From:	Karin L. Harker
To:	DHONT, JEFF
Cc:	Brian J. Stonebrink; John Peterson; Mike Gronseth; Hsin-I Cox; Eric Thomas
Subject:	IKM - ADEQ Evaluation Letter of the RI Report
Date:	Wednesday, January 17, 2018 3:04:15 PM
Attachments:	IKM 9-2016 ADEQ Evaluation on the Final Remedial Investigation Report 1.17.18.docx IKM 9-2016 ADEQ Evaluation on the Final Remedial Investigation Report 1.17.18.pdf

Jeff,

The ADEQ Federal Projects Unit appreciates the opportunity to review the Remedial Investigation Report for Iron King Mine-Humboldt Smelter Superfund Site, Dewey-Humboldt, Yavapai County, Arizona, prepared by CH2M Hill, dated September 2016. Please find the attached evaluation letter (Ref. FPU 18-005) regarding our review in addition to being mailed tomorrow.

Please contact me or John Peterson with any questions regarding this correspondence.

Sincerely,

Karin Harker
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Federal Projects Unit, Waste Programs Division
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602.771.0361

Douglas A. Ducey
Governor

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Misael Cabrera
Director

VIA EMAIL AND U.S. MAIL

January 17, 2018
FPU 18-005

Mr. Jeff Dhont
Environmental Scientist / Superfund Project Manager
U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street, Mail Stop SFD-6-2
San Francisco, CA 94105

Re: IKM, ADEQ Evaluation of the *Remedial Investigation Report, Iron King Mine – Humboldt Smelter Superfund Site, Dewey-Humboldt, Yavapai County, Arizona,* prepared for U.S. Environmental Protection Agency, Region 9, prepared by CH2M HILL, Inc., dated September 2016

Dear Mr. Dhont:

The Arizona Department of Environmental Quality's (ADEQ) Federal Projects Unit (FPU) in consultation with the Arizona Department of Health Services (ADHS) has completed a review of the above referenced document and submits the following comments. Please note the following 1) it is our understanding that the report is final and there are limited opportunities to revise the document. Therefore, ADEQ has limited our review to overall completeness and usefulness during upcoming stages of the CERCLA process, particularly the Feasibility Study (FS) and Remedial Design (RD); and 2) the report findings and conclusions of this letter are in concurrence with ADHS.

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.

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.

   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. 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.

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.

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.

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.

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 are 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.

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 Mine[1] has measured bioavailability closer to the 60% range[2]. 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

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.

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).

12. The report states "If the lead concentrations in environmental media result in a predicted blood-lead level of 10 micrograms per deciliter (µg/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 µg/dL since 2015. This is less than the fetal blood concentration of 10 µg/dL formerly used by CDC and still accepted by EPA.

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

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

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.
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.
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 were 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.
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.

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.
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.
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.
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.
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.

Should you have any questions or consider a clarification meeting necessary regarding this correspondence, please do not hesitate to contact me at (602) 771-0361 or harker.karin@azdeq.gov.

Sincerely,

Karin Harker
Project Manager, FPU
Remedial Projects Section
Waste Programs Division, ADEQ

cc: Brian Stonebrink, ADEQ (via email)
John Peterson, ADEQ (via email)

Mike Gronseth, Matrix Design Group, Inc. (via email)
Hsini Lin, ADHS (via email)
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Project and Reading File