



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
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San Francisco, CA 94105

Superfund Division

June 20, 2019

Mr. John Peterson
Project Manager, Federal Projects Unit
Arizona Department of Environmental Quality
1110 W. Washington Street
Phoenix, AZ 85007

RE: Response to Your Letter of January 17, 2018; Comments on the Final RI Report;
Iron King Mine / Humboldt Smelter Superfund Site; Yavapai County, Arizona

Dear Mr. Peterson:

On January 17, 2018, then-project manager Karin Harker of your office sent to EPA, on behalf of ADEQ, comments on the Final RI Report for the Iron King Mine / Humboldt Smelter (IKHS) site. The RI Report was issued by EPA and dated September 2016. Thank you for providing ADEQ's comments.

This letter provides EPA responses to most of the ADEQ comments. We found that several of the ADEQ comments reflect misunderstandings of EPA's procedures or analyses in the RI Report and the incorporated Risk Assessment. Others warrant a more detailed explanation. We have endeavored to provide necessary clarification and explanation in our responses.

If you have any questions or wish to discuss these matters further, please do not hesitate to contact me at (415) 972-3020 or dhont.jeff@epa.gov.

Sincerely,

A handwritten signature in black ink that reads "Jeffrey A. Dhont". The signature is written in a cursive style and is positioned above the typed name.

Jeffrey A. Dhont
Superfund Remedial Project Manager
Superfund Division

**EPA Responses to
ADEQ Letter of January 17, 2018
Comments on Final RI Report
Iron King Mine / Humboldt Smelter Superfund Site**

The original ADEQ comments are shown in normal type. EPA's responses follow each comment in **bold type**. For clarity, all ADEQ comments are repeated; however, those comments for which a response is not needed here are shown in faded text.

General Comments

1. In general, the Remedial Investigation (RI) report was prepared in general accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA, 1988).
2. The RI report includes approximately 380 pages of text, roughly 330 pages of accompanying figures and tables and close to 3,000 pages of appendices. As is often the case in documents of this size, there are minor typographical and grammatical errors. These minor errors are not included in this comment package because they are inconsequential and do not impact the RI report or the use of the RI report during the FS or RD phases. Additionally, issues that may not be strictly, technically correct are not listed if they are unlikely to impact the conclusions and future decisions.
3. Extensive investigations have been undertaken to collect the data presented in the RI report. These data are from varied media and of various types. For example, 13,000 surface soil samples were collected and evaluated at depths ranging from 0 to 2 feet below ground surface (bgs). Approximately 6,300 of these samples were collected from residential yards. The data collection efforts of the RI, as presently constituted, are sufficient and acceptable. ADEQ agrees that no additional data investigations are required in the RI before moving forward to the FS or Early Action phases of the project.
4. Both the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) appear to be complete and adequately presented. With the exception of questions and comments presented within the specific comments section of this letter, both appear to follow the cited guidance to an appropriate degree.
5. The arsenic screening level of 194 mg/kg in the RI is based on a 1×10^{-4} Excess Lifetime Cancer Risk (ELCR). Pursuant to the ADHS 2003 *Deterministic Risk Assessment Guidance*, site-specific screening/initial remediation levels usually limit ELCR to one-in-one-million (10^{-6}) for Class A proven human carcinogens and to one-in-one-hundred-thousand (10^{-5}) for Class B probable and Class C possible human carcinogens. In addition, according to A.A.C. Title 18, Chapter 7, §205 (D) "Except as provided below [(F) For contaminants that exhibit both carcinogenic and non-carcinogenic effects, the numeric standard that is lower (more protective) shall apply], a person who elects to remediate to a residential SRL may utilize a 1×10^{-5} excess lifetime cancer risk for any carcinogen other than a known human carcinogen. If the current or currently intended future use of the contaminated site is a child care facility or school where children below the age of 18 are reasonably expected to be in frequent, repeated contact with the soil, the person conducting remediation shall remediate to a 1×10^{-6}

excess lifetime cancer risk.” Therefore, ADEQ does not agree with a 10^{-4} ELCR value (Refer to General Comment 6).

In addition, ADEQ has had a policy decision since 1997 to use 1×10^{-5} as the ELCR for Class B and Class C carcinogens. ADEQ documented this decision in the Arizona Administrative Register Notices of Final Rulemaking, Volume 3, Issue #52, dated December 26, 1997 on page 3652.

EPA RESPONSE: The use of the aforementioned screening level for arsenic – which is the upper end of the low risk range - in the report has not been consequential in terms of remedial decisionmaking for residential yards. It should be noted that subsequent to the issuance of the RI Report, in 2017 EPA conducted removal action cleanups of 31 yards based on yard-specific exposure point concentrations as derived in the RI. Regarding arsenic, the yards subject to cleanup were selected based on an ELCR of 5×10^{-5} , not on the screening level cited by ADEQ of 1×10^{-4} . Two other yard cleanups performed by EPA in previous years were consistent with this condition. The total number of yards cleaned up over all three actions over time was 50.

As ADEQ is aware, and as discussed at length in the RI Report, the levels of arsenic in background at this site are elevated and highly variable, which has presented challenges. EPA went to great lengths in the RI to resolve the background and determine the area of potential site impact based on multiple lines of evidence. This is further discussed in the response to ADEQ comment 6, below. ADEQ’s suggestion of using a EPC cleanup level based on a cancer risk of 1×10^{-5} in concept would have resulted in cleanup levels of perhaps one-fourth of background as measured by statistical background threshold concentrations, and below background even at average background concentrations. This would have been untenable. EPA believes that the removal actions taken have been protective and properly address the background concentration problem. There is further discussion of this in the response to the next comment.

6. Several decisions made in developing the RI do not appear as conservative in the sense that the report calculates and presents relatively low risks associated with arsenic contaminated soil. This seems to be a risk management approach that is more typically made when developing remedial alternatives in a Feasibility Study or selecting an “action level” (soil concentration above which actions are taken) in a decision document such as a Record of Decision. Several of these factors leading to the low risk estimates are described below.

EPA RESPONSE: EPA disagrees that the approach used is more appropriate to alternative development or action level determinations than to risk assessment. We believe that the assessment of arsenic background and risk calculation is defensible for risk determination. We disagree with implications in the comments that the background is overestimated and with some of the assertions about the effects that background estimation and use of an incremental risk approach have had. Clarifications are provided below.

Of special note, please note that EPA calculated both overall site risks in addition to incremental risks, and also that EPA did not base incremental background risk subtraction on the UTL (112 mg/kg) for arsenic, but on the UCL of the background data set (42 ug/kg). Also, the HHRA calculated both incremental and total site-based risk.

Effect of Screening Level

First, the screening level and background concentrations for arsenic in soil are 194 milligrams per kilogram (mg/kg) and 112 mg/kg, respectively. The screening level is based on a 1×10^{-4} excess cancer risk (using the low end of the typical CERCLA range from 10^{-4} to 10^{-6}) and a relatively low bioavailability value for arsenic.

EPA RESPONSE: See response to Comment No. 5 with regard to the screening level. Screening levels can take different forms depending on purpose. In this case, the screening level cited by the RI of 194 mg/kg was not ultimately used in the process to select yards for cleanup actions. Rather, yards with an EPC corresponding to 5×10^{-5} was used with respect to arsenic. The screening level did not have an impact on the risks calculated nor on the yards ultimately to which cleanup was applied. Bioavailability is discussed in response to a later comment.

Background Concentrations

The background concentration is on the order of 10 times higher than the background concentration used at other sites across the country. The RI notes that this area is known to have arsenic mineralization but the evaluation used to calculate background may be biased by some individual samples with very high concentrations. It would be helpful to see histograms of the background dataset to evaluate this issue.

Background areas were established using multiple lines of evidence. Once the geographic background areas were established, the 95/95 Upper Tolerance Limit (UTL) for the surface arsenic samples was calculated to determine site background concentrations for surface soils. The 95th UTL is the value that should include 95 percent of the samples, at the 95% confidence level. The specific data set chosen and the 95/95 approach leads to a high numerical value (112 mg/kg), which was used in the incremental risk assessment approach described below. It is informative to note that within close-in, deposition impacted areas (RSAR -A, B, C, D, E, F located within town) the average arsenic levels (95 UCL of the mean) are in the range of 25 to 50 mg/kg and none of the samples (over 250 samples) exceed the background level of 112 mg/kg (see Table 7-14). This condition (hundreds of samples in known deposition impacted areas) where none exceed, or perhaps even approach, the background value is atypical.

EPA RESPONSE: The estimate of background arsenic in soils is defensible and is based on a large and site-specific data set. As described in the RI Report, there are known natural sources of arsenic throughout the valley that have particularly high arsenic concentrations.

In this case we were fortunate to have a very large soil dataset (ultimately 268 background samples, see RI Figure 3-1 for graphical representation) well-distributed spatially across the site and surrounding area, which minimized the need for assumptions on distributions, or the need for use of state-wide averages.

As described in Section 6.2 of the RI Report and in greater detail in RI Appendix E, the background study first identified the area of potential site impact (APSI). We used a combination of: concentration distributions for copper, zinc, lead and arsenic; a statistical assessment of the ratio between shallow and deeper soil data for arsenic; to provide a reasonable estimate of the APSI.

Next, the arsenic soils data from outside the potentially-impacted area were evaluated for background, along with zinc, copper, and lead. Statistical outliers were identified for arsenic and these concentrations were assessed in the context of (a) their location relative to known mineralized areas and (b) analytical data from nearby soil samples. Results from several samples were excluded using this process, concluding that they were not representative of the range of arsenic in natural shallow soils. The remaining data, a total of 268 shallow soil samples, were used to calculate the upper tolerance limit (UTL) using the appropriate statistical method based on the statistical distribution of concentrations.

Regarding outliers, there were a few arsenic concentrations that were well above the calculated UTL, but this fact alone is not valid justification to remove these data. Importantly, the previous geochemical assessment was used for that purpose. The data are provided in the RI Report and the arsenic values are more-or-less continuous up to a concentration of 110 mg/kg, with consecutive concentrations separated by no more than 7 mg/kg, and typically less than 3.5 mg/kg. The strength of this distribution diminishes the influence on the UTL calculation by the relatively few elevated values.

As requested, a histogram of the arsenic soil data is presented at the end of this document. Note that the calculated UTL was for a lognormal distribution, so a standard histogram will not show the symmetric bell curve associated with textbook normal distributions. Like most natural distributions, there is an upper tail to the distributions of soil arsenic in this data set, and the UTL targets this upper range.

There also were a great number of low concentrations of arsenic (and the other metals) in both background and affected areas, and this was to be expected. Soil data are typically highly heterogeneous, especially in their trace element concentration. While some concentrations are elevated from a trace element perspective, they all represent tiny fractions of the soil composition. The goal of the background study is to examine the upper range of background as a tool to assess the question of whether a soil has been impacted by Site activity. Once the background data set was defined, the statistical approaches used to estimate background concentrations were considered standard for the practice at contaminated sites. As indicated in Section 5.1 of Appendix E, the 95/95 UTLs were computed using the U.S. Environmental Protection Agency (EPA) ProUCL software package and included the associated distributional assumptions.

It should be noted that background samples – from points outside the determined areas of potential site impact once the APSI was determined by multiple lines of evidence - were located across the site area surroundings to a distance up from 2 to 3 miles, primarily from the west of the highway and east of the river. Few background data were available due north of town because it is agricultural land. It has been observed that arsenic levels tend to be higher east of the river than west of the highway. This is likely due to differences in weathered geology in soils formation. Regardless, background statistics – including variability - accordingly reflect the aspects of the distribution across all areas around the site, outside the APSI.

The ADEQ comment is misleading in describing screening areas RSAR -A, B, C, D, E, F located within town as “close-in, deposition impacted areas”. As can be seen from

Figures 9-3, -4, and -5 in the RI Report, residential risks at the site are much higher at closer areas, particularly where tailings have been physically moved or migrated. While these screening areas (A,B,C, etc) were determined to be inside the area of potential site impact based on other factors, the average levels from these areas cited in the comment (25 to 50 mg/kg) are not significantly different from average and mean background levels of the entire background distribution (39.1 and 29.4, respectively). It should be borne in mind that the UTL (112 ug/kg) for arsenic is at the 95 percent confidence level for background, not the average. (Note also that, as will be discussed below, EPA did not use the UTL for incremental risk subtraction, contrary to the ADEQ comment).

Use of Incremental Risk Approach with Background

In conformity with CERCLA risk assessment guidance and conservative assumptions, the 95th UCL of the mean was used to evaluate soil concentrations in defined individual exposure areas (e.g., Residential Yard-Specific Risk) in the HHRA (Section 9.0). Before computing the appropriate 95th UCL, the data distributions were evaluated. Using the 95th percent UCL of the mean provides a conservative estimate of exposure resulting from area-specific concentrations in that only 5 percent of the time would the true mean lie above the 95th UCL of the mean.

However, as used in the risk assessment, the 95th UCL of the mean may not result in conservative estimates of risk because of the use of “incremental risk” in the HHRA. The incremental risk is equal to the total site risk minus the background risk (Section 9.6.4 in the RI). By choosing a high estimate of the background concentrations, the calculated risk of the site is lower than would be calculated by using non-conservative estimates of background. For example, using the arithmetic mean or 90/90 UTL for the background in the risk assessment, instead of the 95/95 UTL would result in a higher estimate of incremental risk.

EPA RESPONSE: ADEQ is incorrect in stating that the 95/95 UTL value (112 mg/kg) for arsenic was used in the incremental risk assessment approach. In fact, the 95% Upper Confidence Limit (UCL) of 42.4 mg/kg for the arsenic background data set was used to estimate background risk, from which incremental risk was then computed.

The increase in risk, considering background arsenic in soils, is estimated to be 2×10^{-5} . Therefore, out of 100,000 people two people might develop arsenic-induced cancer given the calculated arsenic background concentration. It would be much clearer to use the total risk instead of the incremental risk in the HHRA of the RI. The background concentration could then be considered in the FS and RD when deciding on areas to be addressed in the remedy. This is important because the background concentration for arsenic was used in the risk assessment to calculate incremental risk, which subtracts out the risk associated with background concentrations of arsenic. Consequently, very few residential areas (seven properties) have incremental risks above 1×10^{-4} .

To some degree, these concerns could be dealt with in developing sampling approaches for removal actions.

EPA Response: It should be noted that the risk assessment computed and reported both total concentration-based risk as well as incremental risk, not only incremental risk. The reader may consider either as may be his or her intention. Also importantly,

incremental risk was not the basis for identifying the yards at which cleanup was performed.

That said, the risk assessment approach considered the presence of high and variable levels of naturally-occurring arsenic and other metals in the region and the fact that actual residential properties exist at the Site. Care has been taken to distinguish the levels of arsenic from mine-related releases from those that occur naturally. EPA 2003 guidance in *Role of Background in the CERCLA Cleanup Program* indicates that “Background information is important to risk managers because the CERCLA program, generally, does not clean up to concentrations below natural or anthropogenic background levels.” This guidance also states that “the COPCs with high background concentrations should be discussed in the risk characterization, and if data are available, the contribution of background to site concentrations should be distinguished.” For this reason, *the IKHS HHRA provided risk assessment results for both total risk (site plus background) and incremental (site minus background) risk. This practice is not uncommon for Superfund sites.*

7. The statistical variability in soil sample results can be handled in a more protective way by developing a decision rule that minimizes Type I errors (erroneously making a decision not to clean up a contaminated property) at the expense of having a high Type II error rate (erroneously deciding to clean up an uncontaminated property). In addition, the 2008 CH2M Hill *Evaluation of Background Metal Concentrations in Soil for the ASARCO LLC Hayden Plant Site* cites the Earth Technology Corporation report prepared for ADEQ (June 1991, where background arsenic in Arizona (USGS samples only) was identified to fall between a range of 1.4 mg/kg and 97 mg/kg, with a mean of 9.8 mg/kg and standard deviation of 17.2 mg/kg. These 47 USGS samples were collected at approximately 50-mile intervals along routes of travel from one field area to another, throughout Arizona. Collection of samples was conducted away from road cuts and fills. Samples were collected at a depth of 8 inches bgs to avoid the effects of surface contamination. ADEQ’s 62 samples in this same background investigation had a much lower range (3.1 mg/kg and 24 mg/kg). The ADEQ samples were also collected throughout Arizona and were specifically noted as background samples in the investigation conducted in 10 different sites known to be contaminated. The depth of samples collected ranged from 0.25 feet to 9 feet bgs. However, the ADEQ samples don’t appear to be statewide, but rather metro-based. Based on comparison background levels throughout Arizona to the established site-specific level for arsenic (112 mg/kg) illustrates a magnitude variance.

EPA Response: As stated in the response to General Comment #6, this project benefitted by having a very large and geographically dense data set that extends across the southern portion of the valley. Therefore, we did not need to rely on regional data such as the State-wide United States Geological Survey (USGS) survey cited in the comment. As noted in the comment, the USGS data showed background values that ranged up to 97 mg/kg, an order of magnitude higher than the average, and similar to the 112 mg/kg UTL value calculated for our study. For comparison, the mean and median of the Iron King Mine Site data set were 39.1 and 29.4 mg/kg, respectively. As noted in the response to General Comment #6, the Site is in a portion of the State with some of the highest naturally-occurring arsenic concentrations.

8. Several separate investigations were conducted by different contractors using varying depths

for surface soils. Surface soils are represented as being collected from the following intervals: 1) at 0.5 feet bgs, 2) at a depth of 2 feet bgs or shallower, 3) 0 to 0.5 feet bgs, 4) 0 to 2 feet bgs, 5) 0 to two inches bgs, 6) depth of 0 feet bgs, and 7) 0 to 1 foot bgs. The HHRA uses surface samples collected from 0 to 2 feet bgs, which encompasses all depth intervals listed above. This is a reasonable methodology because it increases the number of samples available for use in the HHRA although constituent concentrations in samples collected at shallower depths (e.g., 0 to 6 inches bgs) might be expected to be higher than samples collected at deeper depths (based on a typical deposition pattern). It would be useful to statistically evaluate if constituent concentrations at deeper depths came from different populations than those found at shallower depths; particularly when evaluating impacts from surface soil inhalation, dermal contact, and ingestion. Using the broad definition of 0 to 2 feet depth for surface samples likely includes samples that were not subject to aerial deposition from Site releases. It may be appropriate to compare samples from very near surface (say 0 to 6 inches) to the 0 to 2 feet data to evaluate whether the data sets are statistically similar.

EPA Response: Additional clarification on this matter will be helpful. For IKHS, although areal deposition was a potential migration pathway, there have also been cases where tailings were directly disposed, released via flooding events, and moved to deeper soil horizons due to mechanical tilling or other means. As a result, some sampling was directed to address these potential releases.

Data from over 13,000 soil samples collected from the 0 to 2 feet below ground surface (bgs) interval were used for the HHRA. Of these, more than 80% were from the 0 to 0.5 feet bgs horizon. In fact, for the residential yard areas, no results from deeper than approximately 1-foot bgs were used for the HHRA. Soils deeper than 1 foot were used in other areas where it made sense to do so. Additional statistical evaluation of the shallow data does not appear necessary.

9. The site-specific oral bioavailability for arsenic in the HHRA (22.5 %) is significantly less than the EPA default value (60%). Given that many of the samples used in evaluating the bioavailability were collected from non-residential areas (e.g., Humboldt smelter and MTP), it is not clear whether the arsenic 95 percent UCL oral-bioavailability adjustment factor obtained is representative of residential areas given that redox conditions can be highly variable across the site and arsenic in the +3 oxidation state typically is more toxic, soluble and mobile than arsenic in the +5 oxidation state. Additionally, Appendix H states that the test method used to calculate the bioavailability was for lead. As part of the determination of in vitro bioaccessibility the soils were dried by heating which would tend to push arsenic toward the less available +5 oxidation state. Further, as part of the bioavailability study, mice were fed soils or sodium arsenate. Feeding sodium arsenate should not provide conservative results compared to a feeding with sodium arsenite. Table 3 of Appendix H confirms that most of the arsenic was in the +5 oxidation state. Other EPA guidance (including bioavailability studies using juvenile swine with soil from the Iron King Mine¹ has measured bioavailability closer to the 60% range². However, please note that other ADEQ programs within the Remedial Section have accepted a risk-based approach of 40% which was initially established in the ADEQ-approved BHP Northwest Study Area Risk Assessment (Brown and Caldwell, 2009). The distribution used assumed values ranging from 18.3% to an upper value of 50%, and a most likely value of 40%.

¹ Relative Bioavailability of Arsenic in two soils from the Iron King Mine. Prepared for: U.S. Environmental Protection Agency, Prepared by: SRC, Inc. Denver, Colorado, February 2010

² Compilation and Review of Data on `Relative Bioavailability of Arsenic in Soil, OSWER 9200.1-113 Environmental Protection Agency, December 2012

EPA RESPONSE: EPA guidance clearly allows for consideration of bioavailability for CERCLA risk assessments. EPA guidance in *Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil*, OSWER #9200.1-113 (EPA, 2012) states the following: “site-specific assessments of bioavailability should still be performed where such assessments are deemed feasible and valuable for improving the characterization of risk at the site. Default RBA values generally should not be used when site-specific assessments are performed.” This is the approach used for the IKHS Site.

It must be stressed that the site-specific bioavailability estimates derived for IKHS essentially represent the “gold standard” in that there is not only a statistically-defensible number of site-specific *in-vivo* (animal) tests conducted by EPA but these *in-vivo* results were calibrated by a site-specific linear regression to a large number (70) of *in-vitro* analyses distributed throughout the site area. The bioavailability estimates for the IKHS site are therefore considered to have high reliability (see Appendix H for in-depth discussion).

The test methods for lead and arsenic are fundamentally the same and the method has been validated by EPA for use with arsenic. This method has been shown reliable for management decisions at many other Superfund sites.

About half of the *in-vitro* samples were taken from residential yard soils, and the balance were taken from non-residential, mostly tailings areas. Interestingly, the predicted bioavailabilities from both materials were very similar. As part of the assessment of site-specific arsenic bioavailability for IKHS, EPA initially determined that the bioavailability estimate for samples from only residential properties (n=26) was slightly lower (21.5%), not higher, compared to considering the combined residential plus non-residential properties (22.5%). Given the similar values, the entire data set was used to provide a more robust estimate of bioavailability for evaluating potential risks. The average bioavailability was on the order of 15%, and the more conservative 95th percentile was, as mentioned, 22.5%, which was used in the HHRA.

Regarding the potential effect of soil drying on the geochemistry mentioned in the ADEQ comment, please note that the test method is intended to simulate actual human physiological conditions. The soil drying occurred at 37°C (see Appendix H), which is consistent with a normal human temperature of 98.6°F. Moreover, this temperature is clearly within the range of ambient Arizona temperatures that these soils have already experienced in the environment prior to sampling. Given these factors, it is expected that no meaningful change in geochemistry was introduced by the bioavailability test methods.

10. The Human Health Risk Assessment states that “...no hexavalent chromium was detected in soil.” However, Section 7 which deals with the ‘Nature and Extent of Contamination’ reports that hexavalent chromium was found in samples collected from the pyrometallurgical

operations and the slag. Table 7-13 indicates that no data were available for hexavalent chromium in residential soils areas. Additionally, although only a limited number of hexavalent samples were analyzed, Table 7-5 lists areas where hexavalent chromium was found. Table 6-2 indicates that hexavalent chromium was detected at 60 times the residential regional screening level (RSL). Therefore, existing data from other areas may have to be used to determine concentrations at which different exposure pathways, such as ingestion and inhalation, become problematic.

Based on the foregoing it would seem prudent to at least do some preliminary analyses of hexavalent chromium for the HHRA by assuming the trivalent chromium was oxidized to the hexavalent form. Trivalent chromium can be oxidized to hexavalent chromium under environmental conditions although the kinetics of the oxidation reaction are quite slow. Therefore, percentages of chromium in the hexavalent form may increase over time. Manganese was found at levels that exceeded soil screening and background levels and manganese oxides can act as catalysts in oxidizing Cr(III) to hexavalent [Cr(VI)] chromium. Thermodynamically, the Cr(VI) species become important in alkaline solutions when the redox potential increases to $pe + pH = 12$ and if the redox potential reaches $pH + pe = 18$, the Cr(VI) species become important at pH values > 4.5 .

EPA RESPONSE: The statement in the uncertainties section of the HHRA (Section 9.8) was intended to refer to the ten surface samples of tailings material collected from the Main Tailings Pile (MTP) for analysis of hexavalent chromium, Cr(VI), because these were expected to provide a conservative estimate representing how much of the chromium present in airborne dust is in the more toxic hexavalent form. There were no detections of Cr(VI) in these samples. As indicated in Section 6.3.5, Cr(VI) was detected infrequently in site samples and at significantly lower concentrations than total chromium. As a result, chromium was assumed to be present predominantly in the less toxic trivalent form Cr(III). This reduces uncertainty associated with the form of chromium from dust migration and potential for downwind inhalation exposures.

Cr(VI) was detected in three soil samples out of the 29 analyzed for Cr(VI). Two of these detections were from the Humboldt Smelter area (at 1.7 and 18 mg/kg) and one from the MTP (at 1.4 mg/kg). It is true that Cr(III) may be oxidized to Cr(VI) by interaction with manganese oxide (MnO) surfaces and this is the only oxidation mechanism identified as significant in natural systems. This process requires water to dissolve small amounts of Cr(III) and transport these ions to the MnO surface, where Cr(VI) and Mn^{2+} are liberated. However, Cr(VI) is highly soluble and weakly-adsorbed and would be carried away with the water rather than remaining in the soil. The only Cr(VI) likely to be found in near-surface soils would be evaporative salt crusts containing chromate salts. Salt crusts occur at two locations at the site: in ponding areas on the top of the Main Tailings Pile at the former mine, and in a localized area below the Smelter Tailings Swale berm and above the Tailings Flood Plain. Samples from these salts have much higher levels of lead than are found in other tailings areas and localized higher bioavailabilities; cover/cleanup of all of the salt areas will be of priority in remedial decisionmaking.

11. As the project moves forward into remedial design and/or removal action phases, it may be prudent to reconsider the process used to calculate the background concentration for arsenic; the existing background value of 112 mg/kg is unusually high, even for a mining site. The RI

report indicates that the maximum arsenic concentration in the background dataset is 421 mg/kg, which is extremely high for a background area and seems like an outlier. Data evaluation such as a simple histogram of the background arsenic concentrations to look for outliers may be useful, and, if appropriate, eliminating outliers from the dataset and recalculating a background value. Consideration of other existing data (such as arsenic data from areas RSAR -A, B, C, D, E, F) may be warranted.

Consideration should be given to the best way to present human health risk estimates (i.e., total risks with discussion of background risks and how that is used in the FS and ROD versus incremental risks as presently shown).

EPA RESPONSE: A complete response to the components of this comment have already been given in response to ADEQ Comment No. 6. We disagree with the assertion that the background is unjustifiably high given extensive available data. The description and justification for the methods used to calculate the UTL for arsenic are presented in the response to General Comment #6, including the identification and treatment of outliers. A systematic approach was taken to select which data should be considered part of the background data set (see Appendix E). As indicated, the statistical approaches used to define background concentrations were considered standard for the practice, employing the EPA ProUCL software package and associated distributional assumptions.

12. The report states “If the lead concentrations in environmental media result in a predicted blood-lead level of 10 micrograms per deciliter ($\mu\text{g}/\text{dL}$) in greater than 5 percent of the potentially exposed population, then EPA recommends that actions be taken to significantly minimize or eliminate this exposure to lead.” It should be noted ADHS provides follow-up education to children when blood lead levels are above the CDC’s 2012 reference level of 5 $\mu\text{g}/\text{dL}$ since 2015. This is less than the fetal blood concentration of 10 $\mu\text{g}/\text{dL}$ formerly used by CDC and still accepted by EPA.

EPA RESPONSE: Section 9.6.3 acknowledges that the science and methods for assessment of risk from lead exposure is evolving. The HHRA includes an evaluation of lead using both the current residential Regional Screening Level (RSL) value of 400 mg/kg and a “provisional RSL” (that is, not yet formally adopted) of 140 mg/kg. The HHRA provides the results for both the current and provisional values for lead in Table 9-10.

Lead concentrations detected in soil are compared to both the current RSL and the “provisional RSL” to produce a range of the potential adverse effects from lead exposure, allowing for informed risk management decisions.

It should be noted that the provisional screening value has not been fully promulgated by EPA and is currently under review. As such, this value is not yet intended for general application. The impact of further regulatory developments related to lead exposure risk assessment will be revisited periodically (including as part of the 5-year review process).

13. More stringent State environmental applicable or relevant and appropriate requirements (ARARs) for all media for the site are completely absent from the document.

EPA RESPONSE: Potential ARARs are identified and evaluated in the Feasibility Study. EPA has now proceeded with the FS and provided ADEQ with a list of initial potential ARARs for IKHS. Potential ARARs will be further refined as defined alternatives are developed, with additional consultation with the State. ARARs are not ultimately selected until the ROD is issued.

14. In instances where duplicates were collected, the report lacks clarity on how the data were used. For instance, was the parent sample used to characterize regardless of whether it was greater than the duplicate and if relative percent differences were addressed for parent and duplicates.

EPA RESPONSE: The treatment of duplicates is presented in Section 6.1.3.1, and on page 6-5 it is stated that the higher concentration of a duplicate pair was used in all cases. This is also repeated in Section 9.3.2.

15. In accordance with the Arizona Revised Statutes (A.R.S.) section 32-125 and Arizona Administrative Code (A.A.C.) R-4-30-304, final documents must have the seal and signature of an Arizona registrant. If there is a Federal provision which preempts or supersedes this requirement, a citation should be provided within the report or amended to the report and copy of the citation to ADEQ for review and concurrence.

EPA RESPONSE: We do not understand to what this comment applies. What final documents are referred to?

16. The lead and asbestos survey for the remaining on-site structures should move forward with the remedial action.

EPA RESPONSE: During the FS an asbestos survey has taken place for the remaining structures. No asbestos has been found.

Specific Comments

1. **Executive Summary, Page ES-5, 1st Bullet under Screening Levels, throughout.** This bullet lists the soil screening levels used in the development of nature and extent of contamination at the Site. The list of soil screening levels is limited to EPA Regional Screening Levels. Consideration should also have been given to State of Arizona Soil Remediation Levels (SRLs) as presented in Appendix A of the Arizona Administrative Code Title 18 Chapter 7 for completeness.

EPA Response: Although there are always different approaches and screening levels that can be used to evaluate nature and extent of contamination, we believe that the RI Report provides a systematic evaluation of the data generated during the RI that effectively delineates the nature and extent of contamination associated with the IKHS Site. While the prescribed State of Arizona Screening Level for arsenic (10 mg/kg) is far below background, these levels and the State process of developing risk-based levels is being considered during the ARAR process in the Feasibility Study.

2. **Executive Summary, Figures ES-2, ES-5, ES-8 and ES-9.** These figures present the limits of the Area of Potential Site Impact (APSI) and the distribution of arsenic and lead in surface soils. Given that Site contaminants were transported by various means including smelter stack discharges and distribution of windblown tailings, it would have been helpful to have a

wind rose included on these figures (and other similar figures in the main document sections) to assist the reader visualize the possible transport mechanisms for contaminants at the Site.

EPA RESPONSE: Wind rose diagrams were produced during the earlier stages of the RI and are provided in Appendix N.

3. **Section 7.2.1.1, NR17 Main Tailing Pile, Page 7-9, 5th Paragraph.** Based on the text it does not appear that there was indication of slimes in the limited number of soil borings completed within the tailings. These low strength materials could pose constructability and long-term stability issues of regraded slopes if present.

EPA RESPONSE: This point is acknowledged. Three borings by Tetra Tech in November 2018 indicated the tailings consisted of interbedded low plasticity clay and silt with occasional lenses of wetter tailings slime lenses. The tailings slime lenses were less than 1 centimeter thick. Tetra Tech is evaluating tailing slime layers with regard to constructability and long-term stability issues as part of the FS.

4. **Section 9.3.1, Data Used in Baseline HHRA, Page 9-3, 4th paragraph.** This paragraph introduces the fact that groundwater is not considered in this HHRA and justifies this approach by stating that “1) site related impacts to groundwater appear to be confined to the former Iron King Mine and Humboldt Smelter properties and the area between them; and 2) regional groundwater quality includes naturally elevated arsenic, and local domestic water quality may be affected by septic systems and other non-mine related activities.” Eliminating a media and associated pathways from consideration in a baseline HHRA without a more complete evaluation of pathway is not consistent with the goals and objectives of a baseline HHRA. Especially since the first justification does not present an obvious reason for discounting the groundwater medium in an area that represents a substantial portion of the study area. In addition, the failure to include any incremental risk presented from the groundwater medium in the areas where groundwater is known to be impacted by site activities is inconsistent with the approach taken with other media. Since the additive risk is being evaluated in this HHRA (Section 9.6.1, Page 9-20) it is possible that inclusion of incremental risk from groundwater could change the total estimated risk for several of the designated exposure areas. This decision to eliminate groundwater from consideration in the HHRA should be more thoroughly explained and justified or groundwater incremental risks should be calculated and included in the assessment.

EPA RESPONSE: Groundwater is not included in the HHRA primarily because the conclusion of the RI is that groundwater is not affected by site-related contamination, with the exception of sulfate (which has no MCL) near downgradient of the mine; arsenic only immediately across the highway from the mine tailings pile; and chloride, nitrate, and TDS at the former smelter property. These effects are confined to the former Iron King Mine and Humboldt Smelter properties and the area between them. The key observations in the RI regarding groundwater are summarized in Section 11.2.4 of the RI. While investigation suggests that while sulfide oxidation processes are occurring in the tailings pile, neutralization potential and other factors are such that liberation of mobile mining metals to groundwater has not significantly occurred. Data derived from the combination of groundwater monitoring wells and private wells spatially distributed indicate that natural sources of arsenic are responsible for

sporadic elevated arsenic seen east of the river and south of the smelter, but more distant from the site.

The RI characterized the distribution of sulfate, a tracer of the sulfide oxidation process in the tailings pile. Sulfate is far more mobile in groundwater than the mine-related metals and presents a conservative trace of the mine impacts to groundwater. The sulfate concentrations in the townsite to the north and beyond are much lower than those found around the Site and are considered consistent with natural levels in the area. By contrast, trace elements like arsenic are highly variable in groundwater samples from the townsite area. The consistent absence of elevated sulfate in these samples indicates other sources of arsenic. The Report suggests likely candidate sources.

Regionally, groundwater impacts, including elevated arsenic concentrations in public and private wells and EPA bedrock monitoring wells, are associated with natural mineral sources in the area and not mining sources. Many of the private water supply wells northeast of the Site (to the east side of the Agua Fria River) and to the south of the former smelter property have arsenic concentrations exceeding the MCL, and in some cases, concentrations exceed 100 micrograms per Liter. These are areas where naturally-elevated concentrations of arsenic and other metals have been detected in soil and rock outcrops. Private wells typically are screened between the surface and about 300 feet and can intercept water from geologic veins high in metals. These areas would not be subject to groundwater transport of site-related contamination.

Given the essential lack of groundwater site impact to areas of groundwater exposure, the confounding influence of natural arsenic in groundwater, the lack of an apparent significant site impact on groundwater, and that soil is the predominant medium affected by mine-related releases at Iron King Mine, risk management decisions for soil are being made independently from consideration of groundwater.

5. Section 9.3.2.1, Use of X-Ray Fluorescence Data for Risk Assessment, Page 9-5, 1st paragraph. The last sentence in this paragraph is unclear, please revise.
6. Section 9.4.1, Potentially Complete Human Exposure Pathways and Receptors, Page 9-6, throughout. The exclusion of the sediment/surface water direct contact exposure from the residential exposure scenario is not sufficiently justified. Given that residential land use is included in areas surrounding the Agua Fria River it would seem reasonable to include residential exposure to both sediment and surface water. This assumption should be more completely explained and justified.

EPA RESPONSE: When human receptors (including those visiting the Agua Fria River that may also be nearby residents) encounter surface water and sediment, they are addressed as recreational receptors and risks are estimated separately from residential exposures. Given that residents by default are assumed to be exposed at home every day of the week for 26 years, assuming they are also simultaneously exposed as recreators at the river is likely overly conservative. For this reason, a recreator (conservatively evaluated as a 10-year old juvenile) was considered as a separate receptor type. The risk estimates are provided in the HHRA for both residents and recreators, so if a reader of the HHRA chooses, they can sum the two to determine a worst-case estimate of risk.

7. **Section 9.4.3, Human Exposure Area, Page 9-9, throughout.** The subdivision of the site into many exposure areas is thorough and likely improves the applicability of calculated risk. However, when this approach is carried to the extent applied here the unintended consequence is to create a fairly complex risk management scenario. While not incorrect or inappropriate taken on its own the managers involved in implementing any future risk management efforts should be comfortable that this exposure area approach results in a manageable risk management plan.

EPA RESPONSE: This point is acknowledged and EPA has begun to make adjustments and refinements to certain exposure areas while constructing feasibility study alternatives. These are being discussed with ADEQ and are reflected in the FS Strategy Technical Memorandum issued to ADEQ in January. For example, the areas north and south of the Tailings pile can be split into multiple areas based on where data indicate that controls on commercial use versus only residential use may be needed, and where excavation may be beneficial versus unfeasible. After adjusting boundaries of areas for these factors, it can then be useful to examine color concentration dot plots and recalculate risks for a given area assuming certain points are remediated and removed, for example. In short, the risk management area approach taken in the HHRA in the RI was not the final word on risk area management for some parts of the site.

8. **Section 11.5.1, Conclusions, Page 11-17, Iron King Mine Property Bullet List.** The remedial alternatives should also address any remaining open mine workings (i.e. shaft and adits) as they pose an imminent threat to public and remedial worker safety.

EPA RESPONSE: Comment noted; the FS is examining options for open mine workings. There are essentially two: a single adit below the Galena Gulch waste rock wall, and a shaft above and a little south of the waste rock wall.

9. **Section 11.5.1, Conclusions, Page 11-18, Humboldt Smelter Property Bullet List.** The remedial alternatives should also include the safe removal of unstable structures such as the smelter stack and flue and other remaining infrastructure that pose a risk of collapse.

EPA RESPONSE: Comment noted; the FS will consider removal of unstable structures. This is complicated by the fact that some members of the community would like to preserve the structures for historical reasons, while others believe they are a hazard and should be removed. It may be impractical to save them given their poor condition and that removal of the wastes around them may require their removal anyway.

10. **Section 11.5.2, Data Limitations and Recommendations for Future Work, Page 11-19, MTP Stability Analysis Bullet.** Consideration should be given to completing additional investigations (i.e., geophysical and/or Cone Penetration Testing) during the preparation of the FS to confirm the absence of tailings slimes within the main tailings pile. As mentioned previously, these materials if present could complicate construction activities and are a concern for long-term stability of the main tailings pile.

EPA RESPONSE: As previously mentioned, three borings by Tetra Tech in November 2018 confirmed the presence of slime lenses. Feasibility Study efforts are considering slimes as a potential constructability issue for remedial alternatives.

Figure 1

