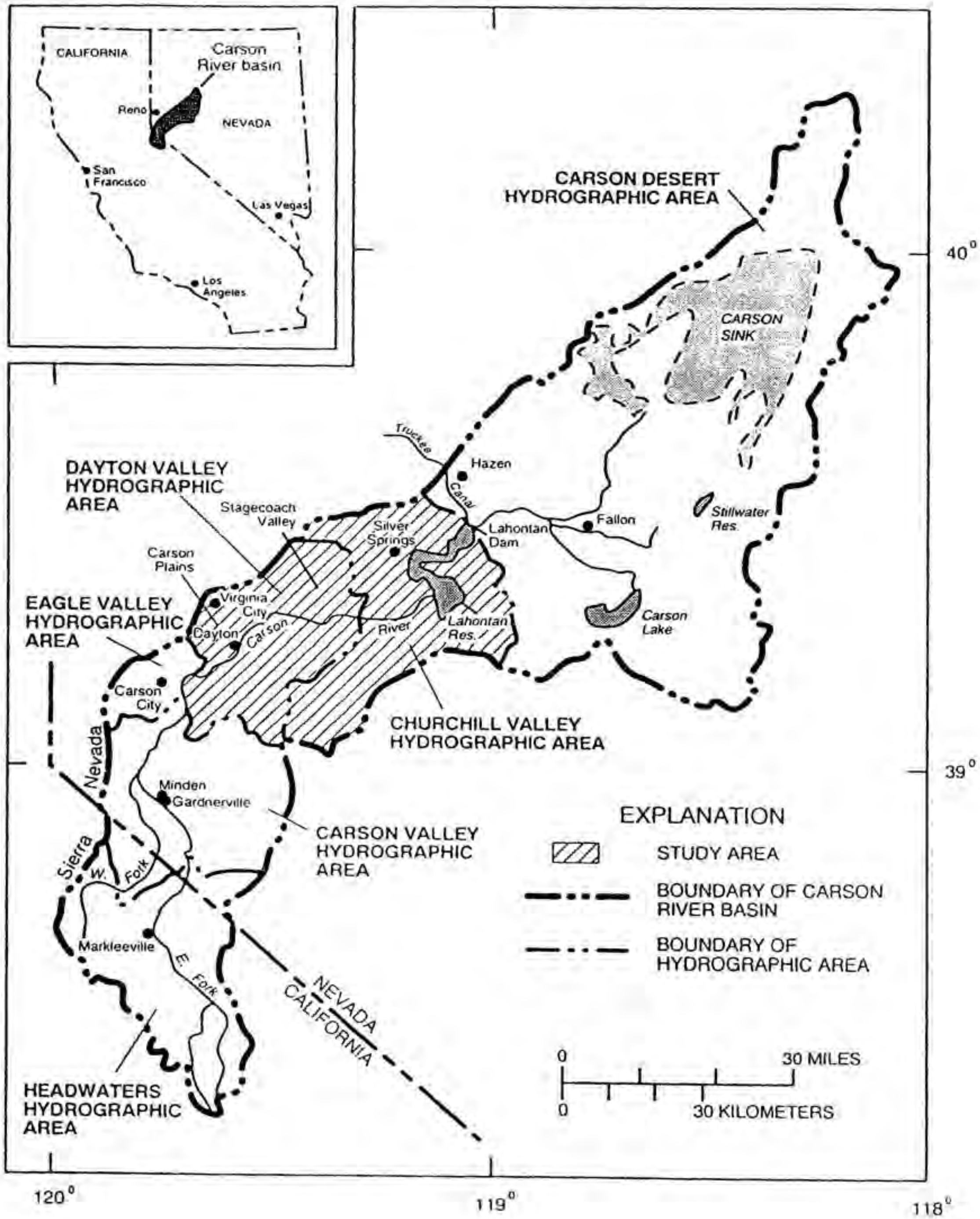


Figure 2: Carson River Basin Hydrographic Areas

Washoe Valley lies between the Carson Mountain Range and the Virginia Mountain Range which separates Washoe Valley from the Carson Basin (see Figure 1). There are two water bodies in Washoe Valley, Washoe Lake and Little Washoe Lake. Most runoff in Washoe Valley drains the eastern slope of the Carson Range. Franktown and Ophir Creeks provide the bulk of the surface runoff that reaches Washoe and Little Washoe Lakes. Steamboat Creek, flowing from Washoe Valley, and Brown's Creek and Galena Creek, comprise the bulk of the surface water resources for Pleasant Valley.

1.3 CLIMATE

The climate of the region is dry due to the "rain shadow effect" created by the Sierra Nevada Mountains which form the western boundary of the region. Average annual precipitation throughout the Carson River drainage basin ranges from between 25 to 50 inches in the headwaters area in the Sierra Nevada Mountains to between 4 and 5 inches near Lahontan Reservoir and Carson Desert (Twiss et. al., 1971).

1.4 DEMOGRAPHICS

The Carson River Mercury Site intersects Lyon County, Storey County, Churchill County, and Washoe County. According to the 1990 census taken by the Department of Commerce, U. S. Bureau of the Census, the population of the counties which are intersected by CRMS are as follows: Lyon County (population 20,001), Storey County (population 2,526), Churchill County (population 17,938), and the South Valley of Washoe County (population 4,596). Additional demographic information is provided in Section 5.0.

1.5 LAND USE

Historical land use in the Carson River basin was mostly agriculture and mining in the 1840s and '50s. The mining industry and population in the basin fell rapidly in the 1880s; however, railroad access to other markets helped promote ranching and farming. Another change in land use was an increase in irrigated acreage in the Carson Desert prompted by the impoundment of Lahontan Reservoir in 1915 and the creation of the Newlands Irrigation Project. Alfalfa is the principal irrigated crop, in terms of acreage and revenue, in the Newlands Irrigation Project. The estimated irrigated acreage ranged from 61,000 to 67,000 acres for the Newlands Project during 1980-87 (U. S. Bureau of Reclamation, 1980). Dayton and Churchill Valleys, which have the smallest populations in the Nevada portion of the Carson basin, are primarily rangeland, with agricultural areas along the Carson River. Land use and population remained relatively unchanged in the Carson River basin from 1890 until 1950, with the advent of suburban development. Since 1950, Carson City, Fallon, and rural populations have grown considerably with most of the urban and suburban development occurring on land that was previously used for agriculture (either irrigated cropland or rangeland). Presently, the local economy and urban land use are dominated by the retail trade and service sectors, primarily casinos and adjunct businesses such as hotels, motels, and restaurants that cater to tourists (Nevada Commission on Economic Development, 1985).

1.6 WATER USE

Major water bodies in the Carson basin include the Carson River, Lahontan Reservoir, Carson Lake, the Stillwater National Wildlife Refuge, and temporary lakes, reservoirs, and alkali flats in the Carson Desert. Lahontan Reservoir is the main storage reservoir for the Truckee Carson Irrigation District (TCID). Uses of surface water include: (1) agriculture irrigation; (2) maintenance of waterfowl and fishery habitats; (3) recreational use by the public such as hunting, fishing, birdwatching, swimming, and camping; and (4) to a limited extent, municipal and light-industrial purposes. Public drinking water systems are only supplied by aquifers and not by the Carson River.

In Washoe Valley there are two water bodies, Little Washoe Lake and Washoe Lake. Little Washoe Lake is used primarily for recreation. Big Washoe Lake is an intermittent lake which provides waterfowl and fishery habitats when it contains water, and provides recreational use for the public. Public drinking water systems are only supplied by aquifers and not directly by the lakes in Washoe Valley.

2.0 SITE HISTORY

2.1 SITE BACKGROUND

Mining in the Carson River drainage basin commenced in 1850 when placer gold deposits were discovered near Dayton at the mouth of Gold Canyon. Throughout the 1850s, mining consisted of working placer deposits for gold in Gold Canyon and Sixmile Canyon. These ore deposits became known as the Comstock Lode.

The initial ore discovered was extremely rich in gold and silver, gold was more abundant in Gold Canyon while silver was more abundant in Sixmile Canyon (Smith, 1943). The early mining methods concentrated on exposing as much of the lode as was possible in wide trenches. Throughout 1859, ore was shipped to San Francisco for processing. After local ore processing began in 1860, most major mines operated their own mills, but there were also a large number of private mills. Initial ore processing techniques were slow and inefficient and a fair amount of trial and error experimenting went into the development of an effective ore-processing technique. Refinements were aimed primarily at increasing the speed of gold and silver recovery, increasing the percentage of gold and silver recovered, and decreasing the amount of gold and silver discarded in tailings piles. The general milling process employed before 1900 involved pulverizing ore with stamp mills, creating a slurry, and adding mercury to the mixture. The mercury forms an amalgam with the precious metals which is then separated from the solution and retorted. After 1900, cyanide leaching and flotation processes replaced amalgamation.

Gold and silver production from the Comstock Lode increased slowly during the early years and 1863 was the first year of large production. Throughout the remainder of the 1860s and most of the 1870s, production remained high as rich ore bodies continued to be discovered at progressively deeper depths. The bottom of the lode was abruptly reached in 1877 at a depth of about 1,650 feet, and 1878 was the first year of dramatically reduced production. Between 1877 and 1878, ore production dropped from 562,519 tons to 272,909 tons and the total value decreased from $36,301,536 to $19,661,394. In 1879, production and value dropped even further. In 1901, the first cyanide-leaching operation began in Sixmile Canyon. Cyanide leaching was capable of recovering more gold and silver from lower- grade material than was possible by amalgamation methods, and during the early 1900s mining operations consisted of mining lower-grade material and reworking former ore dumps and tailings piles. Between approximately 1920 and 1950, large tonnages of low-grade ores were mined (Bonham, 1969). Since approximately 1950, mining operations have been extremely limited in scope. Currently, two mining operations are located within the Sixmile Canyon drainage.

2.2 HISTORY OF SITE INVESTIGATIONS

Elevated mercury levels in the Carson River drainage basin were discovered in the early 1970s when sampling conducted by the U. S. Geological Survey (USGS) revealed elevated levels in river sediment and unfiltered surface water from the Carson River downstream from pre-1900 ore milling sites (Van Denburgh, 1973). Subsequent studies by a number of investigators (Richins, 1973; Richins and Risser, 1975; Cooper, 1983; Cooper et. al., 1985; Hoffman et. al., 1990) have further delineated the extent of mercury in river and lake sediment and water. Based largely on the information presented in these studies, the Carson River below New Empire was added to the National Priorities List (NPL) in August, 1990 due to the widespread occurrence of mercury.

3.0 ENFORCEMENT ACTIONS

Enforcement activities at the CRMS have included issuing orders for the removal of mercury contaminated tailing piles which were found to pose imminent and substantial health risks and conducting a comprehensive investigation of potentially responsible parties (PRPs).

In November, 1990, mercury laden tailings located five miles east of Dayton and adjacent to U. S. Highway 50 were excavated and treated in response to an order issued by EPA. The Respondents addressed the contamination by excavating ostensible tailings and taking the material to the Flowery Mine heap leaching facility for treatment by cyanidation.

In August, 1992, mercury laden tailings located in Dayton, Nevada were excavated and treated in response to an order issued by EPA. For the area bounded by U. S. Highway 50 on the east, Douglas Street to the north, and River Road to the west, the Respondents were ordered to prevent exposure to soil with mercury concentrations greater that 25 ppm. The Respondents addressed the contamination by excavating contaminated soil, backfilling with clean soil, and taking the contaminated soil to the Flowery Mine heap leaching facility for treatment by cyanidation.

As part of the RI/FS, EPA conducted a comprehensive investigation of potentially responsible parties ("PRPs") for the CRMS. This PRP search included historical research to determine the locations of Comstock mills, to develop chain-of-titles for the mills, and to develop general information regarding the operation of the mills. This information was then used to identify PRPs for the CRMS as well as to direct OU-1 field investigations. The findings of the PRP search included maps which describe the locations of 143 historic millsites, identification of 213 entities who had significant involvement with the Comstock Lode, identification of possible corporate successors of historic milling companies, and identification of 300 current land owners.

The identification of corporate successors of historic milling companies is a complex process and EPA's investigation is not yet complete. Accordingly to date, EPA has not yet determined whether any existing entities are actual corporate successors who would be PRPs at the CRMS.

4.0 COMMUNITY RELATIONS ACTIVITIES

There have been extensive community relations activities throughout the course of this project. Community relations activities for the CRMS have included: setting up information repositories, issuing fact sheets to the affected communities (Dayton, Silver City, Virginia City, and Fallon), organizing a technical advisory committee ("TAC") made up of local representatives from various State and federal agencies, making contacts with editors of local newspapers, meeting with county officials, making presentations at county hearings, making presentations for professional organizations, conducting public meetings at the outset of the project and at the proposed plan stage, and speaking with local residents by phone or in person to request property access and to present sampling results. These community relations activities have provided for effective dissemination of information throughout the affected communities as well as for good feedback from the affected communities.

Information repositories were set up to provide public access to the reports used by EPA for developing a strategy for the RI/ FS and to access reports produced by EPA (i.e., RI/FS). The locations of these information repositories are as follows:

Nevada State Library and Archives
401 N. Carson Street
Carson City, Nevada 89710

Dayton Valley Library
Dayton, Nevada 89403

Churchill County Library
553 South Maine Street
Fallon, Nevada 89406

Fact sheets were distributed to the members of the affected communities throughout the course of the project to provide the status of the project and to report important findings. The fact sheets issued to date are as follows:

- March 1991, EPA Begins Cleanup of Mercury Contamination;
- August 1991, EPA Update on the Carson River Mercury Site;
- September 1992, Carson River Mercury Investigation Continues: Surveying and Mapping of Millsites;
- March 1993, EPA to Begin Field Sampling;
- November 1994, EPA Announces Sampling Results; and
- December 1994, EPA Announces Proposed Plan for Soil.

To date, EPA has conducted two series of public meetings for the CRMS project. The purpose for the first series of public meetings was to explain why the region was declared a Superfund site, to describe the Superfund process, and to present EPA's strategy for conducting the RI/FS. This presentation was made in Carson City, Dayton, and Fallon, Nevada on March 24, 25, and 26, 1992, respectively. The purpose for the second series of public meetings was to present the proposed plan for OU-1. This presentation was made in Dayton and Silver City, Nevada on January 18 and 19, 1995, respectively.

5.0 SCOPE AND ROLE OF THE RESPONSE ACTION

5.1 SCOPE OF THE RESPONSE ACTION

The remedy selected for OU-1 of the CRMS addresses human health risks associated with direct exposure to surface soil with elevated mercury levels. It is not within the scope of this response action to address human health and ecological risks associated with mercury in the Carson River system. Although the human health risks associated with consumption of fish and waterfowl from the Carson River system were assessed in the risk assessment for OU-1, response actions to reduce mercury concentrations in fish, waterfowl and other biota will be evaluated in the RI/FS for OU-2. Thus, the remedy selected for OU-1 is only intended to reduce direct exposure to mercury contaminated surface soils and not to protect surface water.

The remedial action objective for OU-1 is to address residential areas where mercury in surface soils is equal to or greater than 80 milligrams per kilogram (mg/kg). There are five areas in Dayton and one area in Silver City, Nevada where mercury levels in surface soil exceed this level. These six areas include five residential yards and one ditch ("Dayton Ditch").

The selected remedy for the five residential yards is to excavate surface soil (estimated to go to a depth of approximately 2 feet below ground surface), dispose of the soil at a RCRA municipal landfill if the soils do not exceed TCLP standards, and restore the excavated areas. If it is determined that all or part of the excavated soil exceed TCLP standards, then the excavated soil will either be treated and disposed of at a RCRA municipal landfill or disposed of at a RCRA hazardous waste landfill. Which of these sub-alternatives to be used will depend on which sub-alternative is found to be more cost effective and the logistics of implementing each sub-alternative. Approximately 5000 cubic yards of soil will be excavated and disposed of as part of this response action.

The selected remedy for the Dayton Ditch is no action. EPA selected no action for the Dayton Ditch because the health risks for this area are not great enough to warrant response actions such as excavation or capping and the State of Nevada and the community do not support addressing the area with institutional controls (i.e., restricting access with a fence). Although EPA has selected no action for the Dayton Ditch, additional samples will be collected from the ditch during the remedial design to further evaluate the level of impact. In the event that EPA determines that some form of remediation is warranted, then EPA will document this remedy selection in an "Explanation of Significant Differences (ESD)" for this ROD or the area will be addressed as part of OU-2.

5.2 ROLE OF THE RESPONSE ACTION

The human health risks assessment established that the exposure pathways of potential concern for the CRMS are: (1) consumption of fish or waterfowl from the Carson River system and (2) incidental ingestion of contaminated soil. The role of the selected remedy is to reduce human health risks by reducing exposure via incidental ingestion of contaminated surface soil. Based on the human health risk assessment, this pathway is found to be of potential concern where surface soils contain mercury at levels equal to or greater than 80 mg/kg.

6.0 SUMMARY OF SITE CHARACTERISTICS

6.1 SOURCES

Sources of mercury in the Carson drainage basin and Washoe Valley include mercury imported during the Comstock era and, possibly, naturally occurring mercury. There is insufficient information to characterize the full extent and significance of naturally occurring mercury in the Carson drainage basin and Washoe Valley. However, according to reports which characterize the geology of the Carson River drainage basin (Thompson, 1956; Bonham, 1969; and Moore, 1969), naturally occurring deposits of mercury of economic importance do not exist in the basin. Less significant natural occurrences of mercury can be associated with mineralized zones and hot springs deposits. Although it is possible that there are such natural occurrences of mercury in the region, such sources are not considered important relative to the large amount of mercury imported to the region during the Comstock era.

Mercury imported to the region during the Comstock era was purchased by mills for processing gold and silver ore. These mills employed various processes to amalgamate gold and silver. All of these processes included pulverizing the ore with stamps; creating an amalgam by mixing the crushed ore, salt, and elemental mercury into a slurry; separating the impregnated amalgam; and, finally, separating the gold and silver from the mercury with a retort. It is estimated that 186 such mills operated during the Comstock era (Ansari, 1989).

6.2 RELEASE MECHANISMS FROM SOURCES

The most widely used ore-processing method during the Comstock era was the "Washoe Process" (Smith, 1943). With this process, the raw ore is wet crushed with stamps, the crushed ore is separated from the slurry in a settling tank and then the crushed ore is charged with mercury (approximately 10 percent of the weight of the ore) (Smith, 1943)) in the amalgamation pan. The amalgam is separated from the slurry and the silver and gold is separated from the amalgam with a retort. It is thought that the majority of the mercury released to the environment was associated with tailings which were separated from the amalgam slurry and discharged into the drainage. Other possible release mechanisms would have included air emissions from the retort, fugitive air emissions throughout the process, and spilling throughout the process where mercury was handled. It is estimated that the loss of mercury exceeded pound for each ton of ore milled which translates to approximately 14,000,000 pounds of mercury (Smith, 1943).

6.3 TRANSPORT MECHANISMS

Potential migration pathways for mercury through the CRMS include surface water, groundwater, soil, and air. Transport mechanisms are as follows:

- fluvial transport of mercury laden sediment and soil,
- fluvial transport of dissolved mercury,
- air transport of particulate mercury,
- air transport of volatile mercury, and
- percolation of elemental mercury and/ or amalgam.

Fluvial transport is considered the most important mechanism for distributing mercury throughout the Carson Drainage and Washoe Valley. This is because mill tailings are considered the most significant release mechanism and this material is easily transported by fluvial processes. Eolian transport mechanisms may also account for the widespread dispersion of mercury in the region. The fate and transport of gaseous mercury emissions to the atmosphere is not well defined, however, it is believed that gaseous mercury was released to the environment from mills while operating and that mercury evasion is presently occurring. Also included as a transport mechanism is percolation which refers to the vertical movement of mercury through the subsurface. This transport mechanism would account for the vertical movement of elemental mercury or amalgam that was released to the environment.

6.4 AREAS OF DEPOSITION AND ACCUMULATION

Areas of deposition and accumulation refers to areas where mercury imported to the region is presently deposited and potentially accumulating as a result of the fate and transport mechanisms discussed in the preceding section. For the purpose of characterizing and assessing human exposure at the CRMS, areas of deposition and accumulation were broken out and assessed separately. These areas and how they were defined for the remedial investigation are as follows:

Millsites/Tailing Piles: refers to the locations of the historic millsites and all associated features (i.e., tailing piles, tailing ponds, flumes, etc.) which are recognized as the original point sources of mercury in the drainage;

Tributaries: refers to the tributaries which drain the Virginia Mountain Range into the Carson basin and Washoe Valley (i.e., Six Mile Canyon, Gold Canyon, etc.,);

Alluvial Fan: refers to the alluvial fan below the mouth of Sixmile Canyon;

Flood Plain: refers to the Carson River floodplain beginning above New Empire and extending to the terminal wetlands;

Carson River: refers to the main channel of the Carson River beginning above New Empire and extending to the terminal wetlands;

Lahontan Reservoir: refers to Lahontan Reservoir which has a surface area of approximately 4,856 acres (EPA, 1977);

Carson Lake: refers to Carson Lake which occupies approximately 5,600 acres (Hoffman et.al., 1990);

Stillwater Wildlife Management Area: refers to the Stillwater Wildlife management area which occupies approximately 9,600 acres during an average water year (Hoffman et.al., 1990);

Indian Lakes: refers to the Indian Lakes recreation area which have a total surface area of approximately 549 acres during an average water year (Tuttle, 1992); and

Washoe Lake: refers to the combined area of Little and Big Washoe Lake which have a combined area of approximately 5,100 acres during a normal water year (Washoe County, 1992).

7.0 SUMMARY OF REMEDIAL INVESTIGATION

The objectives of this phase of the remedial investigation are as follows:

- identify the contaminants of potential concern (COPC),
- develop data for the human health risk assessment (i.e., estimate exposure point concentrations for potentially complete exposure pathways), and
- characterize mercury levels at and around historic millsites.

The remedial investigation activities associated with each of these objectives are described herein.

7.1 IDENTIFY CONTAMINANTS OF POTENTIAL CONCERN

In order to determine if other trace metals occur at levels of concern, approximately 10% of the soil samples (119 samples) were analyzed for all of the trace metals included in EPA's "Target Analyte List (TAL)." Contaminants of potential concern were identified by a two step process. The first step compared the maximum detected concentration in surface soils with EPA's preliminary remediation goal (PRG). Those trace metals exceeding their respective PRG were retained for the second step which compared the arithmetic mean of the concentrations detected at historic millsites and extant tailing piles with the estimated background level for the trace metal. If this mean concentration exceeded the background level, then the trace metal was identified as a COPC. In addition to mercury, arsenic and lead were identified as COPCs by this process.

In assessing the hazards from mercury in a particular environment, it is not enough to know the form in which mercury entered that environment because various transformations can take place. The major forms of mercury which have been identified to date are methyl-mercury, elemental mercury, and mercuric mercury. As part of the effort to identify contaminants of potential concern, soil samples were analyzed to determine the species of mercury generally occurring in soil. These results determined that less than 10% of the total mercury in soils is mercuric chloride or soluble mercury and approximately 90% of the mercury is either mercuric sulfide or elemental mercury. Mercury occurring in fish and waterfowl was assumed to be 100% methyl mercury.

7.2 DEVELOP DATA FOR THE HUMAN HEALTH RISK ASSESSMENT

In order to assess human health risks, exposure point concentrations are determined for the potentially complete exposure pathways. The exposure point concentration is an estimate of the concentration of the COPC that is contacted via an exposure pathway (i.e., ingestion of soil) over a given period of time. In order to estimate exposure point concentrations, samples were collected from media potentially affected by mercury (i.e., soil, air and water) in areas where mercury contamination was suspected to occur. The majority of this environmental sampling was conducted in Dayton where it was assumed that there are the highest levels of mercury occurring in a populated area. This assumption was primarily based on the fact that there were several historic millsites located in and around Dayton. Also, because Dayton is located at the mouth of Gold Canyon and on the flood plain of the Carson River, tailings could be deposited in and around Dayton from other upgradient source areas. Samples were collected from soil, ground water, air, and domestic produce; and exposure point concentrations were derived from the arithmetic mean and the associated 95 percent upper confidence limit (95 UCL). If the data set was insufficient to calculate the 95 UCL, the maximum detected value was used as the exposure point concentration. In addition to the Dayton area, soil samples were also collected from Sixmile Canyon, Gold Canyon, the alluvial fan below Sixmile Canyon, the Carson River flood plain, the beach areas of Lahontan Reservoir, Washoe Lake, and Indian Lakes; and exposure point concentrations were derived to represent the level of contamination in these areas. Exposure point concentrations were also derived for muscle tissue from fish and waterfowl using data from Nevada Department of Wildlife, Nevada Division of Environmental Protection, and United States Fish and Wildlife Service.

The results of this sampling were used to assess the human health risks for the entire study area and establish a mercury action level for surface soil. The human health risk assessment is discussed in Section 8, Summary of Site Risks. The site specific action level born out of this risk assessment is 80 mg/kg. This action level identifies a soil level that would create a dose for a child (age 1-6) equivalent to the oral reference dose (RfD) for inorganic mercury. This action level takes into account the species of mercury generally found in the soil matrix (see Section 7.1) and the bioavailability of those species. The bioavailability factor which was used to derive the site specific action level for mercury is presented in Section 8.1, Exposure Assessment.

7.3 CHARACTERIZE AND ASSESS HISTORIC MILLSITES

Among the areas where mercury was thought to occur, it was assumed that the highest levels of mercury would occur at and around historic millsites and extant tailing piles. The basis for this assumption is that there would be minimal dilution caused by transport. Thus, the remedial investigation included an exhaustive research effort to identify the Comstock mills and map the millsites. Out of this research, the location of 131 mills were identified and the area of these millsites were mapped (Figure 3). At each of the millsites, 5 to 25 surface soil samples were collected to evaluate if levels of mercury, arsenic, and lead were significant. Although subsurface soil was also sampled at millsites, the main objective was to evaluate whether incidental ingestion of surface soil was an exposure pathway of concern at the millsites. Surface soil samples were collected at locations where mercury was thought likely to occur (i.e., tailing piles, tailing ponds, ruins, etc.,).

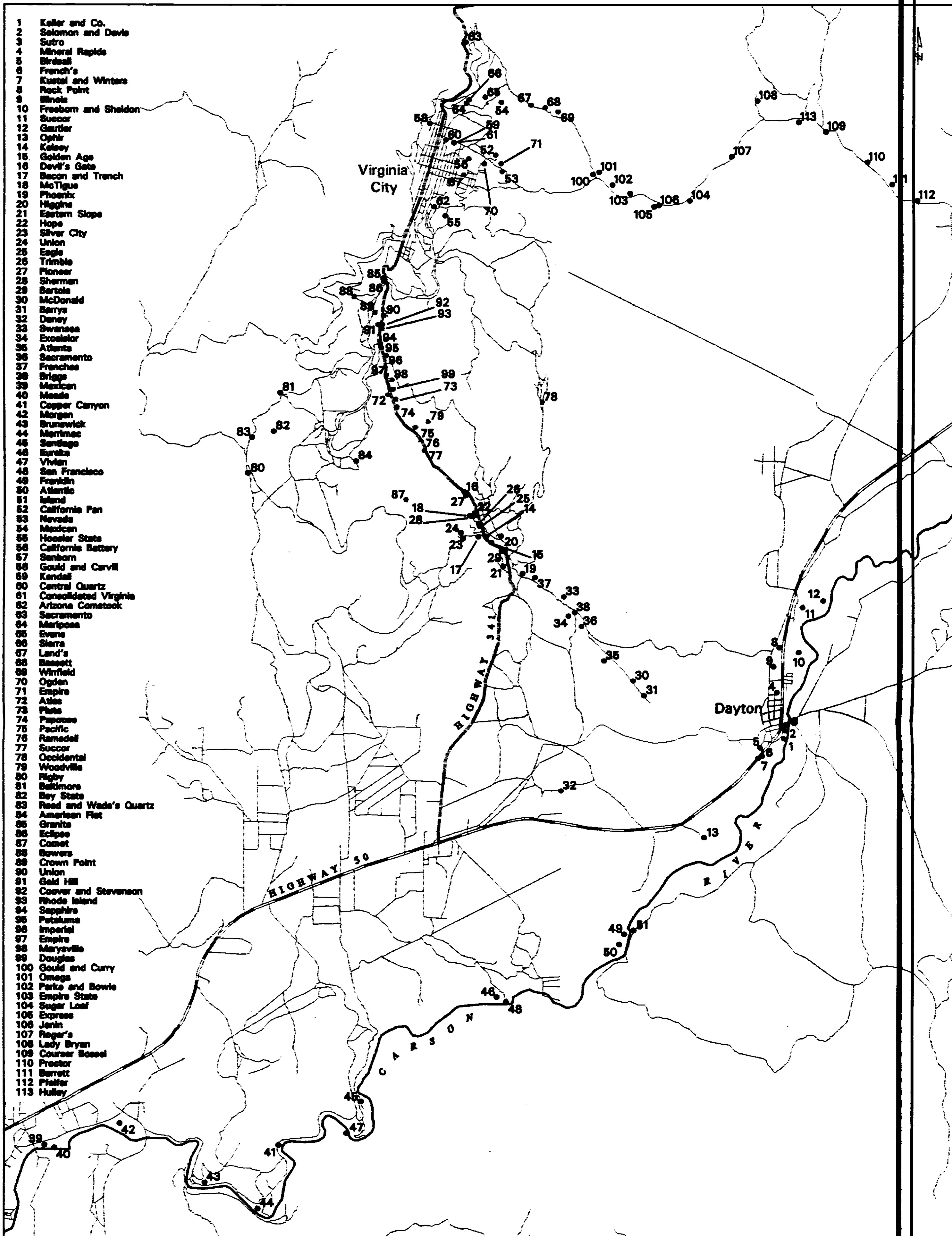
The significance of mercury contamination was evaluated by comparing mercury levels with EPA's site specific Preliminary Remediation Goal (PRG) for soil which is 25 mg/kg. Sampling areas where there were no sample results greater than or equal to 25 ppm were screened out of further evaluation. Sampling areas where there were more than two sampling locations equal to or greater than 25 ppm were evaluated by defining a subarea with the sampling results equal to or greater than 25 ppm and determine the arithmetic mean using the data included in this subarea. Subareas were not defined for sampling areas where there was only one or two samples equal to or greater than 25 ppm, unless the sample(s) could be grouped with an adjacent subarea. Also, if two adjacent samples were equal to or greater than 25 ppm, a line between the two points was buffered to create a subarea. Using the site specific action level of 80 mg/kg, these areas were assessed. Through this process, 6 subareas of potential concern were identified and are described in Figures 5 and 6.

8.0 SUMMARY OF SITE RISKS

The data from the remedial investigation was used to assess human health risk following the procedures described in the Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989 ("RAGS").

8.1 EXPOSURE ASSESSMENT

The purpose for the exposure assessment is to characterize and evaluate the significance of potentially complete exposure pathways. A complete exposure pathway includes the following four elements: 1) a source and mechanism of chemical release, 2) retention or transport medium, 3) a point of human contact or exposure point, and 4) an exposure route (i.e., ingestion, inhalation, or dermal contact) at the contact point. Exposure pathways that were evaluated for the COPCs are described in Table 1.



HISTORIC COMSTOCK MILL LOCATIONS

STOREY - LYON COUNTY, NEVADA

General Area
- Dayton
- Silver City
- Gold Canyon
- Carson River
- Virginia City
- Gold Hill
- American Flat
- Sixmile Canyon

0 2
Miles

Source: Piedmont Engineering, 1993;
1990 US Bureau of Census TIGER Files.
EPA Map by L. Dryden, ATA, 3/15/94.

FIGURE 3

ACTIONABLE AREAS

DAYTON

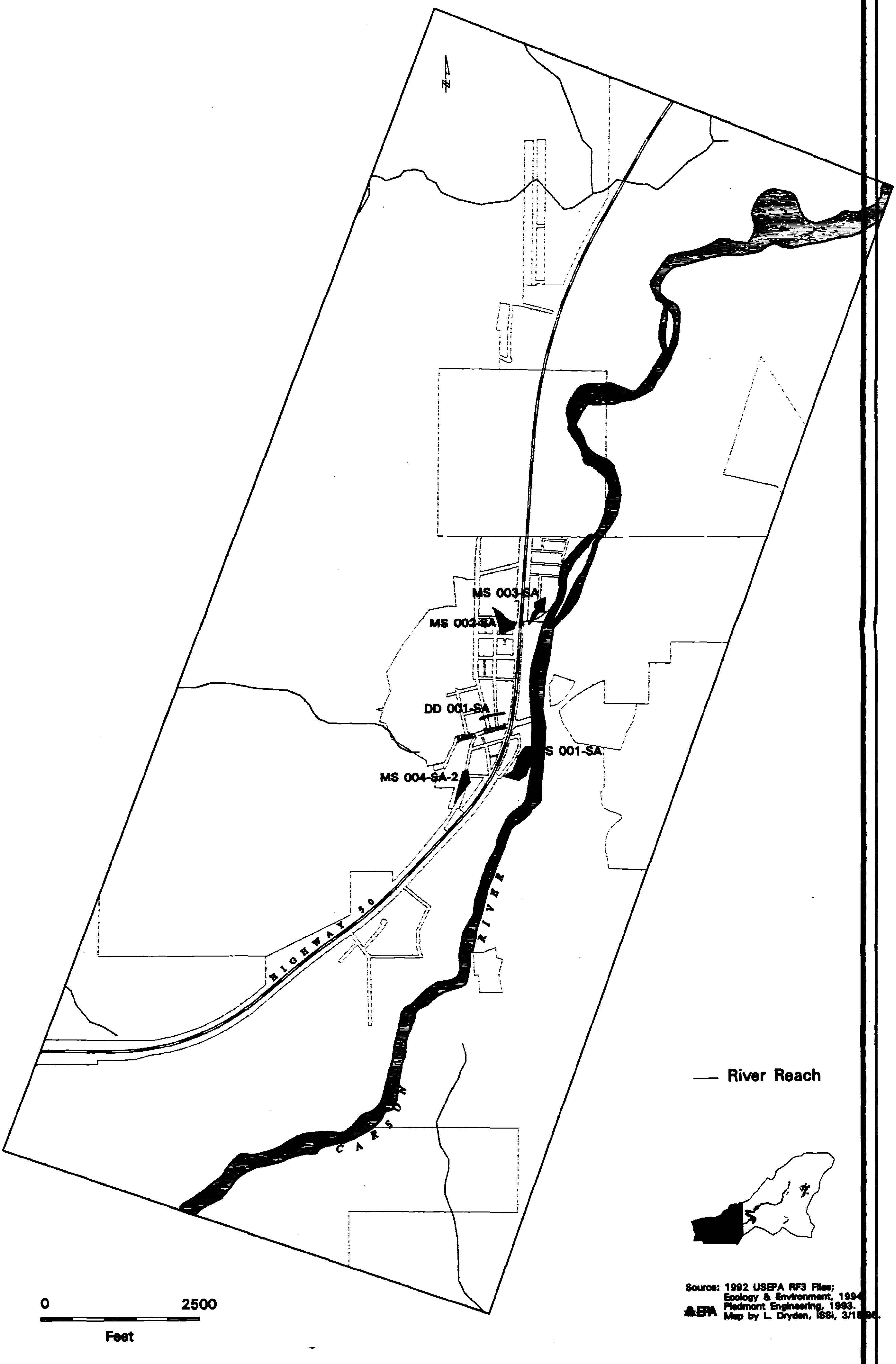
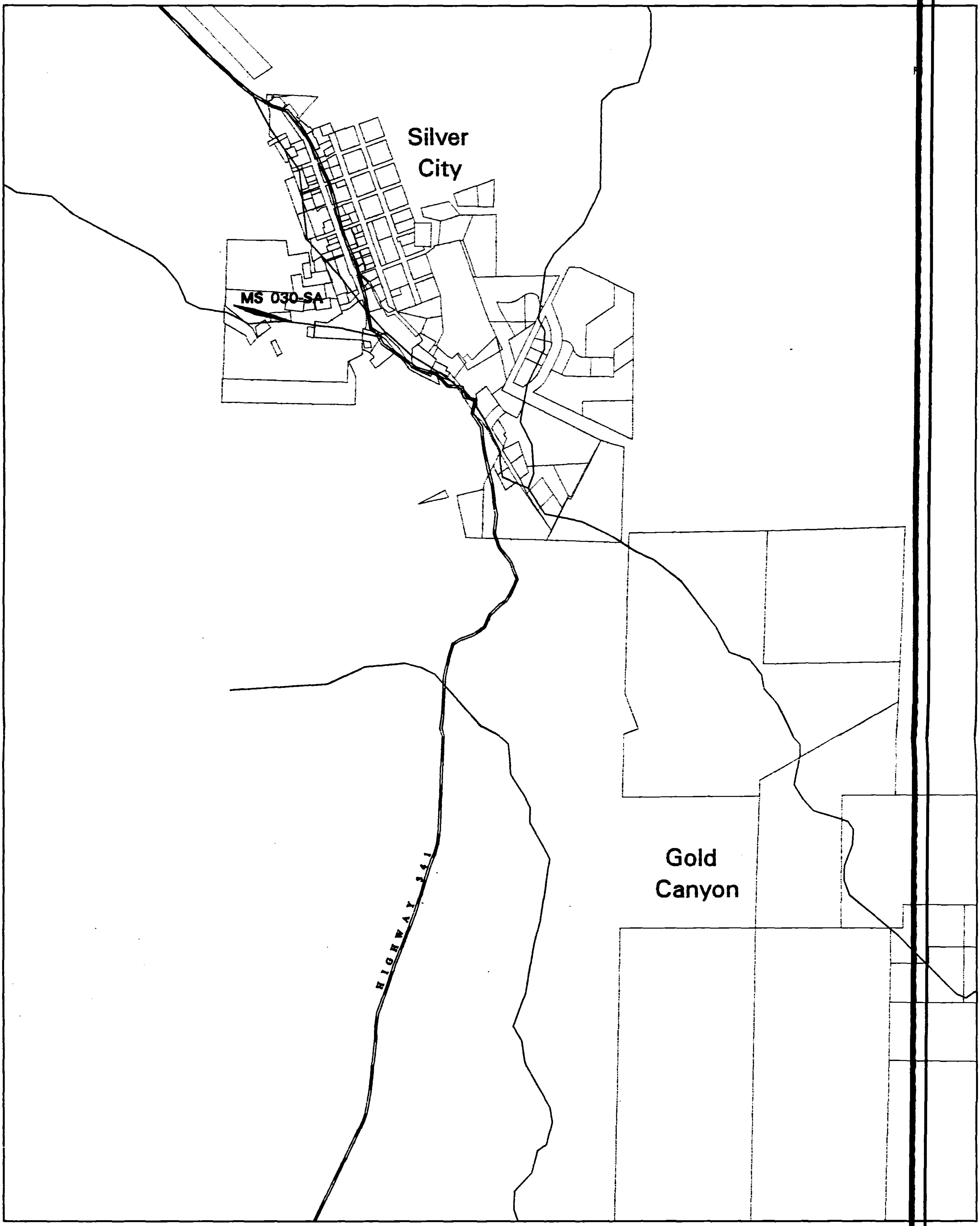


FIGURE 4



ACTIONABLE AREA
SILVER CITY

Source: 1992 USEPA RF3 Files; Ecology & Environment, 1994; Piedmont Engineering, 1993. Map by L. Dryden, ISSI, 3/15/95.

FIGURE 5

TABLE 1: Exposure Pathways Evaluated for the Contaminants of Potential Concern			
Exposure Pathway	**Contaminant of Potential Concern**		
	Mercury	**Arsenic**	**Lead**
Incidental soil ingestion	yes	yes	yes
Incidental sediment ingestion	yes	yes	no
Incidental surface water ingestion	yes	yes	no
Ground water ingestion	yes	yes	yes
Fish consumption	yes	no	no
Waterfowl consumption	yes	no	no
Air inhalation	yes	yes	yes

Ingestion of ground water, surface water and sediment were screened out of the exposure assessment because the COPCs were detected at relatively low levels in these media. The other exposure pathways were evaluated by estimating the chronic daily intake (CDI) of the COPCs for each pathway. The CDI is determined by multiplying the exposure point concentration by the intake factor for that medium.

The estimated CDI of mercury and arsenic via incidental soil ingestion was adjusted to reflect the degree to which metal species are available for absorption following ingestion. The estimated CDI of mercury via incidental soil ingestion was multiplied by 0.28 to reflect the degree to which mercury species are available for absorption following ingestion. Based on mercury species data developed for the CRMS, it was assumed that approximately 90% of the mercury in soil is mercuric sulfide (HgS) and 10% is mercuric chloride (HgCI2). This was considered a conservative assumption given that the mercuric chloride component was generally less than 10%. Using 15% as the oral absorption value for mercuric chloride and 3% for mercuric sulfide, an oral absorption factor of 0.28 was derived ((3/15 x 0.90) + (15/15 x 0.10) = 0.28). The estimated CDI of arsenic via incidental soil ingestion was multiplied by 0.80 to reflect the degree to which arsenic is assumed to be available for absorption.

8.2 TOXICITY ASSESSMENT

The toxicity assessment weighs available evidence regarding the potential for particular chemicals to cause adverse effects in exposed individuals (weight-of-evidence), and quantitatively characterizes the relationship between the extent of exposure to an agent and the increase likelihood and/or severity of adverse effects (dose-response assessment).

The toxicity assessment evaluates noncancer effects using reference doses (RfD) as numeric indicators of toxicity. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive sub-populations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. The oral RfD which was used to evaluate exposure via ingestion to both inorganic and organic mercury is 0.3 ug/kg-day. Because there is an ongoing debate as to whether the RfD for methyl mercury is sufficiently health protective for unborn or young children in critical stages of development, this RfD was not used to evaluate exposure via fish consumption for children and pregnant or nursing mothers. The reference concentration (RfC) used to evaluate exposure to mercury via inhalation is 0.3 ug/m3. The oral RfD which was used to evaluate exposure to arsenic via ingestion is 0.3 ug/kg-day. The RfDs and RfC were obtained from the Integrated Risk Information System (IRIS) updated through June 1993 and the Health Effects Assessment Summary Tables (HEAST) updated through March 1993.

EPA withdrew the established RfD for lead in 1989. This was done because 1) there is not a discernible threshold for health effects related to lead exposure and 2) there are numerous environmental sources of lead which have to be considered in estimating lead exposure. In lieu of the RfD, it was determined that blood levels, which can be correlated with toxic effects, provide the best index for evaluating lead exposure. The blood lead "level of concern" is 10 ug/dL.

The toxicity assessment evaluates cancer effects based on the assumption that cancer can occur at any exposure level ("no-threshold"). EPA use the linear multistage model for extrapolating cancer risks from high dose levels, where cancer responses can be measured, to relatively low dose levels, which are of concern in the environment. This dose-response extrapolation is known as a cancer slope factor (CSF) which is used to estimate lifetime cancer risks associated with chronic low-level exposures to contaminants. The CSFs were also obtained from the Integrated Risk Information System (IRIS) updated through June 1993 and the Health Effects Assessment Summary Tables (HEAST) updated through March 1993.

8.3 RISK CHARACTERIZATION

Risk characterization combines the exposure and toxicity assessments to produce quantitative estimates of risk from the chemicals of potential concern. EPA evaluated the noncancer and cancer health risks associated with each of the complete exposure pathways.

Estimates of noncancer health risks are calculated by dividing the estimated chemical-specific CDI (ug/kg-day) by the respective RfD (ug/kg-day). This ratio is referred to as a "Hazard Quotient (HQ = CDI/RfD)." The sum of HQs for multiple chemicals and pathways is the "Hazard Index (HI)." EPA suggests that a HI greater than one indicates that the associated exposure scenario has a potential to result in adverse noncancer health effects and additional evaluation may be necessary. Although the potential for adverse health effects increases as the HI value increases, the level of concern does not increase linearly. This is because RfDs do not have equal accuracy or precision and are not based on the same severity of toxic effects.

Noncancer health risks associated with lead are quantitatively characterized with the EPA Lead Uptake/Biokinetic Model, Version 0.5 ("UBK Model"). The UBK model was designed to estimate the blood lead levels in children 0 to 6 years of age, based on multi-media lead exposures. The model accounts for the potential environmental and maternal sources of lead (air, diet, drinking water, dust, soil, and the lead concentration in the mother's blood during gestation) for which numerous fundamental assumptions are used.

Cancer risks which are described as the incremental probability that an individual will develop cancer in their lifetime are estimated by multiplying the estimated chemical-specific CDI by the respective cancer slope factor (CSF). The cancer risk range of 10-4 to 10-6 is established as generally acceptable by EPA. In other words, the probability that one additional person out of 10,000 to 1,000,000 could develop cancer as a result of their exposure is considered an acceptable risk.

The estimated HIs and probability of cancer risks are summarized in Tables 2 through 6.

8.4 UNCERTAINTY ASSESSMENT

It must be recognized that the assessment of cancer risks and noncancer hazards by available (generally indirect) methods can provide only crude estimates of risk and this should be borne in mind in making regulatory decisions about permissible exposure concentrations in environmental media.

EPA evaluated the uncertainty of the risk assessment and identified elements of the risk assessment that would tend to overestimate or underestimate potential exposure and risk to individuals within the study area. Risk uncertainties specific to this HHRA are summarized in Table 7.

TABLE 2: Estimated Hazard Indices for Individuals Living On or Adjacent to Impacted Areas			
Exposure Pathway	**Contaminant**	**Typical Estimate[1]**	**High-end Estimate[2]**
Soil Ingestion[3]	Mercury	0.09	2.80
	Arsenic	0.05	1.23
Dust and/or Vapor Inhalation	Mercury	0.10	0.38
	Arsenic	0.002	0.007
Consumption of Domestic Produce	Mercury	0.40	0.80
Hazard Index		0.64	5.22

1. Typical estimate is for an adult.
2. High-end estimate is for a young child (<6 years).
3. Chronic daily intake (CDI) was estimated based on mercury levels measured in surface soil at the MS004 sample area in Dayton.

TABLE 3: Estimated Hazard Indices for Recreational Land Use In and Around Impacted Areas			
Exposure Pathway	**Contaminant**	**Typical Estimate[1]**	**High-end Estimate**
Soil Ingestion[2]	Mercury	0.01	0.24
	Arsenic	0.002	0.10
Dust and/or Vapor Inhalation	Mercury	0.002	0.016
	Arsenic	0.00003	0.0003
Hazard Index		0.01	0.36

1. Both the typical and high-end estimates are for a school age child (7 - 18 years of age).
2. Chronic daily intake (CDI) was estimated based on mercury levels measured in surface soil at the TP007 sample area in Sixmile Canyon.

TABLE 4: Estimated Hazard Indices for Consumption of Fish and Waterfowl			
Indicator Species/Location	**Contaminant**	**Typical Estimate[1]**	**High-end Estimate**
White Bass/Carson River Above Lahontan	Mercury	3.5	6.5
Walleye/Lahontan Reservoir	Mercury	2.6	4.9
White Bass/Carson River Below Lahontan	Mercury	1.1	2.1
White Bass/Indian Lakes	Mercury	2.2	4.1
White Bass/Washoe Lake	Mercury	0.6	1.2
Shovelers/Carson Lake	Mercury	1.4	2.0
Shovelers/Stillwater	Mercury	0.5	0.8
Mallards/Carson Lake	Mercury	0.3	0.6
Mallards/Stillwater	Mercury	0.2	0.5

1. Both typical and high-end estimates are for an adult.

TABLE 5: Potential Cancer Risks for Individuals Living On or Adjacent to Impacted Area			
Exposure Pathway	**Contaminant**	**Typical Estimate[1]**	**High-end Estimate**
Soil Ingestion[2]	Arsenic	3 E-6	4 E-5
Dust and/or Vapor Inhalation	Arsenic	1 E-6	4 E-6
Cancer Risk		4 E-6	4 E-5

1. Both the typical and high-end estimates are for an adult (life-time resident).
2. Chronic daily intake (CDI) was estimated based on arsenic levels measured in surface soil in Dayton.

TABLE 6: Potential Cancer Risks for Recreational Landuse in Impacted Areas			
Exposure Pathway	**Contaminant**	**Typical Estimate**	**High-end Estimate**
Soil Ingestion[2]	Arsenic	4 E-8	1 E-5
Dust and/or Vapor Inhalation	Arsenic	2 E-8	2 E-7
Cancer Risk		6 E-8	1 E-5

1. Both the typical and high-end estimates are for a school-age child (7 - 18 years).
2. Chronic daily intake (CDI) was estimated based on arsenic levels measured in surface soil in Sixmile Canyon.

TABLE.7: Summary of Site Specific Uncertainties Associated with Risk Estimates		
Uncertainty Factor	**Effect of Uncertainty**	**Comment**
Exposure point concentrations used for volatile mercury.	May over- or underestimate risk	Exposure point concentrations used for volatile mercury were derived from the method detection limit and were not actually measured. Therefore, levels of volatile mercury in indoor and ambient air may actually be more or less than the exposure point concentration.
Exposure point concentrations for mercury levels in surface soil on the alluvial fan.	May overestimate risk	Exposure point concentrations used to evaluate incidental ingestion of soil on the alluvial fan were derived from a data set which included samples from the area of transport where tailings from Sixmile Canyon are deposited. Current residential areas on the alluvial fan are north of the area of transport. Mercury levels measured in samples collected from current residential areas did not exceed 25 mg/kg.
Exposure point concentrations for mercury levels in surface soil on the flood plain.	May overestimate risk	Exposure point concentrations used to evaluate incidental ingestion of soil on the flood plain were derived from the highest concentrations detected on the flood plain. The 95 UCL for all of the samples collected from the flood plain (18.20 mg/kg) is a factor of 20 less than the value used to estimate the high-end risks for this scenario.
Use of an indicator species to estimate mercury exposure associated with consumption of fish and waterfowl.	May overestimate risk	To the extent that the actual diets include lesser contaminated fish and waterfowl, the indicator species approach used in this HHRA is likely to overestimate exposures.
Arsenic which was identified in tailings and at historic millsites was not measured in fruit and vegetables.	May underestimate risk	Arsenic can also be taken up by plants.
Cancer slope factors for arsenic	May overestimate risks	Slope factors are based on a 95th percent UCL derived from a linearized model. Considered unlikely to underestimate risks.
Cancer risk estimates assume there is no threshold.	May overestimate risks	Possibility that some threshold exists.
Reference doses (RfDs) for mercuric mercury are derived from animal studies.	May over- or underestimate risks	Extrapolation from an animal to human may induce error because of differences in absorption, pharmacokinetics, target organs, enzymes, and population variability.

8.5 ECOLOGICAL RISK ASSESSMENT

The ecological assessment for the CRMS is presently ongoing and the results of this study will be presented in the remedial investigation report for OU-2. The focus of this study is to assess the severity of ecological risks and impacts associated with mercury in the Carson River system. Mercury is unique among metals in its tendency to bioaccumulate and biomagnify in higher trophic levels. Bioaccumulation most readily occurs in aquatic environments where mercury is methylated and then either ingested or absorbed by aquatic organisms. This ecological assessment is most concerned with the diversity of wildlife which are supported by the Carson River watershed and are part of the aquatic food chain. In particular, the Lahontan Reservoir and wetland areas below Lahontan Dam provide significant habitat for large populations of migrating and resident water birds.

The outcome of this ecological assessment will be an understanding of how severely wildlife are impacted or threatened by the present levels of mercury in the Carson River system as well as an understanding of what factors regulate mercury cycling in the Carson River system. This information will provide the basis for evaluating methods to reduce mercury concentrations in fish, waterfowl, and other biota. If there is any evidence that current loading from point and diffuse sources will achieve this end, then further soil remediation may occur to reduce loading. At this time, the only remedial action objective is to reduce direct human exposure to mercury contaminated surface soil.

8.6 RISK ASSESSMENT CONCLUSIONS

The conclusions of the HHRA for the CRMS are as follows:

- The contaminants of potential concern (COPCs) for the CRMS are *mercury, arsenic* and *lead*. Mercury was imported to the region during the Comstock era (1859-1900) to process ore. Although mercury is also naturally occurring in the region, such sources are not considered important relative to the large amount of mercury imported to the region during the Comstock era. Arsenic and lead are naturally occurring trace metals in the region which were concentrated in the environment by natural and anthropogenic processes.

- The highest concentrations of the COPCs are found at and around historic millsites and extant tailing piles. The COPCs also occur in areas where discharged tailings and other eroded material from historic millsites have come to be deposited. These areas include: the alluvial fan below Sixmile Canyon, the flood plain of the Carson River below New Empire, the active channel of the Carson River below New Empire, Lahontan Reservoir, Carson Lake, Stillwater, Indian Lakes and Washoe Lake.

- Although the soil ingestion pathway is important for all of the COPCs, the significance of this pathway varies according to the land use (i.e., residential, occupational and recreational) and according to the concentration of the COPC in surface soil. For residential land use, mercury was detected in surface soil at levels which translate into a HI>1 for a young child (<6 years of age). For recreational or open land use areas (i.e., Brunswick, Sixmile Canyon, Gold Canyon, Lahontan Reservoir, Indian Lakes, and Washoe Lake beach areas), none of the COPCs were found to occur in surface soil at levels which are considered significant for this exposure pathway.

- Inhalation of airborne contaminants does not appear to be an exposure pathway of concern for any of the COPCs irrespective of the land use scenario (HI<1).

- Ingestion of ground water does not appear to be an exposure pathway of concern for any of the COPCs.

- Incidental ingestion of surface water and sediment while swimming does not appear to be an exposure pathway of concern for any of the COPCs.

- Consumption of produce grown in contaminated soil was found to be a complete exposure pathway for mercury. However, this pathway does not appear to be of concern (HI<1).

- Individuals who consume fish or waterfowl from the Carson River system should be cautioned that the risks are proportional to the amount and type of fish and waterfowl consumed. Using an indicator species approach, typical HI estimates for selected indicator species were found to exceed 1 for the consumption of white bass from the Carson River above and below Lahontan Reservoir and Indian Lakes; and for consumption of walleye from Lahontan Reservoir. Also using an indicator species approach, typical HI estimates were found to exceed 1 for the consumption of shovelers from the Carson Lake area. Because fish and waterfowl from the Carson River system are contaminated with mercury, it is recommended that pregnant or nursing mothers and young children (<6 years) not consume fish or waterfowl from this drainage.

9.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents the comparative analysis of the remediation alternatives considered to prevent incidental ingestion of surface soils where mercury levels in surface soil exceed 80 mg/kg in existing residential areas. This comparative analysis is a summary of the Feasibility Study Report for the Carson River Mercury Site prepared by Ecology and Environment, Inc., and dated December 20, 1994 ("FS"). The purpose for the FS was to identify, screen and evaluate remedial alternatives to achieve the remedial action objective for

9.1 DESCRIPTION OF REMEDIATION ALTERNATIVES

The basic remediation alternatives which were considered in the FS are as follows:

- No Action
- Institutional Controls
- Capping
- Ex-situ stabilization
- In-situ stabilization
- Ex-situ treatment/Land Disposal

With exception for Alternative 1, the FS identified numerous methods and technologies for each of these alternatives. For example, as part of Alternative 5, eight different remediation technologies were identified for treating mercury contaminated soil. Different methods and technologies were also identified for institutional controls, capping, excavation, disposal, restoration, and containment. All of these technologies and methods were screened according to effectiveness, implementability, and cost in order to limit the number of alternatives which were further evaluated in the detailed analysis.

The alternatives that were retained through this screening process and were evaluated in the detailed analysis are as follows:

<u>Alternative 1- No Action</u>

The "No Action" alternative serves as a baseline for comparing other remedial alternatives. Under the this alternative, the areas of concern are neither addressed by engineering measures nor institutional controls. Thus, there are no costs associated with this alternative.

<u>Alternative 2 - Institutional Controls</u>

Institutional controls are measures to protect public health by controlling access to the areas of concern but not by physically addressing the impacted surface soils. The types of institutional controls that were considered for the current areas of concern include deed restrictions, posting signs, and erecting fences.

Alternative 3 - Capping

This alternative consists of paving over the surface soil to prevent exposure to the soil. As necessary, soil would be excavated to make space for paving, but as much soil as possible would be left in place. The excavated soil would be transported to an off-site landfill for disposal. Equipment required for excavation would include backhoes, loaders and hand tools.

Paving would consist of covering exposed soil with asphalt or concrete. In order to ensure the integrity of the cap, annual inspection of the paved areas would be required so that cracks and other breaks could be repaved. Site restoration would consist of replacing fences and other structures to the extent possible. However, trees and vegetation would not be replaced in the capped areas.

As part of this alternative, deed or construction restrictions might also be required to prevent disturbance of subsurface mercury remaining onsite, and/ or to require health and safety measures for the protection of onsite workers and residents during any future subsurface construction. If such restrictions are necessary, then the specifics of the restrictions would be determined as part of the remedial design.

Alternative 4 - Excavation and Off-Site Land Disposal with or without Treatment

This alternative, which is the remedial alternative that EPA is selecting in the ROD, includes options for disposing of some or all of the contaminated soil at a municipal landfill, and ex-situ treatment if warranted by the total mercury levels at specific locations. Whether excavated soil will require treatment before disposal depends on whether these soils exceed the mercury standards for the toxicity characteristic leachate procedure (TCLP) set forth in 40 C.F.R. §261.24 **1**. If TCLP tests determine that certain portions of the excavated soils exceed the TCLP standards (0.2 mg/l), then those excavated soils which exceed the TCLP standard will receive ex-situ treatment before disposal at a RCRA municipal landfill or, alternatively, will be taken to a RCRA hazardous waste landfill. However, if the excavated soils do not exceed the TCLP standard, then excavated soils will be disposed of at a RCRA municipal landfill without treatment. Based on data developed as part of the remedial investigation, excavated soils are not expected to exceed the TCLP standard.

In the event that treatment is required before disposal at a municipal landfill, then this alternative sets forth performance standards for treatment in lieu of a specific treatment alternative. Thus, if treatment is found to be necessary, then any technology that meets the prescribed performance standards can be employed. The performance standards that would be applied to a treatment technology are set forth in the Nevada Bureau of Mining Regulation and Reclamation Guidance Document for Alternate Use of Mine Waste Solids-Disposal Outside of Containment, dated May 3, 1994. This document prescribes criteria for evaluating if material is acceptable for alternate uses. Based on the FS, the technologies that would most likely be used for treating contaminated soil are either gravity separation or a conventional mining technology (i.e., cyanidation).

1 As discussed further in Section 8.2.2 below, EPA has determined that the wastes being remediated at the CRMS are exempt from the definition of hazardous waste under Section 3001(b)(3)(A)(ii), and 40 C.F.R. §261,4(b)(7), (the "Bevill amendment" provision). Nevertheless, EPA has determined that, based on certain guidance from the Nevada Bureau of Mining and on public health considerations, contaminated soils that exceed TCLP standards should not be disposed of in a municipal landfill without treatment.

In the event that the excavated soil does not exceed the TCLP standard, then this alternative involves excavation of surface soil, disposal at a municipal landfill, and restoration of excavated areas. Both alternatives involve excavation of contaminated surface soil (estimated to go to depth of approximately 2 feet below ground surface), and site restoration. Site restoration would involve returning the affected area to pre-excavation conditions which may include replacing fences, structures, and vegetation. Potential institutional controls would be the same as described for Alternative 3.

Long-term Sampling and Response Plan

With exception for Alternative 1, certain institutional controls were considered to be an additional part of each of the described alternatives. These institution controls, which will be known as the "Long-term Sampling and Response Plan," are to manage impacted areas that will not be remediated as part of this operable unit. The FS did not evaluate remediation alternatives for impacted areas in Sixmile Canyon and adjacent to the Carson River between New Empire and Dayton because these areas do not pose health risks with the current land use (non-residential). In the event that residential development is proposed in these areas or other areas where mercury levels may exceed 80 mg/kg, then certain procedures described in the Long- term Sampling and Response Plan will be followed.

The Long-term Sampling and Response Plan will set forth specific sampling guidelines for characterizing mercury levels in surface soils and for addressing impacted areas. The areas where any residential development will be subject to the guidelines prescribed in this plan are generally described as follows:

Sixmile Canyon - Refers to the tributary of the Carson River that begins near Virginia City in the Virginia mountain range and meets the Carson River approximately five miles east of Dayton. The segment of concern is the canyon which begins just below Virginia City and extends to the mouth of the canyon just above the alluvial fan.

Alluvial Fan - Refers to the alluvial fan below the mouth of Sixmile Canyon. The fluvial channels extending across the fan from the mouth of Sixmile Canyon to the Carson River confluence are the areas of concern.

Brunswick Canyon - Refers to the Carson River flood plain between New Empire (the Mexican Mill) and Dayton.

Carson River Flood Plain Above Lahontan Dam - Refers to the Carson River flood plain extending between Dayton and Lahontan Reservoir.

Carson River Flood Plain Below Lahontan Dam - Refers to the flood plain of the South Branch of the Carson River beginning below Lahontan Dam and extending to Carson Lake.

In instances where residential development is proposed within these defined areas, Nevada Division of Environmental Protection (NDEP) will provide the interested parties with the Long-term Sampling and Response Plan Guidelines. The guidelines will provide specific instructions for sampling an area to assess mercury levels in surface soils, instructions for interpreting and reporting results, instructions for follow-up sampling, and instructions for addressing impacted areas.

The Long-term Sampling and Response Plan Guidelines will be developed by EPA as part of the remedial design for this operable unit. The guidelines will be administered through NDEP's Bureau of Corrective Actions. However, development within the boundaries of the specified areas will be monitored through NDEP's Bureau of Water Pollution Control which reviews sewerage facility plans for new developments made up of five or more subdivisions. For smaller developments, the county planning offices will notify NDEP of proposed developments, and NDEP will contact the developer. The Long-term Sampling and Response Plan does not provide for NDEP to enforce the implementation of the guidelines. Rather, NDEP will notify EPA of any recalcitrant parties and EPA will have the discretion of using the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Sections 104 and 106 authorities to enforce compliance with the guidelines..

9.2 DETAILED ANALYSIS OF ALTERNATIVES

This section provides an explanation of the criteria used to select the remedy, and the analyses of the remedial action alternatives in light of those criteria, highlighting the advantages and disadvantages of each of the alternatives.

9.2.1 CRITERIA

The alternatives were evaluated using nine criteria. These criteria, which are listed below, are derived from requirements contained in the National Contingency Plan (NCP), 40 C.F.R. §300 et seq. and CERCLA Section 121(b) and 121(c).

Overall Protection of Human Health and the Environment - The assessment against this criterion describes how the alternative, as a whole, achieves and maintains protection of human health and the environment.

Compliance with ARARs - The assessment against this criterion describes how the alternative complies with ARARs as well as any advisories, criteria, and guidance that the lead and support agencies have agreed are " to be considered."

Long-term Effectiveness and Permanence - The assessment of alternatives against this criterion evaluates the long- term effectiveness of alternatives in maintaining protection of human health and the environment after response objectives have been met.

Reduction of Toxicity, Mobility, and Volume Through Treatment - The assessment against this criterion evaluates the anticipated performance of the specific treatment technologies an alternative may employ.

Short-term Effectiveness - The assessment against this criterion examines the effectiveness of alternatives in protecting human health and the environment during the construction and implementation of a remedy until response objectives are attained.

Implementability - This assessment evaluates the technical and administrative feasibility of alternatives and the availability of required goods and services.

Cost - This assessment evaluates the capital and operation and maintenance (O&M) costs of each alternative.

State Acceptance - This assessment reflects the State's (or support agency's) apparent preferences among or concerns about alternatives.

Community Acceptance - This assessment reflects the community's apparent preferences among or concerns about alternatives.

9.2.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

Section 121(d) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U. S. C. Section 121(d) requires that remedial actions at Superfund sites comply with all the requirements of Federal or State environmental or facility siting laws, which are known in the Superfund program as Applicable or Relevant and Appropriate Requirements (ARARs).

This section summarizes the Federal and State statutes and regulations which EPA has determined are the ARARs for the selected remedial alternative for OU 1 of the CRMS.

Definition of ARARs

ARARs are defined as standards or requirements that are found to be either "applicable" or "relevant and appropriate" to the conditions and circumstances found at the site. Guidance for identifying ARARs may be found in the National Contingency Plan (55 Fed. Reg. 8741 et. seq. March 8 1990) and CERCLA Compliance With Other Laws Manual, Part I, Overview of RCRA Clean Water Act and Safe Drinking Water Act, OSWER Directive 9234.1-01 (August 1988) and CERCLA Compliance with Other Laws Manual Part II Clean Air Act, State Requirements and Other Environmental Statutes, OSWER Directive 9234.1-02 (August 1989).

"Applicable" requirements are defined as those cleanup standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State law that specifically address or regulate a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a Superfund site. "Applicability" implies that the remedial action or the circumstances at the site satisfy all of the jurisdictional prerequisites of a requirement.

"Relevant and Appropriate" requirements are defined as those standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State law, that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site or to the remedial action alternatives. For example, requirements may be relevant and appropriate if they would be "applicable" but for jurisdictional restrictions associated with the requirement.

In addition to legally binding laws and regulations, EPA or the State may identify other non-promulgated advisories, criteria or guidance as "To Be Considered" requirements (TBCs). If no ARARs address a particular situation, or if existing ARARs do not ensure protectiveness, then advisories, criteria or guidelines are to be considered (TBCs) to set cleanup goals. If such an advisory, criterion or guideline is selected in the ROD, then it becomes a requirement that the remedial action must meet.

Section 121(e) implicitly states that no Federal, State, or local permits (administrative requirements) are required for remedial actions conducted entirely on site. However, these on-site remedial actions must meet the substantive requirements of ARARs. Any action which takes place off-site, however, is subject to the full requirements of Federal, State, and local regulations. Requirements which are applicable to offsite actions are not ARARs and are not "frozen" at the time the ROD is signed. Rather, all requirements--whether substantive or administrative-- which exist at the time of the offsite action must be met.

State Requirements as ARARS

Under CERCLA, all Federal requirements may be ARARs for a particular site; State requirements may be considered ARARs provided that they are:

- Promulgated standards, with full weight of law;
- More stringent than Federal requirements;
- Identified to EPA in a timely manner;
- Found not to result in a statewide prohibition on land disposal; and
- Consistently applied statewide.

ARAR Categories

ARARs have been divided into three categories: (1) chemical-specific, (2) location-specific, and (3) action-specific requirements. Not all requirements fall neatly into these categories; some requirements may overlap and encompass more than one category. The three categories are defined as follows:

Chemical-specific requirements are usually health or risk-based numerical values or methodologies that set limits on concentrations of specific hazardous substances, pollutants and contaminants that may be found in, or allowed to discharge into, the environment.

Action-specific ARARs are technology or activity-based requirements which set limitations on actions taken with respect to removal, treatment or disposal of hazardous substances.

Location-specific requirements set restrictions on concentrations of contaminants or conduct of activities solely because they occur in a special location. These ARARs relate to the geographic or physical location of the site, such as in a wetland, floodplain, wildlife reserve or historic site.

The legal requirements determined to be ARARs for the remedial action selected in this ROD are as follows:

<u>Chemical-specific requirements</u>

Nevada Contaminated Soil and Ground Water Remediation Policy, June 25, 1992.

There are no promulgated Federal or Nevada regulations which govern soil cleanup levels for the type of remedial action selected in this ROD. However, the Nevada Contaminated Soil and Ground Water Remediation Policy, although not promulgated, contains soil cleanup standards that have previously been identified as "to be considered." After further review, and in the absence of other promulgated standards, EPA has determined that the cleanup standards in this policy should apply to the remedial action selected in the ROD.

The intent of this policy is to provide a rational and concise process for determining remediation standards for soil and ground water. Section A. 5 of the policy recommends particular cleanup levels in cases where ingestion or dermal exposure is of primary concern and groundwater has not been impacted nor is expected to be. For the COPCs at the CRMS, the cleanup levels are as follows:

mercury	20 mg/kg
arsenic	80 mg/kg
lead	no standard

Section C of the policy states that site specific cleanup levels may be used in place of those set forth in the policy if the site specific levels are developed according to a scientifically valid risk assessment. For the CRMS, EPA performed a human health risk assessment and developed a surface soil standard for mercury of 80 mg/kg based on this risk assessment. Thus, this standard will be used in lieu of the cleanup level recommended in the policy. EPA did not develop a site specific standard for arsenic; therefore, the cleanup level recommended in the policy is pertinent and will be followed.

Nevada Bureau of Mining Regulation and Reclamation Guidance Document for Alternate Use of Mine Waste Solids-Disposal Outside of Containment dated May 3,1994.

This guidance document describes the types of tests (i.e., Toxicity Characteristic Leaching Procedure, EPA Method 1311) and the respective criteria which should be used to determine if mine waste solids are acceptable for alternate uses. Under the selected remedy, if any excavated soils exceed TCLP levels, then the soils will undergo treatment. The purpose for this guidance is to ensure that mine wastes, particularly spent heap leach material, is not placed in unmanaged disposal facility (i.e., without a liner, monitoring system, etc.,) unless certain prescribed tests, including TCLP, demonstrate that metals are not mobile or leachable and that the material will not generate acid drainage. Although not promulgated, EPA has previously identified this guidance document as "to be considered." After further review, and in the absence of other promulgated standards, EPA has determined that, in the event any of the wastes are treated, the test procedures and criteria set forth in this policy should apply. Also according to this guidance, EPA has determined that if any portion of the excavated material does not meet TCLP standards, then the material must be treated before disposal at a RCRA municipal landfill or the material must be disposed of at a RCRA hazardous waste landfill.

Action-specific Requirements

Discussion of the Resource Conservation and Recovery Act.

EPA has determined that requirements relating to hazardous waste under the Resource Conservation and Recovery Act (RCRA), Subtitle C, 42 U.S.C. §6921 et seq., and the regulations promulgated thereunder, are not ARARs for the selected remedial action. The basis for this determination is that the wastes to be remediated under this ROD are mining wastes that are exempt from the definition of hazardous waste under RCRA Section 3001(b)(3)(A)(ii), 42 U.S.C. §6921(b)(3)(A)(ii), and 40 C.F.R. Section 261.4(b)(7) (also known as the "Bevill amendment").

Pursuant to 40 C.F.R. §261.4(b)(7), the Bevill exclusion provides that "solid waste from the extraction, beneficiation and processing of ores and minerals (including coal), including phosphate rock and overburden from the mining of uranium ore [are not hazardous wastes]. For purposes of § 261.4(b)(7), beneficiation of ores and minerals is restricted to the following activities: crushing, grinding, washing, dissolution, crystallization, filtration, sorting, sizing, drying, sintering, pelletizing, briquetting, calcining to remove water and/or carbon dioxide, roasting in preparation for leaching... gravity concentration, magnetic separation, electrostatic separation, floatation, ion exchange, solvent extraction electrotwinning, precipitation, amalgamation, and heap, dump, vat, tank, and in-situ leaching."

40 C.F.R. §261.4(b)(7) also provides that solid waste from the processing of ores and minerals includes only twenty specific wastes that are set forth in that subsection.

Since the wastes at the CRMS stem from gold and silver ore mining and milling activity that occurred in the middle of the nineteenth century, it is difficult to say with certainty whether or not the waste involved at the CRMS fall within the Bevill exclusion. However, based upon available information, the wastes stem from beneficiation and extraction of minerals; such wastes are exempt from the definition of hazardous waste under RCRA. Accordingly, EPA has concluded that RCRA regulations are not ARARs for 1the CRMS.

The selected remedial action will involve disposal of the wastes offsite. Laws and regulations that are pertinent to off-site activity are not ARARs per se, and thus are not frozen at the time the ROD is signed. Rather, the pertinent requirements which exist at the time of the offsite action must be met. In light of the Bevill exemption, the wastes disposed of off-site would not be subject to RCRA regulation. However, in order to ensure that public health is protected and given the recommended procedures in the Nevada Bureau of Mining Regulation and Reclamation Guidance of May 3, 1994, EPA has determined that excavated wastes that exceed the mercury standards for the TCLP test (i.e., TCLP exceeds 0.2 mg/l) will either be treated and disposed of at a municipal landfill or, alternatively, will be disposed of at a hazardous waste landfill. As noted previously, Based on the data EPA has reviewed to date, EPA believes that little if any of the contaminated soils will exceed the TCLP standard for mercury.

Nevada Bureau of Mining Regulation and Reclamation Guidance Document for Alternate Use of Mine Waste Solids-Disposal Outside of Containment dated May 3,1994.

As discussed above in reference to chemical- specific requirements, EPA has determined that the test procedures and criteria set forth in this criteria should be followed in the event any of the wastes are subject to treatment.

Nevada Administrative Code §445.734 (Fugitive Dust Emissions).

Nevada Administrative Code §445.734 requires that the handling, transporting or storing of any material be performed in a manner which does not allow controllable particulate matter to become airborne. The excavation of contaminated soils will need to comply with this requirement.

<u>Location-Specific ARARs</u>

Executive Order No. 11988; 40 C.F.R. §6.302(b); 40 C.F.R. Part (Appendix A).

These requirements provide that within areas subject to a one percent or greater chance of flooding in any given year, actions shall be taken to reduce the risk of flood loss, minimize the impact of floods on human safety, health and welfare, and restore and preserve the natural and beneficial values of flood plains. Since certain of the areas where remedial action will be taken are within a 100 year flood plain, these requirements are applicable to the extent that the remedial action should be performed in such a manner that it does not increase the risk of flood loss.

Executive Order on Protection of Wetlands Exec. Order No. 11990.

This Executive Order requires Federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands, as defined in Executive Order 11990, §7(c), and 40 C.F.R. Part 6, Appendix A, §4(j). Since certain of the areas where remedial action will occur are adjacent to the Carson River, this requirement is applicable to the extent that the selected remedial action should be performed in such a manner that it avoids any adverse impact on wetlands.

Clean Water Act §404; 40 C.F.R. Part 230; 33 C.F.R. Part 320-330.

These requirements protect wetlands, as defined in 40 C.F.R. §230.3(t) and 33 C.F.R. §328.3(b), by prohibiting the discharge of dredged or fill material without a permit, and taking actions to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands to the extent possible. Since certain areas where remedial action will occur are adjacent to the Carson River, these requirements are applicable.

Archaeological and Historic Preservation Act, 16 U.S.C. §469, 40 C.F.R. §6.301(b) and (c).

This Federal law and the pertinent regulation establishes procedures to preserve historical and archaeological data which might be destroyed through alteration of terrain as a result of Federal activity. Given the limited scope and area of the selected remedial action, EPA believes that it is unlikely that any historical property or archaeological remains will be encountered. However, in the event any such property or data are encountered, EPA will comply the required procedures to ensure that such property or data are preserved.

9.2.3 COMPARATIVE ANALYSIS

This section evaluates the relative performance of the alternatives described in Section 8.1 with respect to the nine criteria so that the advantages and disadvantages associated with each cleanup option are clearly presented. This analysis is described herein according to each of the nine criteria.

<u>Overall Protection of Human Health and the Environment</u>

The scope of this OU-1 is to only address human health risks associated with direct exposure to surface soils bearing mercury in excess of 80 mg/ kg and is not attempting to address environmental risks. Methods to address environmental risks will be evaluated as part of OU-2.

For the residential yards, Alternatives 3 and 4 satisfy this criterion. With Alternative 1, the impacted yards would not be addressed in any manner and the risks described in Section 7.4 would not be reduced. Alternative 2 is also not considered to adequately reduce human health risks because the residential yards remain impacted and it is difficult to control access to residential yards, especially by young children. Both Alternatives 3 and 4 provide protection of human health by eliminating the exposure pathway of concern and thereby reducing the human health risks. Alternative 3 eliminates the exposure pathway by capping the impacted areas and Alternative 4 eliminates the exposure pathway by removing the impacted soil from the residential yards.

For the Dayton Ditch, Alternatives 2, 3, and 4 satisfy this criterion. Again, Alternative 1 would not address the defined risks in any manner. It is noted that the Dayton Ditch may pose less of a health risk than the other areas because (1) mercury levels measured in the Dayton Ditch are relatively low (maximum = 109 mg/kg, minimum = 9 mg/kg, and n = 4); and (2) the action level assumes that a young child is exposed to contaminated soil 350 days per year which is considered a conservative estimate for the ditch. Alternative 2 would satisfy this criteria if access to the ditch is effectively controlled. Unlike the residential yards, the Dayton Ditch is not private property and thus it is feasible to use fencing to control access. With a fence erected along the stretch of the Dayton Ditch that extends through Dayton, access would be minimized and the health risks would thereby be reduced. Alternative 3 would entail lining the ditch channel with either rip-rap, cement, grass, or with a combination of these. This would effectively reduce exposure to mercury contaminated soils presently deposited in this reach of the Dayon Ditch. However, this would not ensure that additional contaminated soils are not deposited in this reach of the ditch in the future. Thus, it is not known whether this alternative would satisfy this criterion in the future. Alternative 4 would entail excavating the contaminated soils from the Dayton Ditch which would effectively reduce exposure to mercury contaminated soils presently deposited in this reach of the Dayon Ditch and would satisfy this criterion. However, as with Alternative 3, it is unknown whether this alternative would satisfy this criterion in the future.

<u>Compliance with ARARs</u>

As discussed in greater detail in Section 8.2.2, EPA has determined that the contaminated soils being addressed in this ROD are probably exempt from regulation under RCRA by virtue of the Bevill Amendment. Thus RCRA requirements are not ARARs for this OU. The only other directly applicable or relevant and appropriate requirements (as distinguished from guidance and advisories "to be considered") are certain action-specific and location specific requirements which would only be pertinent to alternatives 3 or 4 and which alternatives 3 or 4 would meet. Thus it would appear that any of the remedial alternatives would comply with directly applicable or relevant and appropriate requirements.

In addition, however, EPA has identified two Nevada guidance documents that are pertinent to the remedial alternatives for this OU and has determined that the recommended procedures should be followed. The two Nevada guidance documents are: the Nevada Contaminated Soil and Groundwater Remediation Policy, dated June 25, 1992, which provides cleanup standards for soil; and the Nevada Bureau of Mining regulation and Reclamation Guidance Document for Alternate Use of Mine Waste Solids/Disposal Outside of Containment, dated May 3, 1994, which provides that in appropriate circumstances (such as where the use or displacement of the wastes may degrade surface water or ground water) mining wastes should be evaluated under the TCLP procedures.

EPA has determined that the standards and procedures provided in these guidance documents are pertinent to the risk-reduction objectives of this OU and that the selected remedial alternative should comply with them. Both remedial alternatives 3 and 4 would meet the criteria of the two Nevada guidance documents. Alternative 4 would unequivocally meet the criteria and Alternative 3 would meet the criteria assuming that Nevada considered the capping to be sufficiently protective.

Long-term Effectiveness and Permanence

For the residential yards, Alternatives 3 and 4 would satisfy this criterion. Since Alternatives 1 and 2 are not considered protective of human health for the reasons previously described, these alternatives would not provide long- term effectiveness and permanence.

Alternative 3 mitigates human exposure by placing a cap over the impacted areas. Given that this alternative does not attempt to address the full depth of the surface soil horizon and thereby may leave behind soils with concentrations exceeding 80 mg/kg, it is possible that periodic monitoring may be required to ensure the integrity of the cap (i.e., 5 year reviews). However, even if cracks were to form on the cap, any contamination exposed by cracks would not pose significant health risks. This is because the average mercury concentration over the impacted area would still be much less than 80 mg/kg. On the other hand, if portions of the cap were purposely removed for excavation (i.e., utility repairs or installations), then the excavated soil and the exposed area might be of concern. Thus, the long-term effectiveness would depend on the residual levels of mercury contamination and the effectiveness of the institutional controls. Because such long- term institutional controls are difficult to enforce, this is considered a disadvantage for Alternative 3.

Alternative 4 mitigates exposure by removing the contaminated surface soil from the impacted area and replacing it with clean fill. As with Alternative 3, there is a potential for leaving behind mercury concentrations exceeding 80 mg/kg. However, the advantages with this alternative are that: (1) a larger amount of the contaminated soil is removed from the impacted areas than is the case with Alternative 3, by excavating to a maximum depth of 2 feet below ground surface, and thus less impacted soil is left behind, and (2) it is less likely that institutional controls will be required with Alternative 4 because it is less likely that impacted soil will be left behind and the mercury concentrations at 2 feet below ground surface and greater will be better defined as a result of confirmation sampling. In light of this criterion, Alternative 4 is considered the better alternative for addressing impacted yards.

For the Dayton Ditch, Alternative 1 would provide no added risk reduction and thus this criterion is not applicable. Alternative 2 does not attempt to remove mercury contaminated soil from the Dayton Ditch and thus, the long-term effectiveness and permanence depends on the long-term effectiveness of the institutional controls. It is not possible to predict how effectively the fence will reduce access nor is it possible to predict how long the fence will be properly maintained. Therefore, these uncertainties are disadvantages for Alternative 2. Both Alternatives 3 and 4 would effectively address the contaminated soil and sediments presently deposited in the Dayton Ditch but it is unknown whether future runoff will deposit significant levels of contamination in the ditch. Alternatives 2, 3, and 4 compare about the same against this criterion.

Reduction of Toxicity, Mobility, or Volume Through Treatment

For both the residential yards and the Dayton Ditch, only Alternative 4 may include treatment and thereby may be evaluated according to this criterion. Treatment will become part of Alternative 4 if a significant portion of the impacted soil does not attain TCLP standards for mercury and thereby is a characteristic hazardous waste (see Section 8.1). In the event that excavated soils are found to be characteristic hazardous waste, then treatment will be required before disposal at a municipal landfill. In lieu of specifying a treatment technology, this alternative sets forth performance standards for a treatment technology. Thus, if treatment is found to be necessary, then any technology that meets the prescribed performance standards can be employed. The performance standards that would be applied to a treatment technology are set forth in the Nevada Bureau of Mining Regulation and Reclamation Guidance Document for Alternate Use of Mine Waste Solids-Disposal Outside of Containment, dated May 3, 1994. Based on the FS, the technologies that would most likely be used for treating contaminated soil are either gravity separation or a conventional mining technology (i.e., cyanidation).

Any technology for treating mercury contaminated soil is, at best, only capable of separating mercury from the soil matrix. Mercury, which is an element of the Earth, cannot be broken down or reduced in mass. Thus, despite what technology is used to treat soil, the treatment products will always include concentrated mercury and clean soil. Given that there are several technologies that are equally capable of recovering mercury from soil, this alternative could include any one of the technologies which are capable of achieving the specified performance standards. The performance standards which are specified in the referenced guidance document satisfy this criterion by reducing the toxicity of the soil and reducing the mobility of the mercury.

Short-term Effectiveness

In protecting human health and the environment during the construction and implementation phase, Alternatives 1 and 2 pose little to no hazards to human health and environment while Alternatives 3 and 4 do include implementation activities which might create hazards for nearby residents and for workers. Both Alternatives 3 and 4 include excavation. The principal hazards for both residents and workers associated with excavation are: (1) generation of suspended dust; (2) operation of heavy equipment; and (3) the traffic of haul trucks in residential areas. These hazards will be thoughtfully considered in the remedial design and effective measures will be employed to minimize these hazards. These measures may include: performing the work when the winds are least strong, using dust suppressants to control emissions, properly covering staged material and material in the haul trucks to control dust emissions, using traffic controllers to monitor and regulate traffic, and relocating residents. The only environmental hazard is surface erosion of excavation areas and staging piles. This hazard will be minimized by performing the work during the dry season and maintaining covers over staged soil and excavated areas. Both Alternatives 3 and 4 will require approximately four weeks per area to achieve the remedial action objective. In summary, Alternatives 1 and 2 pose little to no hazards to human health and environment while Alternatives 3 and 4 each pose the same hazards and require about the same amount of time to implement.

Implementability

Technical implementability does not apply to Alternative 1.

There are no foreseen technical obstacles for erecting a fence around the boundaries of the Dayton Ditch, Alternative 2. However, accessing the ditch during peak flow events is a special consideration. During peak flow events, the culverts which pass beneath Highway 50 and Pike Street can become obstructed by debris. In such events, access to the culverts is necessary to remove debris and prevent flooding. Thus, if a fence is erected along the ditch, a gate or some other means of access will be required at the culverts. A potential administrative factor for this alternative is ensuring that the fence is properly maintained in perpetuity. If necessary, long-term maintenance of the fence would have to become part of the State Superfund Contract for this operable unit.

The excavation component of Alternatives 3 and 4 is technically straight forward with only minor considerations. Technically, the excavation should be easy to carry out using standard equipment that is readily available. The only foreseen technical issues are: (1) excavating material near the banks of the Carson River (see MS001-SA on Figure 4), and (2) excavating material near unstable slopes and structures (MS004-SA on Figure 4). At MS001-SA, it is possible that excavation and backfilling activities will require reshaping the river bank in order to fill in a ditch and create an evenly graded area. In order to ensure that any buried material and the disturbed top soil resists erosion, erosion control measures will have to implemented. Although there is a large variety of erosion control measures, it will be a challenge to find the best measure for this area. At MS004-SA, the impacted area is near the toe of hillside. Based on a cursory examination of this hillside, it appears that it is not stable. Thus, if any excavation is necessary at the toe of this hillside, it will be a challenge to control sloughing. Finally, there are two small sheds within the impacted area which appear to be unstable structures. If it is necessary to excavate material from around these structures, it may be necessary to destroy these sheds and replace the structures.

The excavation component for Alternatives 3 and 4 may pose some administrative and logistical challenges. At MS003-SA, it appears that the impacted soil extends beneath several mobile homes. Rather than attempting to excavate between the trailers which are very restrictive spaces, it may be more efficient to move the mobile homes before excavating the areas. If relocation is necessary, between 10 and 15 households will have to be relocated during the period of excavation. It is estimated that the period of excavation will be approximately 4 weeks, which includes disconnecting utilities as well as inventorying, moving, and storing all of the property and structures associated with each mobile home. The principal challenges associated with relocation include: coordinating with residents, accommodating all of the needs of the residents during the excavation period, and providing temporary residency in Dayton where there are no motels or hotels. A possible way to manage the relocation with the least disruption to residents is to relocate trailers to a nearby trailer park. It is believe that this would minimize the effort associated with moving personal items and would minimize disruption to daily lives. This and other options will be further evaluated as part of the remedial design.

Finally, Alternative 4 may include soil treatment. Although there are various technologies for recovering mercury from soil, the best technology for treating soil will depend on the species of mercury in the soil matrix. Mercury speciation was performed as part of the remedial investigation but the results were inconclusive. The results clearly demonstrated what fraction of the mercury is mercuric chloride (information required for the risk assessment) but did not conclusively determine the relative fractions of elemental mercury and mercuric sulfide. If treatment is required, further speciation analyses or bench scale testing may be necessary for identifying the best treatment technology.

Cost

The cost estimates for residential yards are described in Table 8. Cost estimates for Alternatives 3 and 4 were not developed for the Dayton Ditch because it was recognized that the costs for these alternatives would be significantly greater than institutional controls and because the risks associated with this area do not warrant these alternatives.

State and Public Acceptance

The Feasibility Study and the Proposed Plan fact sheet were reviewed by Nevada Division of Environmental Protection (NDEP) and they expressed support for Alternative 4 for the residential yards and opposed Alternative 2 for the Dayton Ditch. In a letter dated March 29, 1995, the State of Nevada (NDEP) concurred with EPA's selected remedy for OU-1 of the CRMS.

The Proposed Plan fact sheet was provided to the communities of Dayton and Silver City and public hearings were conducted in Dayton and Silver City on January 18 and 19, 1995, respectively. The Proposed Plan fact sheet solicited written comments from the communities and comments were also recorded at the public hearings. The majority of the comments EPA received from the public expressed skepticism regarding the health risks associated with mercury in surface soil and the value of any type of remediation. However, the owners of impacted parcels did not object to Alternative 4. The communities also expressed some concern with Alternative 2 for the Dayton Ditch. Residents are mainly concerned with the aesthetics of a fence and that a fence would cause problems during peak flow events when access to the culverts can be essential to remove large debris and avoid flooding.

TABLE 8: Cost Estimates for Residential Yards			
Alternative	**Capital Cost**	**Operation & Maintenance Cost**	**30 Year Present Worth**
1	$0	$0	$0
2	NA **a**	NA	NA
3	$543,000 **b**	$0	$543,000
4a	$2,090,000 **c**	$0	$2,090,000
4b	$4,792,095 **d**	$0	$4,792,095
4c	$829,834 **e**	$0	$829,834

a. Not applicable because institutional controls were not considered a viable alternative for residential yards.

b. Assumes excavation and replacement of 1005 cubic yards of soil, disposal without treatment at a municipal landfill, paving over 67,500 square feet, and installation of 400 feet of fence around the Dayton Ditch.

c. Assumes excavation and replacement of 6000 cubic yards of soil, disposal without treatment at a hazardous waste landfill ($150/ton), and installation of 400 feet of fence around the Dayton Ditch.

d. Assumes excavation and replacement of 6000 cubic yards of soil, treatment at $500/ton, and disposal at a municipal landfill ($10/ton), and installation of 400 feet of fence around the Dayton Ditch.

e. Assumes excavation and replacement of 6000 cubic yards of soil, disposal without treatment at a municipal landfill ($10/ton), and installation of 400 feet of fence around the Dayton Ditch..

10.0 SELECTED REMEDY

Based upon consideration of the requirements of CERCLA, the detailed analysis of the alternatives, and comments from the State and the public, EPA has selected Alternative 4 for the residential yards and Alternative 1 for the Dayton Ditch.

The selected remedy for the five residential yards is to excavate contaminated surface soil (estimated to go to a depth of approximately 2 feet below ground surface), dispose of the soil at a RCRA municipal landfill if the soils do not exceed TCLP standards, and restore the excavated areas. Approximately 5000 cubic yards of soil will be excavated and disposed of as part of this response action. If it is determined that all or part of the excavated soil exceed TCLP standards, then the excavated soil will either be treated and disposed of at a RCRA municipal landfill or disposed of at a RCRA hazardous waste landfill. Which of these sub-alternatives that will be used will depend on which sub-alternative is found to be more cost effective and the logistics of implementing each sub-alternative. In the event that subsurface soil is impacted and is not addressed, then this remedy may also include institutional controls which would prescribe handling and disposal requirements for any future excavations within the impacted area.

Both Alternatives 3 and 4 were considered to be viable alternatives for residential yards, however, Alternative 4 was selected over Alternative 3 based on "long-term effectiveness and permanence." Both Alternatives 3 and 4 are considered to be protective of human health and both of the alternatives achieve all of the ARARs for this operable unit. Issues regarding implementability and short-term effectiveness are very similar for Alternatives 3 and 4 because both alternatives include excavation. In the unlikely event that

Alternative 4 includes treatment or disposal at a RCRA Subtitle C disposal facility, then there may be more implementability issues and factors than there are for Alternative 3. The capital cost for Alternative 3 is estimated to be less than for any of the scenarios presented for Alternative 4. Among the three scenarios presented for Alternative 4, it is most likely that this alternative will not require either treatment or disposal at a hazardous waste landfill. Thus, the cost comparison was based primarily on the estimated cost for Alternative 4c in Table 8.1. Although the estimated capital cost for Alternative 3 is less than for Alternative 4c, Alternative 4 was selected based on "long-term effectiveness and permanence." Alternative 4 requires that soil is excavated to a maximum depth of 2 feet below ground surface or to the depth of contamination. Alternative 3 would require minimal excavation to prepare the surface for the cap and it is likely that institutional controls would be required to address future exposure to subsurface contamination or to address the uncertainty. Because a larger amount of contaminated soil is removed with Alternative 4 and because this alternative will require more rigorous confirmation sampling to define the depth of excavation, it is less likely that institutional controls would be required to manage residual contamination or to address any uncertainty regarding subsurface contamination. Although it is not possible to project costs for institutional controls at this time, EPA believes that the cost for Alternative 3 would be augmented by institutional control costs. In light of this criterion, Alternative 4 is considered the better alternative.

The selected remedy for the Dayton Ditch is no action. EPA selected no action for the Dayton Ditch because the health risks for this area are not great enough to warrant response actions such as excavation or lining the ditch and the State of Nevada and the community do not support addressing the area with institutional controls (i.e., restricting access with a fence). Although EPA has selected no action for the Dayton Ditch, additional samples will be collected from the ditch during the remedial design to further evaluate the level of impact. In the event that EPA determines that some form of remediation is warranted, then EPA will document this remedy selection in an "Explanation of Significant Differences (ESD)" or ROD amendment, or the area will be addressed as part of OU-2.

Alternative 2 was originally proposed by EPA for the Dayton Ditch which would have entailed fencing the ditch to restrict access and thereby reducing exposure. EPA selected this alternative over capping and excavation based on human health risks and cost. Although the Dayton Ditch is an actionable area based on the 80 mg/kg action level, the health risks are considered less significant than for the residential yards. The basis for this judgement is (1) the relatively low mercury levels measured in the Dayton Ditch (maximum = 109 mg/kg, minimum = 9 mg/kg, and n = 4); and (2) the action level assumes that a young child is exposed to contaminated soil 350 days per year which is considered a conservative estimate for the ditch. Given the relatively low risks, EPA could not justify the costs associated with either excavating or lining the ditch. Thus, EPA proposed restricting access with a fence. Although this alternative would provide some risk reduction, it is not considered to be significant enough to override the opposition expressed by the State of Nevada and the community of Dayton. Therefore, EPA is selecting Alternative 1 for the Dayton Ditch. EPA will collect additional samples from the ditch during the remedial design to further evaluate the level of impact. In the event that EPA determines that some form of remediation is warranted, then EPA will document this remedy selection in an Explanation of Significant Differences (ESD) or ROD amendment, or the area will be addressed as part of OU-2.

In summary, the selected remedy for OU-1 of the CRMS is as follows:

- Excavation of approximately 5000 cubic yards of contaminated soils, disposal at a RCRA municipal and/or hazardous waste landfill, and restoration of properties. In the event that there is residual contamination in the subsurface soil and it is not addressed, then this alternative may also include institutional controls; and

- Implementation of institutional controls to ensure that any residential development in present open land use areas known or suspected to be impacted by mercury includes characterizing mercury levels in surface soils and, if necessary, addressing impacted soils. These institutional controls will be referred to as the "Long-term Sampling and Response Plan."

11.0 STATUTORY DETERMINATIONS

As required under Section 121 of CERCLA, the selected remedial action is protective of human health, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. The selected remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. However, because treatment of soils may not occur, this remedy may not satisfy the statutory preference for treatment as a principal element of the remedy.

The selected remedy is protective of human health in that it mitigates exposure to mercury which is equal to or exceeds 80 mg/ kg in surface soil. The selected remedy is technically feasible and meets all of the ARARs which are pertinent to this operable unit.

Because this remedy will result in hazardous substances remaining on-site above health-based levels, a five-year review, pursuant to CERCLA Section 121, 42 U.S.C. Section 9621, will be conducted at least once every five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

12.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The remedy selected in this ROD is different from the remedy originally proposed by EPA. In the Proposed Plan fact sheet, EPA proposed fencing the Dayton Ditch in order to restrict access and thereby reduce exposure. Based on opposition expressed by the State of Nevada and the community of Dayton, the selected remedy for the Dayton Ditch is Alternative 1, No Action. The basis for this change is discussed in Section 10.

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PART III. RESPONSIVENESS SUMMARY

This section summarizes and responds to all significant comments received during the public comment period (32 days) on EPA's proposed plan for Operable Unit 1 (OU-1) of the Carson River Mercury Site (CRMS) in Storey, Lyon, and Churchill Counties, Nevada. This summary is divided into three sections. Section 1 provides a summary of the major issues raised as written comments. Sections 2 and 3 summarize the questions and comments made at the public meetings held in Dayton and Silver City on January 18 and 19, 1995, respectively. Copies of all of the written comments received by EPA are included in the CRMS Administrative Record, which are available for review at the information repositories. The transcript of the public meeting, including all of the questions and comments, is also available at the information repositories.

1.0 WRITTEN COMMENTS

1. Nevada Division of Environmental Protection

Comment: As part of the proposed plan for OU-1 of the CRMS, EPA is proposing institutional controls referred to as the "Long-term Sampling and Response Plan (LTSRP)" for non-residential areas that are impacted and, possibly, deed restrictions for any subsurface contamination that is not addressed. How will EPA ensure that these institutional controls are implemented and does EPA have the legal authority to enforce these institutional controls.

Response: The concern expressed by NDEP is also shared by EPA, especially for the LTSRP. First, EPA does have the legal authority to enforce compliance with institutional controls under CERCLA, Section 104 and 106. However, EPA believes that the LTSRP will be effectively implemented through public awareness. By now, it is commonly known that part of the Carson drainage is a Superfund site due to mercury and that there are liability risks related to purchasing property that is impacted by mercury. Given that EPA is unable to clearly delineate the exact boundaries of the Superfund site, prospective buyers, realtors, lending institutions, and environmental consultants should recognize the value of using prescribed guidelines for evaluating properties of interest. With regard to institutional controls at the impacted residential properties, EPA has selected Alternative 4, Excavation, in hope of minimizing the need for such institutional controls. However, if necessary, institutional controls will be utilized at those impacted properties if there is residual contamination in the subsurface soil and it is not addressed.

2. Nevada Division of Environmental Protection

Comment: In the Proposed Plan fact sheet, EPA indicates that there are no capital or future costs associated with Alternative 1, No Action, when this alternative should include future costs for long-term monitoring. Please explain.

Response: Based on the definition of "no action" EPA used in the Feasibility Study and the Proposed Plan fact sheet, no action does not include any future monitoring. Rather, long-term monitoring is considered a form of institutional controls. Thus there are no long-term monitoring costs associated with this alternative.

3. Sharon D. Hunt

Comment: The commenter believes that mercury contamination in Dayton is not a public health hazard based on the apparent well being of many of the residents who have spent their entire lives in the Dayton area. The commenter then suggests that Alternative 1, No Action, is the better alternative.

Response: EPA is addressing areas where mercury contamination in surface soil is equal to or greater than 80 mg/kg. This action level is based on the potential health risks for a young child (less than 6 years of age) who may ingest an average of 200 mg of soil per day. This action level, 80 mg/kg, translates to a level of exposure for a young child that is below the level at which adverse effects are expected to occur. These adverse effects are to the kidney progressing from swelling and redness to more serious effects such as proteinurea (proteins in the urine). By selecting an action level which is below the threshold for adverse effects, EPA is being protective of human health.

4. Sharon D. Hunt

Comment: First, the commentor would like to know what are the implications if her property, which presently appears to be impacted, is not addressed. Secondly, the commentor is concerned that the value of her property is already reduced due to the presence of mercury and she would like to know if her property will regain the full market value after cleanup. Finally, the commentor would like to know if the property will have limited landuse after the cleanup.

Response: As a result of the human health risk assessment, EPA has set forth an action level (80 mg/kg) which the Agency is using to determine if properties are impacted by mercury. In the event that a property owner objects to cleanup activities on his or her property, EPA may attempt to negotiate an agreement with the property owner, or EPA may issue an unilateral order to that property owner. Should EPA not address an impacted property, the property owner will be subject to some risks. First, there are the health risks which are discussed under Comment 3. Secondly, there are liability risks if an incident of mercury poisoning is attributed to the property. Finally, there are risks that the value of the property will be reduced and that the property owner will be unable to sell the property or borrow money against the property. If EPA addresses contamination on the property, the specifics of the cleanup will be documented in an appropriate manner. After cleanup, if no residual contamination remains on the property, there will be no land use limitations for the property. However, as discussed in the "Selected Remedy" section of the ROD, some institutional controls may be utilized in the event that residual contamination remains on the property.

5. Mickey Lawler, 21st Century Environmental Management, Inc.

Comment: The commenter requests the results from soil analyses, wildlife analyses, and TCLP analyses. The commentor also requests any maps which describe the distribution of mercury in surface soil.

Response: The Human Health Risk Assessment and Remedial Investigation Report for the Carson River Mercury Site, December 1994, which is available at the information repositories, contains results from all of the soil sampling and provides maps which describe where EPA collected samples and provides the respective levels. As part of this phase of the remedial investigation, seven soil samples which contained elevated mercury were analyzed using TCLP. These analyses were performed as preliminary test to determine if excavated soil would exceed TCLP. These results are discussed in this ROD and are included in the administrative record. Wildlife sampling is part of Operable Unit 2 (OU-2) of the remedial investigation and feasibility study, and thus there are no results to provide at this time. The final report for OU-2, which will contain the results from all wildlife sampling, is scheduled to be completed in October, 1995.

Comment: The commenter refers to 40 C.F.R. Part 268.42 and poses the following questions: (1) what is the sampling plan for determining the total mercury content of excavated soil, and (2) will the total mercury content affect how the soil is regulated and thereby addressed (i.e., if soils exceed 260 mg/kg and are thereby defined as "High Mercury" in the Land Disposal Restrictions)?

Response: The sampling plan for determining the total mercury content of excavated soil will be developed as part of the remedial design which is scheduled to be completed in the Fall, 1995. However, as is discussed in this ROD, mercury contaminated soil from the CRMS is exempt from Land Disposal Restrictions by virtue of the Bevill Amendment. Thus, even if the soils are found to exceed 260 mg/kg, the soils will not be addressed differently. However, if soils are found to exceed TCLP standards, the soils will have to be treated before disposal at a RCRA municipal landfill or disposed of at a RCRA hazardous landfill. If the soil is sent to a RCRA hazardous waste landfill, the soil will be subject to the regulations which govern the landfill.

Comment: The commentor requests additional information regarding the cost analysis for Alternative 4.

Response: A description of the cost analysis is provided in the Feasibility Study for the Carson River Mercury Site dated December 20, 1994. This study is available for review at the information repositories.

2.0 COMMENTS FROM DAYTON PUBLIC MEETING ON JANUARY 18, 1995

6. Harold Tracey

Comment: The commenter owns property in Dayton and believes that property values have dropped significantly since the local media started releasing information regarding the Carson River Mercury Site. The commenter would like to receive compensation for the depreciation of real estate prices.

Response: This comment is concerning property values as they relate to the boundaries of the Carson River Superfund site and the public perception of the problem. For this site, EPA has not attempted to define the perimeter of the site because the extent of mercury contamination is too widespread. Thus, there has been an ongoing uncertainty about what areas are impacted and what areas are clean. Although EPA is unaware of any actual depreciation in real estate values, it is possible that this uncertainty might have some effect on real estate values in Dayton and other areas. Now that EPA has identified the historic millsites, established an action level, and has identified the impacted areas based on this action level, there should be less uncertainty as to whether a property is impacted. Also, by providing the State with prescribed sampling guidelines, EPA believes that property values will be less affected by uncertainty. With regards to what the local media reports, EPA only releases factual information to the media. Unfortunately, EPA has little control over how the information is relayed to the public through newspapers, radio, and television.

7. Victoria Predere

Comment: The commenter has been a resident of Dayton for over 60 years and she finds it difficult to believe that health risks that EPA is attempting to reduce are actually real.

Response: See Comment 3.

8. Don Dallas

Comment: The commenter does not understand why the Carson River is a Superfund Site. The commenter is also concerned that EPA will not select Alternative 1, No Action, even if the community unanimously supports this alternative.

Response: The CRMS was added to the National Priorities List (NPL) in August, 1990 due to the widespread occurrence of mercury. As with all Superfund sites, the site was evaluated and scored according to EPA's Hazard Ranking System (HRS) model. With the HRS model, a site is scored based on the contaminants of concern, the affected media, exposure pathways, the size and proximity of potentially exposed human populations, and the proximity of wildlife habitat. In order to be proposed for the NPL, a site must score above 28.5. The HRS score for the CRMS was 39. In the circumstance where a state does not have any Superfund sites, that state can propose a site for the NPL if that site is eligible according to the HRS. The CRMS was nominated by the State of Nevada as the

State's first Superfund site.

The purpose for the proposed plan comment period is to provide the public an opportunity to comment on the response actions proposed by EPA. In the event that the public provides valid reasons for modifying the proposed remedy or selecting a different remedy, EPA will strongly consider those comments and EPA might change the remedy selection based on the comments. Although the prevailing opinion among the communities is that the health risks are not real and that Alternative 1 is the best alternative, EPA feels that remediation is warranted based on the reasons presented under Comment 3. Also, the owners of the impacted properties recognized the practical value of addressing the impacted areas and they support the proposed remedy.

9. Gloria Marsh

Comment: The commenter would like to know how EPA will formally document that a property is " clean" after remediation is complete.

Response: See Comment 4.

10. Harold Tracy

Comment: The commenter is concerned with the Long- term Sampling Response Plan. In particular, he is concerned that the LTSRP will impose regulations on privately owned property and will reduce the value of the land and reduce the chances for people to develop their land.

Response: The areas that will be managed with the LTSRP are areas that were found to be impacted or areas that are potentially impacted by mercury. Given that these areas are identified in the remedial investigation report, it is likely that if a landowner elects to develop in one of these impacted areas, mercury contamination will be an issue that the landowner will have to address. The purpose for the LTSRP is to provide the landowner with clear guidelines for assessing if mercury is a problem and, if necessary, guidelines for addressing the problem. By providing these guidelines, EPA feels that the inevitable costs associated with developing or transferring land that is impacted or is potentially impacted by mercury will be greatly reduced.

3.0 COMMENTS FROM SILVER CITY PUBLIC MEETING ON JANUARY 19, 1995

11. Tom Card

Comment: First, the commenter asks if EPA determined the species of mercury in surface soil and then he asks if elemental mercury is really a health hazard.

Response: As part of soil investigations EPA attempted to characterize the species of mercury in surface soil, but due to conflicting results from two different labs using two different procedures, EPA was unable to establish whether mercuric sulfide or elemental mercury is the predominant species. However, EPA was able to conclude that less than 10 percent of the total mercury is mercuric chloride, which is the most soluble form of inorganic mercury. It is true that elemental mercury is the least soluble form of mercury and, as a result, poses the least risk when ingested. Since EPA could not establish what is the predominant form of mercury in surface soil, the action level assumed that 90 percent is mercuric sulfide and 10 percent is mercuric chloride.

Comment: Based on the assumption that elemental mercury is the predominant form of mercury in the soil matrix, the commenter expresses skepticism about the health risks associated with exposure to soil and recommends Alternative 1, No Action, as the best alternative.

Response: See Comment 3.

Comment: The commenter is concerned that EPA will use outside contractors to perform all of the work associated with the remedial action and would like to see local contractors used to perform the work.

Response: To the maximum extent possible, EPA will attempt to use local contractors to perform the remediation work. It is important to note that before a contractor can be considered to perform the soil excavation work, the contractor will have to meet certain requirements for handling hazardous substances. Assuming that local contractors possess the required qualifications, EPA will attempt to employ them.

<u>12. Mr. Laughlin</u>

Comment: The commenter believes that the CRMS was added to the NPL for political reasons. The commentor also refers to the open hearths of the steel mills in Pittsburgh as more significant problems.

Response: See Comment 8.

<u>13. Harold Tracy</u>

Comment: The commenter questions whether EPA had access approval to perform sampling on the Ricci Ranch. Secondly, the commenter questions whether EPA used prison crews to perform sampling.

Response: Access was requested prior to accessing private property to perform sampling. There were a handful of properties where EPA was unable to contact the land owner prior to conducting sampling. In those instances, EPA proceeded with the sampling when there were no fences or signs that denied access. but sampling was carried out anyway because there were no fences or signs to prevent access. In response to the second comment, EPA only used professionals to perform field investigations and EPA never used a prison team.

Attachment 2

Nevada Division of Environmental Protection
Screening/Action Level for Arsenic in Surface Soil in the Carson River Basin

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Nevada Division of Environmental Protection Screening/Action Level for Arsenic in Surface Soil in the Carson River Basin

1.0 Introduction

This paper discusses the development of a generic screening/action level for background concentrations of arsenic in surface soils within the Carson River basin. The Nevada Division of Environmental Protection (NDEP), Bureau of Corrective Action (BCA) gathered data from 397 native soil samples collected from a depth of 0" – 12" from random sampling locations throughout the Carson River basin in Nevada (Tidball, et al, 1991). These data were statistically evaluated to develop a generic screening/action level of 32 milligrams/kilogram (mg/kg) for arsenic in surface soil within the Carson River basin. NDEP has implemented this approach because arsenic occurs naturally in many of Nevada's soils at levels that exceed generic risk-based concentrations. Details of NDEP's analysis used to develop this screening/action level for arsenic are described in the following sections of this paper.

2.0 Data Summary and Screening/Action Level Calculation

NDEP statistically evaluated arsenic data from 397 soil samples collected to determine the regional distribution of elements in the alluvium of the Carson River basin. These soil samples were collected as part of a study by the National Water Quality Assessment Program (NAWQA) to determine both the character of water quality and the factors that affect that quality (Tidball, et al, 1991). The Carson River Basin was subdivided into a grid of cells, 5 km on a side, and one or more random sampling locations were selected within each cell (Figure 1). Results from a statistical analysis of these data indicate that the samples are representative of the range of native arsenic concentrations in most areas of the Carson River basin. The range of arsenic concentrations extends from a minimum of 1 mg/kg to a maximum of 73 mg/kg (Table 1), with an average (arithmetic mean) of 13.1 mg/kg and a 95th percentile of 32 mg/kg.

The arsenic data were plotted on normal probability plots, using both raw and log-transformed values (Figure 2). Normal probability plots are graphs of measurements, ordered from lowest to highest and plotted against a standard normal distribution function. The vertical axis is scaled in units of concentration, and the horizontal axis is scaled in units of the normal distribution function (normal quantile). Data that are normally distributed will fall along the diagonal line in the plots of concentration versus the expected normal quantile; data that are lognormally distributed will show the same relationship when the log-transformed values are plotted on such a graph. Here, the arsenic data show a good fit to a lognormal distribution (see Figure 2). (However, NDEP notes that the large sample size [n = 397] of this data set allows the data to be treated as a normally distributed sample population, according to the Central Limit Theorem [see USEPA, 2006]).

This graphical analysis of the arsenic data shows a nearly continuous distribution with perhaps a slight inflection at approximately 40 mg/kg (see Figure 2). This distribution, along with the lack of extreme values, suggests that the data represent a single background population (or perhaps two slightly different background populations that reflect differences in the source and sink area of the basin). The data plotted on a map show that higher concentrations of arsenic are generally found in the lower reaches of the drainage basin, in the area of the Carson Sink (see Figure 1). This spatial distribution is consistent with the geochemical behavior of arsenic in an alkaline oxidizing environment, where dissolved arsenic migrates readily as an oxyanion before accumulating in the sediments and soils of a closed basin (Hem, 1992).

NDEP's evaluation of the arsenic data indicates that the 397 samples are representative of the range of variability within a single background population. Therefore, NDEP has determined that the 95th percentile of 32 mg/kg represents an appropriate and conservative generic screening/action level for arsenic in surface soils within the Carson River drainage basin. The 95th percentile of 32 mg/kg represents native soil concentrations that can reasonably be expected for most areas of the Carson River basin.

3.0 Sample Preparation

Soil samples were air dried at ambient temperature and aggregates were gently crushed to pass a 2 mm stainless steel screen. The material less than 2 mm was thoroughly mixed and split in a Jones splitter. A subsample was then ground to less than 100 mesh using a vertical grinder equipped with ceramic plates (Tidball, et al, 1991).

Twenty five percent of the analysis-of-variance soil samples represent analytical duplicates. In addition, four internal reference standards were randomized within every group of 40 analyses. All samples, replicates, and standards were randomized and analyzed in that order. This has the effect of transforming any systematic laboratory error into a random error (Tidball, et al, 1991).

4.0 Analytical Technique

Arsenic levels were determined by utilizing the continuous-flow hydride generation atomic absorption spectroscopy method. A 0.25 g sample was digested with HNO_3, $HClO_4$, H_2SO_4, and HF acids. After digestion, the sample was diluted to 54 ml with 10 percent HCl acid and allowed to sit overnight to ensure the conversion of Se-VI to Se-IV. An aliquot of the sample was reacted with sodium borohydride in a continuous flow system to generate the appropriate gaseous hydride compound. The hydride gas was separated from the aqueous phase using a specially designed phase separator and the gas was swept into a quartz atomization cell positioned in the light path of the atomic absorption spectrometer. Arsenic was quantified using a series of external standards and the appropriate linear regression procedure. The lower limits of determination for Arsenic was 0.1 (mg/kg). The relative standard deviation for these determinations was approximately 10 percent (Tidball, et al 1991).

5.0 Standard Screening Level Approach

Typically, NDEP employs generic screening levels, such as the United States Environmental Protection Agency (EPA) Region 9 Regional Screening Levels (RSLs) (EPA9, 2010) for residential soil, when making an initial determination regarding potential soil contamination at a site. Soil concentrations that exceed the RSLs require further analysis to determine whether the facility poses an unacceptable risk to human health or the environment. EPA Region 9 calculates these RSLs conservatively without consideration of site-specific factors and bases the RSLs for carcinogens, like arsenic, on a 1×10^{-6} excess individual cancer risk. The EPA Region 9 RSL for arsenic in residential soil is 0.39 mg/kg (EPA9, 2010). Arsenic has been shown to have both carcinogenic and non-carcinogenic effects (ATSDR, 2000; IRIS, 2005).

The data NDEP utilized indicates that arsenic concentrations in native Carson River basin soils can range from 1 mg/kg to 73 mg/kg. Generally, cleanup levels are not set at concentrations below naturally occurring levels. Since the range of arsenic concentrations in native Carson River basin soils exceeds the residential RSL, NDEP does not consider the EPA9 RSL an appropriate screening level for arsenic in Carson River basin soils.

6.0 Screening/Action Level Applicability

With this paper NDEP intends to provide a reasonable screening/action level for unrestricted exposure to arsenic in surface soil. NDEP intends that this screening/action level be used generally to determine whether remediation of arsenic is necessary at sites located within the Carson River basin unless site-specific information indicates that this screening/action level is not appropriate. NDEP considers arsenic unique in that it is generally present in Nevada soils at concentrations above the Region 9 RSL and NDEP does not intend to implement the same approach for other contaminants.

It is important to note that NDEP considers the top two feet of soil to be surface soil. The EPA Risk Assessment Guidance for Superfund (RAGS) Volume I Human Health Evaluation Manual (Part A) states, "Assessment of surface exposures will be more certain if samples are collected from the shallowest depth that can be practically obtained, rather than, for example, zero to two feet" (EPA, 1989). However, the arsenic surface soil screening/action levels apply to the top two feet of soil to account for changes in the soil column resulting from activities like gardening, children and pets digging, resodding, bioturbation (worms, ants, moles, etc. disturbing the soil) and repairing roads or driveways. Therefore, NDEP recommends that investigators collect samples from various depths no more than 1 foot in thickness throughout the top two feet of soil in order to make decisions regarding remediation.

7.0 Site-Specific Screening/action Levels

NDEP's generic screening/action level may not be appropriate for all sites. Site-specific background concentrations may exceed the generic screening/action level of 32 mg/kg. If this is likely, NDEP encourages investigators to collect a statistically significant number of background samples to establish a valid site-specific background concentration. Because soils are generally heterogeneous, NDEP typically requires 20 or more soil samples for statistical analyses. Because arsenic occurs in different forms in the soil, it may be appropriate to calculate site-specific risk-based concentrations based on the type of arsenic found at the site. NDEP may require site-specific speciation or bioavailability analysis or both at sites where this approach is proposed. If land use restrictions are appropriate for an industrial or recreational facility, NDEP may consider site-specific risk-based concentrations based on limited exposure appropriate.

8.0 Conclusion

In conclusion, NDEP has developed a generic screening/action level of 32 mg/kg for arsenic based on the 95th percentile of the normal probability distribution of 397 sample locations randomly distributed throughout the Carson River basin.

This screening level can be used in making an initial determination regarding potential arsenic contamination in soil at a site located in the Carson River basin. If adequate sampling indicates that site-specific background concentrations exceed this level, site-specific cleanup levels may be appropriate. In addition, if the technical practicability or the costs of cleaning up a facility to 32 mg/kg or both warrant developing a site-specific cleanup level based on speciation or site-specific bioavailability studies NDEP may consider alternate screening/action levels on a site-specific basis.

9.0 References

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Hem, J.D., 1992. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey Water-Supply Paper 2254.

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FIGURE 1 – SPATIAL LOCATION OF INDIVIDUAL ARSENIC SAMPLES

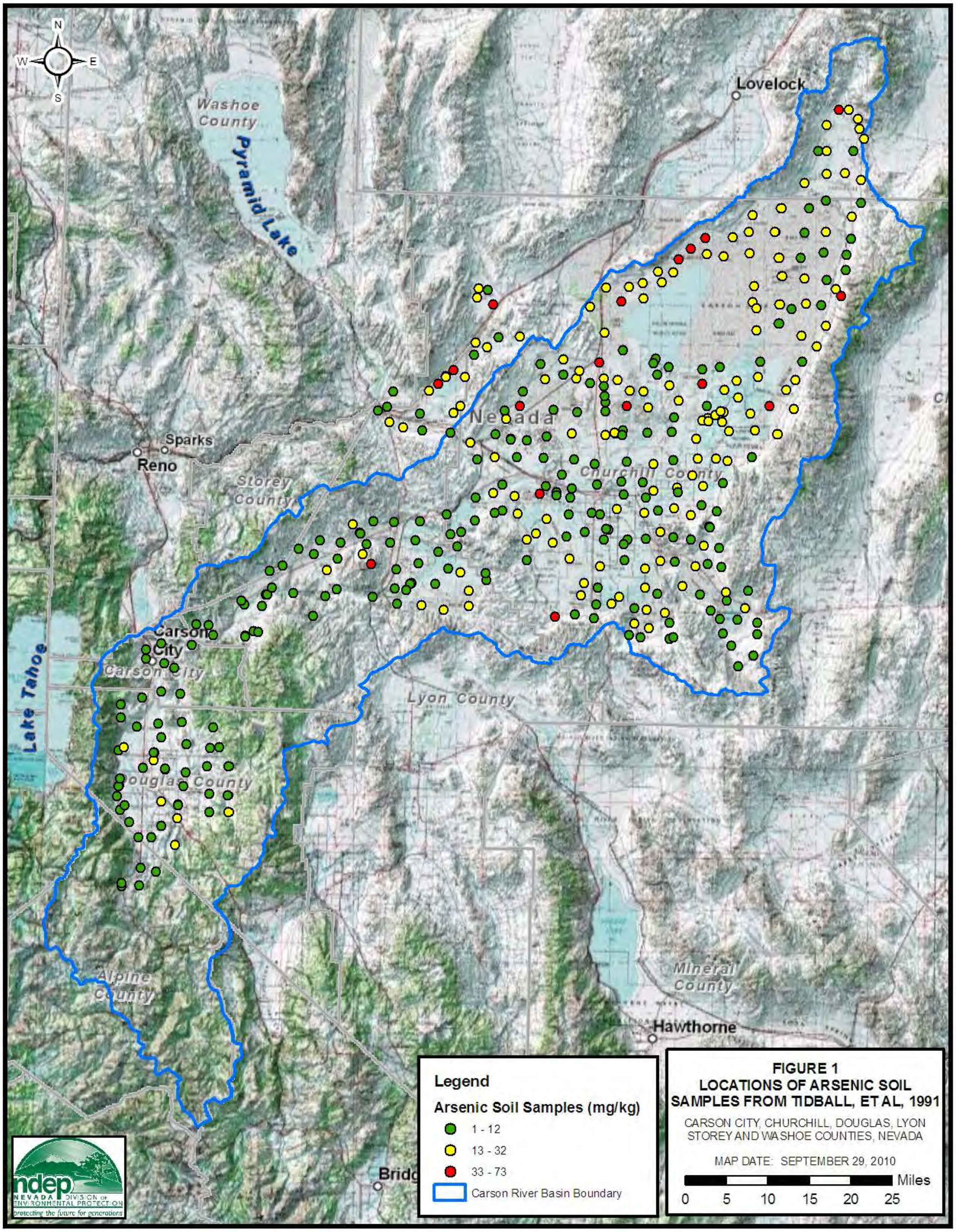
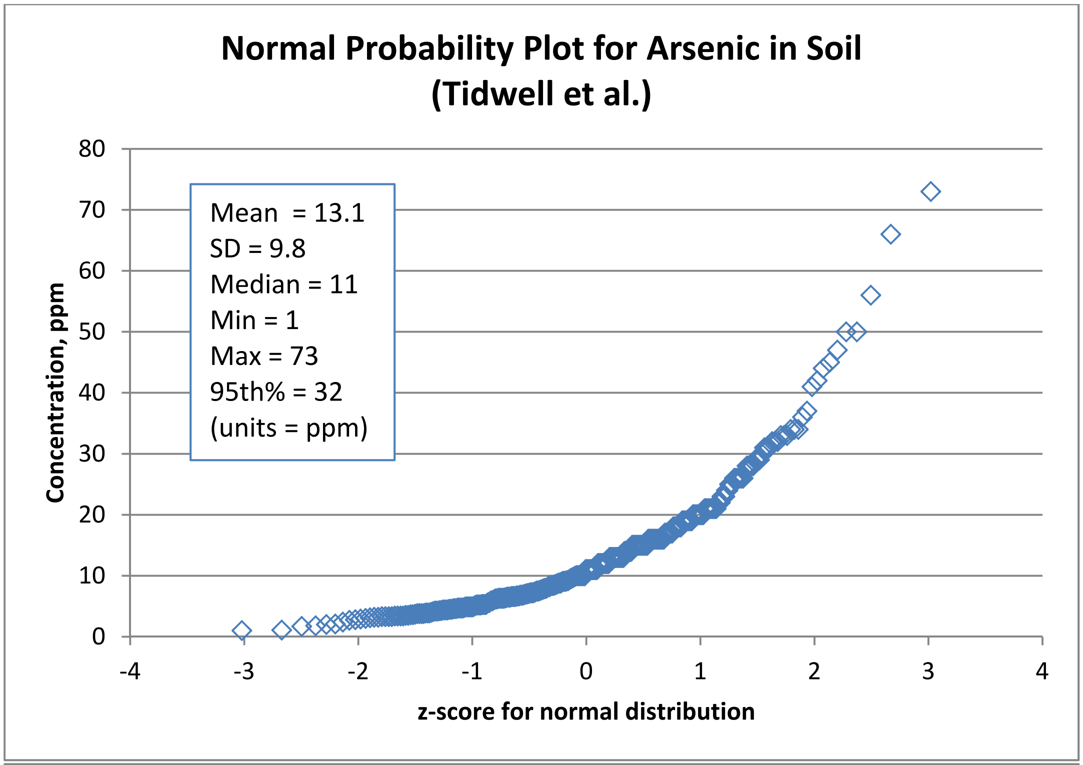


FIGURE 2 – PROBABLITY PLOTS OF ARSENIC DATA



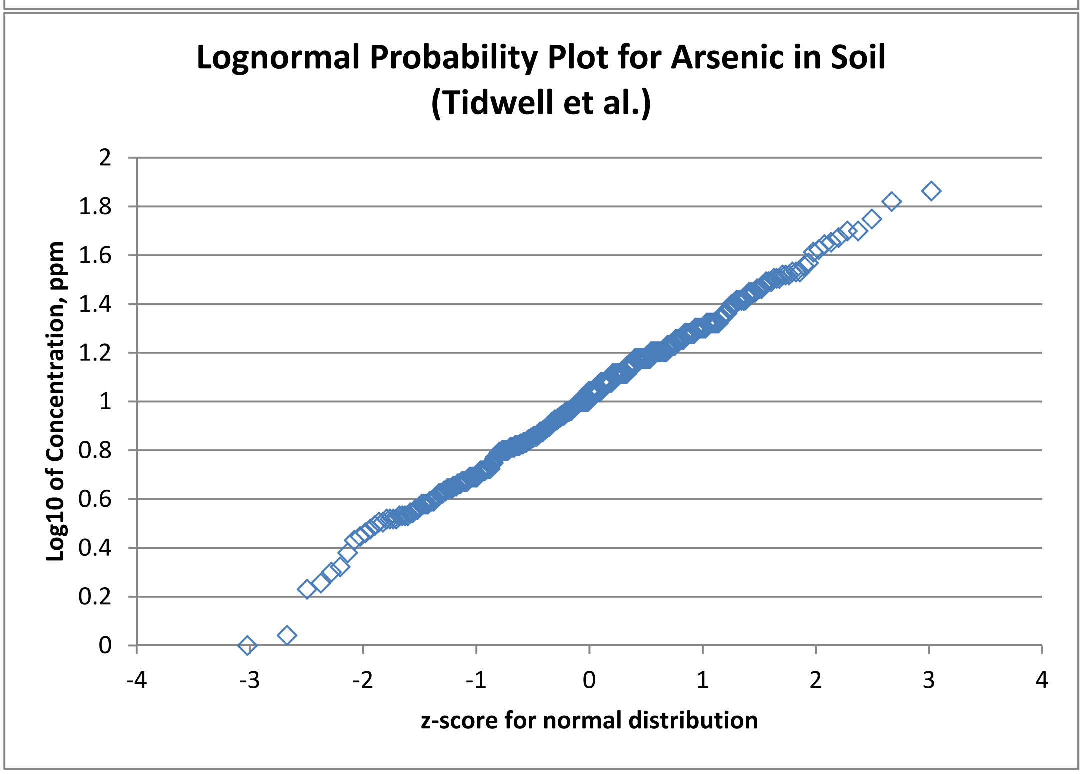


TABLE 1 – INDIVIDUAL ARSENIC SAMPLE RESULTS

SAMPLE ID	SECOND ID	LATITUDE	LONGITUDE	ARSENIC LEVEL (mg/kg)
1111	D286640	39.61555	-118.6036	16
1121	D286662	39.61555	-118.6036	6.3
1211	D286594	39.64444	-118.5931	21
2111	D286564	39.30056	-118.8072	15
2121	D286555	39.30056	-118.8067	19
2211	D286531	39.32167	-118.8008	13
3111	D286674	39.40667	-118.9108	10
3121	D286652	39.40667	-118.9114	20
3211	D286577	39.39111	-118.8725	19
4111	D286298	39.67916	-118.7333	32
4121	D286649	39.67916	-118.7333	31
4211	D286644	39.66083	-118.7044	16
5111	D286312	39.57167	-118.9728	6.4
5121	D286432	39.57111	-118.9722	5.3
5211	D286479	39.56972	-118.9364	10
6111	D286408	39.58528	-118.7364	3.6
6121	D286359	39.58639	-118.7372	28
6211	D286720	39.59083	-118.7189	9.1
7111	D286613	39.42445	-118.5189	19
7121	D286321	39.42389	-118.5181	8.4
7211	D286332	39.40167	-118.5608	6.3
8111	D286488	39.45083	-118.6369	3.7
8121	D286573	39.45083	-118.6367	8.7
8211	D286429	39.44639	-118.6664	26
9111	D286660	39.245	-118.6514	33
9121	D286736	39.245	-118.6514	25
9211	D286402	39.22778	-118.6703	3.2
10111	D286443	38.91555	-119.7003	8.8
10121	D286557	38.915	-119.7006	8.8
10211	D286665	38.94833	-119.6894	5.3
11111	D286606	38.97639	-119.7319	15
11121	D286353	38.9775	-119.7314	12
11211	D286735	38.99139	-119.7592	13
12111	D286466	38.94611	-119.8336	1.7
12121	D286511	38.945	-119.8353	3.5
12211	D286498	38.9275	-119.8389	1.8
13111	D286287	39.00555	-119.7564	7.5

13121	**D286431**	**39.00528**	**-119.7583**	**7.5**
13211	**D286275**	**39.03305**	**-119.7433**	**4.7**
14111	**D286352**	**39.215**	**-119.5628**	**6.7**
14121	**D286697**	**39.21389**	**-119.5628**	**5.8**
14211	**D286602**	**39.22333**	**-119.5428**	**3.9**
15111	**D286356**	**39.28806**	**-119.5189**	**11**
15121	**D286454**	**39.28806**	**-119.5147**	**10**
15211	**D286505**	**39.30111**	**-119.5047**	**3.3**
16111	**D286585**	**39.36195**	**-119.4119**	**7.3**
16121	**D286618**	**39.36083**	**-119.4119**	**9.3**
16211	**D286603**	**39.33417**	**-119.3822**	**17**
17111	**D286528**	**39.40083**	**-119.3092**	**6.9**
17121	**D286525**	**39.39944**	**-119.3089**	**5.3**
17211	**D286685**	**39.38167**	**-119.2939**	**12**
18111	**D286707**	**39.31472**	**-119.1894**	**7.8**
18121	**D286686**	**39.31306**	**-119.1939**	**6.6**
18211	**D286295**	**39.30222**	**-119.2019**	**11**
19111	**D286572**	**39.67889**	**-119.1236**	**28**
19121	**D286611**	**39.67805**	**-119.1231**	**32**
19211	**D286278**	**39.66583**	**-119.1408**	**50**
20111	**D286519**	**39.62333**	**-119.2558**	**7**
20121	**D286387**	**39.62333**	**-119.2544**	**6.3**
20211	**D286703**	**39.59583**	**-119.2494**	**13**
21111	**D286358**	**39.22611**	**-118.6042**	**3.6**
21121	**D286430**	**39.22611**	**-118.6042**	**4.6**
21211	**D286384**	**39.23**	**-118.5967**	**3.4**
22111	**D286634**	**39.81972**	**-118.4292**	**16**
22121	**D286728**	**39.82**	**-118.4289**	**15**
22211	**D286514**	**39.80972**	**-118.4206**	**16**
25542900	**D286484**	**38.76889**	**-119.8219**	**1**
25542950	**D286503**	**38.77472**	**-119.8222**	**2**
25543050	**D286366**	**38.90361**	**-119.8306**	**2.1**
25543150	**D286446**	**38.9575**	**-119.8331**	**7**
25543200	**D286490**	**39.00806**	**-119.8375**	**3.5**
25543250	**D286504**	**39.06583**	**-119.8353**	**4.1**
25543300	**D286710**	**39.08778**	**-119.8361**	**3.4**
26042900	**D286418**	**38.77111**	**-119.7817**	**2.4**
26042950	**D286548**	**38.80278**	**-119.7806**	**3.3**
26043000	**D286563**	**38.85639**	**-119.7875**	**5.2**
26043050	**D286489**	**38.88222**	**-119.8083**	**7.6**
26043100	**D286372**	**38.91139**	**-119.8197**	**4.2**

26043150	D286444	38.97833	-119.7822	9.1
26043200	D286389	39.01333	-119.8261	13
26043250	D286283	39.04972	-119.7978	3.4
26043300	D286664	39.10056	-119.7892	1.1
26043350	D286617	39.16972	-119.7825	5.9
26043400	D286276	39.185	-119.7836	3
26542950	D286666	38.79694	-119.7453	4
26543000	D286675	38.85695	-119.7578	4.4
26543050	D286360	38.8775	-119.7375	2.7
26543100	D286310	38.92056	-119.7381	16
26543250	D286307	39.05667	-119.7508	8
26543300	D286616	39.11333	-119.7458	3.3
26543350	D286689	39.16222	-119.7411	7.7
26543400	D286347	39.1975	-119.7494	3.1
27043000	D286343	38.84472	-119.7042	14
27043050	D286592	38.89139	-119.7022	14
27043150	D286455	38.9725	-119.6858	6.7
27043200	D286622	39.02139	-119.6853	6.8
27043250	D286658	39.06028	-119.6972	10
27043300	D286393	39.10944	-119.7025	2.8
27043350	D286314	39.15472	-119.7186	7.2
27043400	D286344	39.19639	-119.6797	5.2
27043450	D286702	39.23306	-119.6722	5.6
27543050	D286442	38.90333	-119.63	8.4
27543100	D286369	38.93611	-119.6306	6.1
27543150	D286445	38.98444	-119.6386	4.3
27543200	D286598	39.01694	-119.6322	6.5
27543201	D286364	39.01805	-119.6119	8.2
27543250	D286508	39.0525	-119.6275	7.2
27543400	D286468	39.21472	-119.6336	6.2
27543450	D286588	39.23139	-119.6433	11
28043050	D286440	38.90472	-119.5872	26
28043100	D286706	38.93417	-119.5894	4.7
28043150	D286515	38.985	-119.5897	8.4
28043450	D286684	39.26944	-119.5664	6.5
28043451	D286636	39.25333	-119.4094	8.7
28043500	D286527	39.27611	-119.5731	5.6
28543400	D286737	39.22222	-119.5331	2.9
28543450	D286361	39.26805	-119.5261	3.3
28543550	D286726	39.32944	-119.5111	5.2
29043500	D286716	39.29278	-119.4564	11

29043550	D286318	39.33917	-119.4817	7.9
29043600	D286377	39.37	-119.4478	11
29543500	D286713	39.28778	-119.3844	9.1
29543600	D286668	39.38639	-119.3986	10
30043500	D286537	39.30111	-119.3583	12
30043550	D286329	39.35389	-119.3581	4.9
30043600	D286670	39.38306	-119.3525	5.3
30043650	D286532	39.41555	-119.3264	14
30543500	D286740	39.28972	-119.2767	12
30543550	D286428	39.36361	-119.3022	16
30543551	D286306	39.34722	-119.2828	73
30543650	D286741	39.42194	-119.2794	7.4
30543850	D286448	39.61583	-119.275	7.2
31043450	D286492	39.27806	-119.2219	3.8
31043500	D286724	39.30472	-119.2267	4.4
31043550	D286333	39.33805	-119.2247	12
31043600	D286692	39.38472	-119.2406	12
31043650	D286463	39.42167	-119.2336	7.1
31043800	D286714	39.5875	-119.2183	13
31043900	D286456	39.65055	-119.2425	4.7
31543450	D286317	39.27583	-119.1664	28
31543550	D286621	39.35	-119.175	4.3
31543600	D286690	39.39028	-119.1831	8.3
31543650	D286587	39.42361	-119.1739	9.2
31543800	D286687	39.5825	-119.1747	8.8
31543850	D286438	39.61195	-119.18	6.5
31543900	D286400	39.6525	-119.1606	21
32043450	D286513	39.26889	-119.1156	21
32043500	D286415	39.31445	-119.1364	4.9
32043550	D286556	39.37083	-119.1319	4.9
32043551	D286698	39.34195	-119.1086	3.8
32043600	D286614	39.40194	-119.1044	8.2
32043650	D286420	39.43667	-119.1147	6.3
32043800	D286677	39.57972	-119.1092	11
32043850	D286470	39.615	-119.1036	20
32043950	D286679	39.69	-119.1069	33
32543450	D286471	39.27667	-119.0592	28
32543500	D286654	39.30444	-119.0597	18
32543550	D286522	39.33611	-119.0803	13
32543600	D286565	39.40722	-119.0806	6.6
32543601	D286733	39.38111	-119.0886	6.3

32543650	D286597	39.4275	-119.0508	11
32543701	D286424	39.46778	-119.0497	7.1
32543750	D286571	39.53444	-119.0486	12
32543800	D286520	39.56417	-119.0639	15
32543850	D286309	39.62722	-119.0894	26
32543900	D286401	39.67805	-119.0808	19
32543950	D286709	39.7175	-119.0597	12
32544000	D286635	39.73889	-119.0572	20
32544050	D286586	39.81778	-119.0564	13
32544100	D286517	39.83417	-119.0542	15
33043500	D286494	39.32306	-119.0206	6.3
33043550	D286378	39.33472	-119.0228	7.1
33043650	D286669	39.44611	-118.9883	10
33043651	D286327	39.44139	-119.0058	11
33043700	D286342	39.49111	-118.9892	9.5
33043701	D286397	39.47667	-119.0097	15
33043750	D286553	39.53972	-119.0083	23
33043800	D286625	39.58	-119.0075	12
33043850	D286567	39.60695	-118.9847	15
33043851	D286620	39.62111	-118.9875	9.1
33043950	D286650	39.73195	-119.0306	20
33044000	D286480	39.74944	-119.0056	12
33044050	D286390	39.80722	-119.0192	66
33044100	D286695	39.83194	-119.0322	10
33543550	D286413	39.36028	-118.9306	6.7
33543600	D286558	39.39611	-118.9311	17
33543650	D286705	39.44139	-118.9533	17
33543700	D286405	39.47222	-118.9619	17
33543750	D286516	39.53944	-118.9583	4.9
33543850	D286599	39.63028	-118.9539	41
33543900	D286467	39.65556	-118.9475	7.5
33544000	D286322	39.75111	-118.9564	14
34043450	D286286	39.26194	-118.865	50
34043650	D286350	39.43333	-118.8881	17
34043651	D286609	39.48	-118.8658	4.6
34043700	D286370	39.47667	-118.9044	56
34043701	D286570	39.49055	-118.8917	7.9
34043702	D286376	39.47472	-118.8667	7.5
34043750	D286552	39.54	-118.8981	4.4
34043800	D286628	39.57722	-118.8922	4.5
34043850	D286363	39.62444	-118.8769	5.9

34043900	D286447	39.67833	-118.8972	26
34043950	D286610	39.70417	-118.9094	12
34543450	D286729	39.26694	-118.8203	7.2
34543550	D286379	39.36444	-118.8339	20
34543600	D286419	39.4025	-118.8414	3.9
34543601	D286433	39.41083	-118.8011	9.7
34543650	D286373	39.44139	-118.8378	6.6
34543700	D286460	39.48778	-118.8317	6.3
34543701	D286473	39.47139	-118.8361	4.5
34543702	D286409	39.51056	-118.8561	5.2
34543750	D286305	39.53806	-118.8281	6.5
34543800	D286590	39.58417	-118.8347	14
34543850	D286678	39.62167	-118.8239	10
34543900	D286543	39.68028	-118.8278	18
34543901	D286596	39.68694	-118.8561	10
34543950	D286732	39.69361	-118.8203	15
34543951	D286711	39.7125	-118.8572	14
35043450	D286738	39.26028	-118.7758	8.2
35043451	D286591	39.28389	-118.7714	9.2
35043500	D286391	39.31389	-118.7697	12
35043550	D286510	39.35194	-118.7653	15
35043600	D286676	39.39806	-118.7581	7.9
35043601	D286392	39.41611	-118.7467	6.6
35043602	D286311	39.41778	-118.7522	6.8
35043650	D286354	39.44305	-118.7667	6.6
35043651	D286313	39.445	-118.7858	9.2
35043700	D286693	39.49417	-118.7758	5.2
35043750	D286578	39.53083	-118.7822	10
35043800	D286655	39.58167	-118.7581	13
35043850	D286457	39.62305	-118.7597	10
35043851	D286476	39.63917	-118.7608	4.6
35043900	D286637	39.67194	-118.7956	6.8
35043901	D286331	39.68139	-118.7653	27
35043902	D286725	39.6675	-118.7636	3.2
35043903	D286301	39.65083	-118.7617	6.2
35043950	D286404	39.70917	-118.7764	36
35044000	D286338	39.76111	-118.765	24
35044050	D286589	39.80695	-118.7992	29
35044100	D286717	39.84083	-118.7636	13
35543400	D286672	39.2325	-118.6964	9.8
35543450	D286546	39.27917	-118.6847	11

35543451	D286340	39.25195	-118.685	29
35543500	D286500	39.29889	-118.7203	16
35543501	D286328	39.28611	-118.7375	18
35543550	D286374	39.36361	-118.71	7.6
35543600	D286575	39.39944	-118.7042	6.4
35543601	D286673	39.39083	-118.7125	10
35543650	D286708	39.4525	-118.7292	30
35543700	D286477	39.50028	-118.7206	7.7
35543701	D286538	39.47833	-118.715	7.8
35543750	D286701	39.53639	-118.7086	4.9
35543801	D286320	39.58278	-118.7197	6.5
35543850	D286680	39.63361	-118.7119	33
35543950	D286541	39.73167	-118.7233	9.9
35544050	D286334	39.81694	-118.7283	34
35544100	D286459	39.84278	-118.7122	26
36043450	D286349	39.27722	-118.6572	26
36043500	D286291	39.31611	-118.6628	16
36043501	D286288	39.305	-118.6344	9.9
36043550	D286723	39.34972	-118.6622	13
36043551	D286284	39.3625	-118.6294	23
36043600	D286540	39.41444	-118.6306	17
36043601	D286434	39.40139	-118.6628	12
36043700	D286593	39.48555	-118.6475	15
36043701	D286323	39.47361	-118.6639	4.2
36043702	D286547	39.50083	-118.6722	6.7
36043750	D286682	39.53278	-118.6486	19
36043800	D286534	39.5875	-118.6642	4.7
36043850	D286285	39.63111	-118.6628	20
36043900	D286550	39.66	-118.6731	13
36043901	D286407	39.68972	-118.6439	6.9
36043950	D286551	39.71778	-118.6481	6.2
36043951	D286645	39.71	-118.6531	12
36044050	D286303	39.82361	-118.6778	25
36044100	D286566	39.85028	-118.6794	19
36044150	D286624	39.87056	-118.6467	29
36543450	D286639	39.25528	-118.6061	4.9
36543451	D286731	39.27222	-118.6164	21
36543500	D286375	39.31889	-118.5783	15
36543550	D286277	39.36222	-118.5953	11
36543600	D286569	39.40445	-118.5997	4.5
36543650	D286647	39.45639	-118.6006	21

36543700	**D286330**	**39.49166**	**-118.5939**	**19**
36543701	**D286523**	**39.48389**	**-118.5922**	**8.8**
36543750	**D286439**	**39.54055**	**-118.6031**	**5.1**
36543800	**D286539**	**39.58917**	**-118.6078**	**6.6**
36543900	**D286648**	**39.67056**	**-118.6158**	**15**
36543950	**D286521**	**39.70278**	**-118.6183**	**8.1**
36544100	**D286421**	**39.85111**	**-118.6369**	**32**
36544101	**D286509**	**39.86945**	**-118.6108**	**20**
36544150	**D286441**	**39.89194**	**-118.5997**	**34**
37043450	**D286451**	**39.2775**	**-118.5139**	**4.8**
37043500	**D286280**	**39.30556**	**-118.5381**	**8.4**
37043550	**D286325**	**39.35889**	**-118.5222**	**6**
37043551	**D286290**	**39.35472**	**-118.5497**	**15**
37043601	**D286630**	**39.39083**	**-118.5306**	**13**
37043650	**D286631**	**39.46167**	**-118.5378**	**10**
37043651	**D286681**	**39.44389**	**-118.5608**	**25**
37043700	**D286561**	**39.495**	**-118.5353**	**16**
37043750	**D286300**	**39.54306**	**-118.5489**	**20**
37043751	**D286472**	**39.51445**	**-118.5597**	**16**
37043800	**D286502**	**39.57833**	**-118.5519**	**22**
37043850	**D286643**	**39.63583**	**-118.5297**	**9.7**
37043851	**D286574**	**39.61444**	**-118.5267**	**14**
37043852	**D286341**	**39.61055**	**-118.5394**	**19**
37043853	**D286507**	**39.60972**	**-118.5258**	**22**
37043900	**D286535**	**39.67556**	**-118.54**	**34**
37043950	**D286626**	**39.70028**	**-118.5411**	**11**
37044150	**D286326**	**39.91195**	**-118.5719**	**45**
37044151	**D286582**	**39.90333**	**-118.535**	**16**
37044200	**D286638**	**39.93028**	**-118.5392**	**37**
37543350	**D286482**	**39.18056**	**-118.4494**	**7.2**
37543400	**D286495**	**39.23695**	**-118.4839**	**5.5**
37543401	**D286483**	**39.21583**	**-118.4653**	**3.9**
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37543500	**D286464**	**39.31**	**-118.4786**	**16**
37543501	**D286299**	**39.29583**	**-118.4769**	**8.5**
37543550	**D286481**	**39.35361**	**-118.4914**	**3.4**
37543600	**D286282**	**39.38694**	**-118.4964**	**4.2**
37543650	**D286465**	**39.45222**	**-118.5025**	**5.3**
37543700	**D286659**	**39.50083**	**-118.4894**	**8.6**
37543750	**D286497**	**39.54028**	**-118.4814**	**13**

37543751	D286294	39.54361	-118.5067	21
37543800	D286485	39.59333	-118.4786	13
37543850	D286395	39.62639	-118.4906	16
37543851	D286436	39.62	-118.5094	14
37543852	D286694	39.62778	-118.4981	23
37543853	D286642	39.60889	-118.4939	22
37543900	D286423	39.68083	-118.4631	14
37543901	D286345	39.66472	-118.4911	15
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37544150	D286414	39.89861	-118.4972	17
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38043750	D286633	39.54722	-118.4247	9.5
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38543800	D286580	39.58917	-118.3692	15
38543850	D286653	39.6375	-118.3878	44
38543900	D286576	39.66639	-118.3525	21
38544000	D286478	39.7825	-118.3703	12
38544050	D286530	39.81639	-118.3686	20
38544100	D286346	39.86639	-118.3639	16
38544150	D286394	39.89806	-118.3725	18
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39043950	D286324	39.71611	-118.3161	11
39044000	D286506	39.76139	-118.3186	15
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39044150	D286422	39.89806	-118.3228	6.8
39044200	D286461	39.94305	-118.3147	11
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39044300	D286667	40.02861	-118.3169	21
39433050	D286427	39.81639	-118.2739	9.4
39543950	D286339	39.74361	-118.2844	21
39544000	D286281	39.77972	-118.2633	17
39544051	D286595	39.83333	-118.2297	42
39544100	D286304	39.86	-118.2628	8.6
39544101	D286368	39.84472	-118.2428	21
39544150	D286656	39.90833	-118.2708	12
39544200	D286336	39.94528	-118.2658	16
39544250	D286385	39.99972	-118.2681	9.1
39544300	D286601	40.04472	-118.2672	18
39544350	D286435	40.08583	-118.2672	16
39544351	D286337	40.08583	-118.2864	9.6
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39544450	D286453	40.15833	-118.2408	47
40044100	D286297	39.87833	-118.2203	11
40044150	D286715	39.90556	-118.2192	7
40044200	D286542	39.93361	-118.2089	7.3
40044250	D286524	39.99639	-118.1875	11
40044251	D286355	39.97167	-118.2086	13
40044300	D286545	40.03556	-118.1875	19
40044301	D286663	40.04667	-118.225	18
40044350	D286474	40.08583	-118.2069	11
40044400	D286526	40.14222	-118.1969	31
40044401	D286398	40.10778	-118.1828	13
40044402	D286734	40.12472	-118.1928	24
40044450	D286315	40.15833	-118.2178	31

Attachment 3

Evaluation of Metals Data from Tidball et al. (1991): Arsenic, Lead and Mercury

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Evaluation of Metals Data from Tidball et al. (1991): Arsenic, Lead and Mercury

Mary A. Siders, Ph.D.
NDEP, BCA
June 29, 2012

1.0 Introduction

The Nevada Division of Environmental Protection (NDEP), Bureau of Corrective Action (BCA) evaluated data from 397 native soil samples collected from a depth of 0" to 12" from random sampling locations throughout the Carson River basin in Nevada (Tidball et al., 1991). Previously, the NDEP statistically evaluated these data to develop a generic screening/action level of 32 milligrams/kilogram (mg/kg) for arsenic in surface soil within the Carson River basin. In this current evaluation, the NDEP reviewed the Tidball data set for lead and mercury.

2.0 Data Summary and Screening/Action Level Calculations

The NDEP statistically evaluated metals data from 397 soil samples collected to determine the regional distribution of arsenic, lead and mercury in the alluvium of the Carson River basin. These soil samples were collected as part of a study by the National Water Quality Assessment Program (NAWQA) to determine both the character of water quality and the factors that affect that quality (Tidball et al., 1991). The Carson River Basin was subdivided into a grid of cells, 5 km on a side, and one or more random sampling locations were selected within each cell.

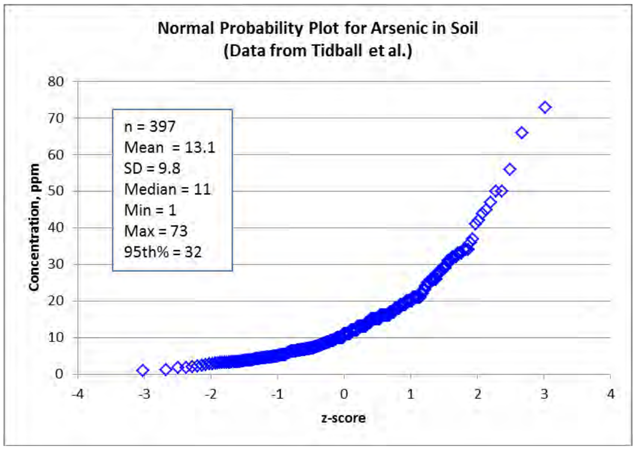
2.1 Arsenic (As)

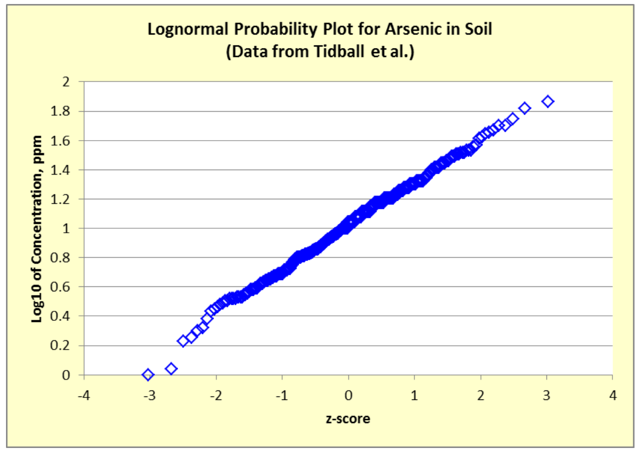
Results from a statistical analysis of these data indicate that the samples are representative of the range of native arsenic concentrations in most areas of the Carson River basin. The range of arsenic concentrations extends from a minimum of 1 mg/kg to a maximum of 73 mg/kg (Table 1), with an average (arithmetic mean) of 13.1 mg/kg, median of 11 mg/kg and a 95th percentile of 32 mg/kg.

The arsenic data were plotted on normal probability plots, using both raw and log-transformed values. Normal probability plots are graphs of concentration measurements, ordered from lowest to highest and plotted against a standard normal distribution function or z-score. The vertical axis is scaled in units of concentration, and the horizontal axis is scaled in units of the normal distribution function (normal quantile) or z-score. Data that are normally distributed will fall along the diagonal line in the plots of concentration versus the expected normal quantile; data that are lognormally distributed will show the same relationship when the log-transformed values are plotted on such a graph. Here, the arsenic data show a good fit to a lognormal distribution.

This graphical analysis of the arsenic data shows a nearly continuous distribution with perhaps a slight inflection at approximately 40 mg/kg. This distribution, along with the lack of extreme values, suggests that the data represent a single background population (or perhaps two slightly different background populations that reflect differences in the source and sink area of the basin). The data plotted on a map show that higher concentrations of arsenic are generally found in the lower reaches of the drainage basin, in the area of the Carson Sink. This spatial distribution is consistent with the geochemical behavior of arsenic in an alkaline oxidizing environment, where dissolved arsenic migrates readily as an oxyanion before accumulating in the sediments and soils of a closed basin (Hem, 1992).

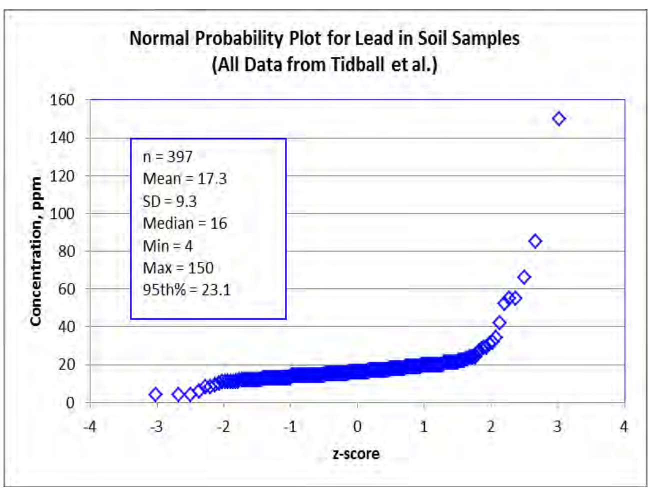
NDEP's evaluation of the arsenic data indicates that the 397 samples are representative of the range of variability within a single background population. Therefore, NDEP has determined that the 95th percentile of 32 mg/kg represents an appropriate and conservative generic screening/action level for arsenic in surface soils within the Carson River drainage basin. The 95th percentile of 32 mg/kg represents native soil concentrations that can reasonably be expected for most areas of the Carson River basin.

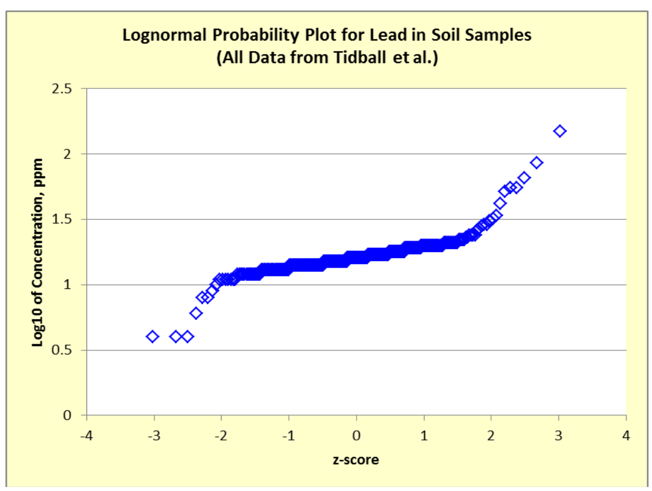




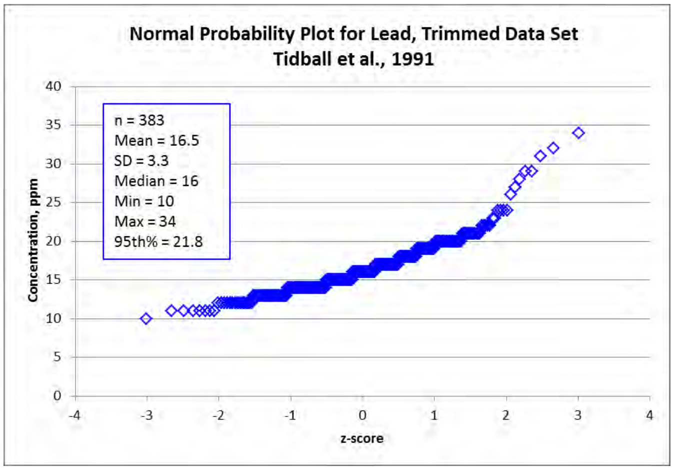
2.2 Lead (Pb)

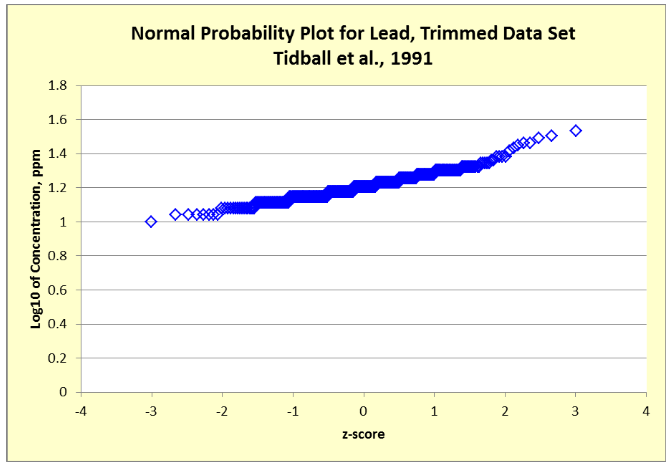
Whereas the data for arsenic appear to constitute a single background population, the data for lead suggest some samples represent anthropogenic contribution or input from mineralized areas. When data from all 397 samples are plotted, there appear to be about a half dozen high-end and low-end outliers (below). To avoid biasing summary statistics (Helsel and Hirsch, 2002), seven high-value and seven low-value data points were excluded and the data and summary statistics were recalculated ("trimmed" data set, n = 383).





The data for lead were re-plotted and the summary statistics recalculated for the trimmed data set. The plots of the trimmed data set (below, n = 383) show a more reasonable approximation of a single lognormally distributed population, with only a slight change in the mean and 95th percentile values from the complete data set (above, n = 397). The median value remains unchanged; however, the standard deviation and the maximum concentration are noticeably lower in the trimmed data set, as may be expected when outliers are excluded.



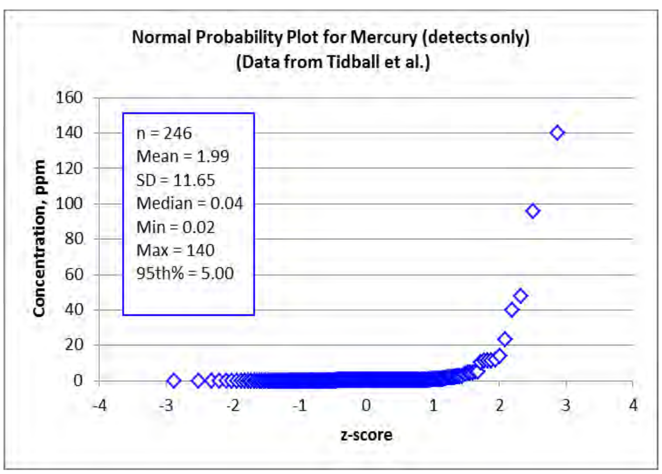


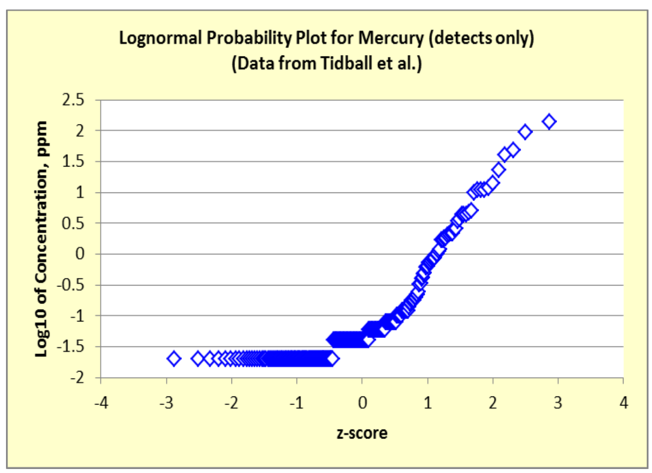
Results from a statistical analysis of the trimmed data set suggest that these samples are representative of the range of natural lead concentrations in most areas of the Carson River basin. The range of natural lead concentrations appears to extend from the reporting limit to a maximum of 34 mg/kg, with an average (arithmetic mean) of 16.5 mg/kg, median of 16 mg/kg and a 95th percentile of 21.8 mg/kg for the trimmed data set (n = 383).

The NDEP notes that samples with concentrations of lead greater than 50 mg/kg in the Tidball data set also contained high levels of copper, mercury and, in some cases, silver and zinc. A spatial analysis of these samples may help explain why these samples contained anomalously high concentrations of selected metals.

2.3 Mercury (Hg)

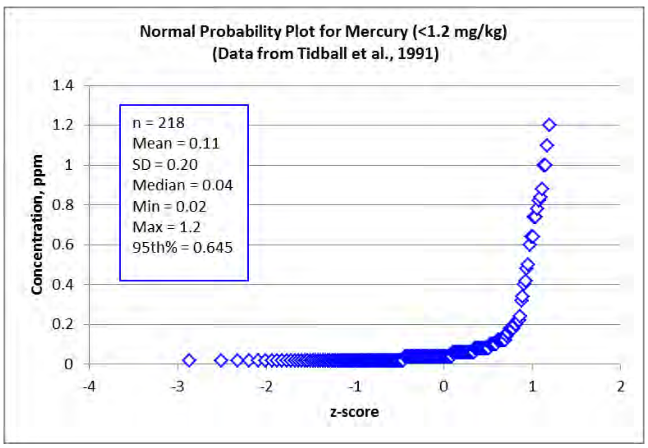
The data set for mercury contained a significant proportion of qualified results, and the unqualified results ranged from 0.02 to 140 mg/kg. There were only 10 samples with reported concentrations greater than 10 mg/kg; most of which showed elevated concentrations of other metals (in particular, copper, lead, zinc, and silver). An additional 14 samples were reported to contain from 2 to 10 mg/kg mercury. Excluding only the nondetect results produced the statistical summary (n = 246) shown in the plots below.

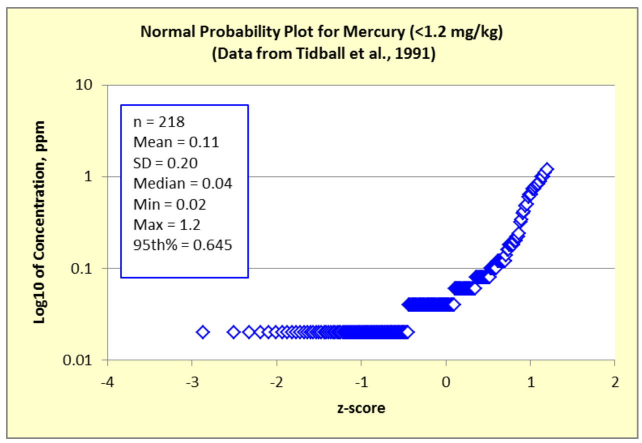




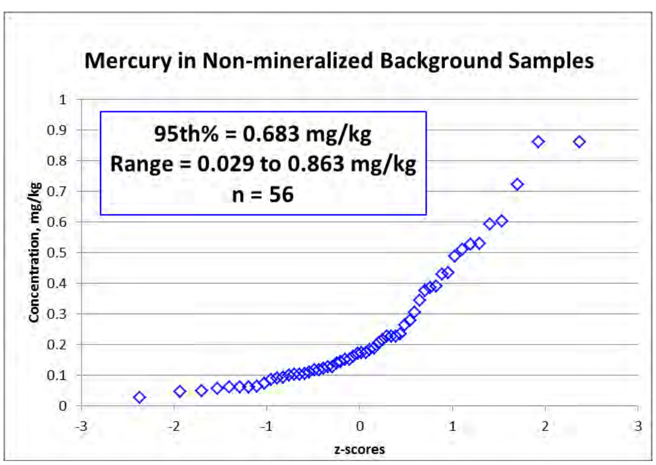
A series of probability plots was prepared for detected concentrations of mercury in reduced data sets, as high-value outliers were successively excluded. These plots were examined for the presence of what appeared to be outliers and multiple populations. After these reviews, the NDEP concludes that there is no definitive or completely clear cut line between "background" and "contaminated" level for mercury in this data set. The complex geochemical behavior of mercury in the environment, along with anthropogenic sources and proximity to mineralized areas, makes it exceedingly difficult to clearly discern "background" from "not background." Consider that, in the Tidball data set, mercury was not detected in nearly 40% of the samples and was detected at the detection limit (0.02 mg/kg) in another 20% of the 397 soil samples analyzed. Only 32 samples (about 8% of the 397 soil samples) contained greater than 1.0 mg/kg mercury.

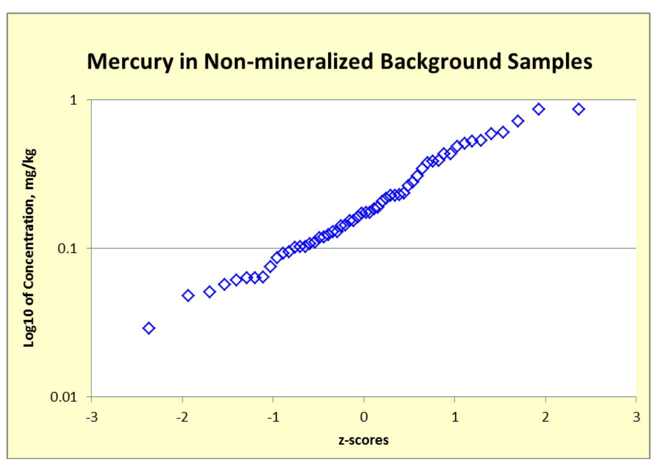
In some cases, anthropogenic mercury in a soil sample is clear (e.g., 140 mg/kg); however, when concentrations of mercury are reported as 10 mg/kg or less, the task of recognizing background becomes more difficult. Associations with other metals may assist in identifying mercury-contaminated soils and distinguishing these from soils containing natural levels of mercury. For the Tidball data set, the best approximation shows "background" concentrations ranging from less than the detection limit up to 1.2 mg/kg.





Another smaller background study (n = 56) conducted by Comstock (2012) showed what appeared to be a continuous background population for mercury, with concentrations ranging from the detection limit up to 0.86 mg/kg.





Data from the Tidball study (Tidball et al., 1991, n = 397) and the recent background study conducted by Comstock (Comstock Mining, 2012, n = 56), suggest that concentrations of mercury in soil that exceed 1 mg/kg are unlikely to represent background conditions in non-mineralized areas.

3.0 Summary for Arsenic, Lead and Mercury

Analytical data for 397 soil samples collected and described by Tidball et al. (1991) provide a basis for establishing the ranges of background concentrations for metals in alluvial soils of the Carson River basin. The NDEP previously used these data to establish a background screening level of 32 mg/kg for arsenic in soil. In this current analysis, the NDEP evaluated the data for lead and mercury. The 95th percentiles were calculated as 32 mg/kg for arsenic, 21.8 mg/kg for lead and 0.645 mg/kg for mercury. The full summary statistics for all three metals are compiled in Table 3.

4.0 References Cited

Comstock Mining. 2012. Metals data for 56 soil samples collected from background areas.

Helsel, D.R. and R. M. Hirsch. 2002. Statistical Methods in Water Resources Techniques of Water Resources Investigations, Book 4, Chapter A3. U.S. Geological Survey. 522 pages.

Hem, J.D. 1992. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey Water-Supply Paper 2254. 263 pages.

Tidball, R.R., Briggs, P.H., Stewart, K.C., Vaughn, R.B. and E.P. Welsch. 1991. Analytical data for soil and well core samples from the Carson River basin, Lyon and Churchill Counties, Nevada. U.S. Geological Survey Open-File Report 91-584A (hard copy) and 91-584B (digital).

Table 1. Analytical Summary from Tidball et al. (1991)

Metal	Method	DL	N	Qualified, n	Unqualified, n	Minimum, unqualified	Maximum, unqualified
As	H - Hydride generation AA	0.1 ppm	397	0	397	1 ppm	73 ppm
Pb	I - ICP AES	4 ppm	397	2	395	4 ppm	150 ppm
Hg	CV - Cold vapor AA	0.02 ppm	397	151	246	0.02 ppm	140 ppm

Table 2. NDEP Summary of Metal Associations Observed for the Tidball Data Set

SAMPLE_ID	Ag_ppm	As_ppm	Co_ppm	Cr_ppm	Cu_ppm	Hg_ppm	Ni_ppm	Pb_ppm	Zn_ppm
15111	2	11	16	38	43	**11**	18	29	89
15121	6	10	18	34	**81**	**48**	17	**66**	**120**
16211	2	17	19	36	53	0.02	31	18	**120**
18111	3	7.8	15	31	32	**14**	16	31	85
28043150	2	8.4	18	46	56	0.02	**75**	18	**250**
29043500	6	11	17	40	55	**23**	20	**52**	**130**
29543500	**13**	9.1	15	38	50	**40**	17	**55**	**120**
30543500	**13**	12	15	34	**75**	**96**	17	**85**	**180**
30543551	2	73	19	46	57	0.02	21	9	83
33043700	5	9.5	10	30	27	**11**	20	32	86
33044050	2	66	13	37	31	0.06	17	12	66
34543601	6	9.7	10	25	36	**12**	10	**55**	**150**
34543850	2	10	**38**	**230**	50	0.02	**180**	8	72
35043851	2	4.6	21	**96**	34	0.02	**67**	11	64
35043900	2	6.8	**49**	**320**	57	0.04	**280**	6	66
35043902	2	3.2	**42**	**320**	64	0.02	**190**	4	66
35043903	2	6.2	**40**	**320**	64	0.02	**210**	4	66
36043550	2	13	16	27	47	**11**	21	28	94
36043900	**17**	13	17	52	**170**	**140**	31	**150**	**170**
Filter	>10	>60	>30	>90	>70	>10	>60	>50	>110
Metals	Ag_ppm	As_ppm	Co_ppm	Cr_ppm	Cu_ppm	Hg_ppm	Ni_ppm	Pb_ppm	Zn_ppm

Table 3. Results from NDEP Background Evaluation of the Tidball Data Set

Metal	N total	N used	Mean	SD	Median	Minimum	Maximum	$95^{th}\%$	Units
Arsenic	397	397	13.1	9.8	11	1.0	73	32	mg/kg
Lead	397	383	16.5	3.3	16	10	34	21.8	mg/kg
Mercury	397	218	0.11	0.20	0.04	0.02	1.2	0.645	mg/kg

Attachment 4

Letter from the Nevada Division of Environmental Protection
Concurrence with EPA Explanation of Significant Differences

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STATE OF NEVADA
Department of Conservation & Natural Resources
DIVISION OF ENVIRONMENTAL PROTECTION

ndep
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

Brian Sandoval, Governor
Leo M. Drozdoff, P.E., Director
Colleen Cripps, Ph.D., Administrator

September 27, 2013

Jere Johnson
USEPA REGION 9
75 Hawthorne Street
Mail Code: SFD-8-2
San Francisco, CA 94105

Dear Ms. Johnson:

The Nevada Division of Environmental Protection has reviewed and concurs with the September 25, 2013 final draft Explanation of Significant Differences (ESD) for the Carson River Mercury Site Operable Unit 1 Record of Decision.

If you have any questions regarding this matter, please contact Jeff Collins at (775) 687-9307 or jrcollins@ndep.nv.gov.

Sincerely,

Dave Emme
Deputy Administrator
Nevada Division of Environmental Protection

cc: Mike Montgomery, US EPA Region 9, 75 Hawthorne St., Mail Code SFD-8, San Francisco, CA 94105
Jeff Collins, Bureau of Corrective Actions, NDEP