ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Governor

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Sent via U.S. Mail

March 5, 2019
VRP 19-168

Mr. David Rhoades
President and General Manager
Freeport-McMoRan Sierrita Inc.
PO Box 527
Green Valley, AZ 85614-0527

RE: Review of 2018 Revised *Baseline Human Health Risk Assessment*
Freeport Sierrita Mine, 6200 W. Duvall Mine Road, Green Valley, Arizona
VRP Site Code: 100073-03

Dear Mr. Rhoades:

The Arizona Department of Environmental Quality (ADEQ) Voluntary Remediation Program (VRP) has reviewed the *Baseline Human Health Risk Assessment* (BHHRA), dated November 2018. The BHHRA was prepared by Arcadis U.S., Inc. (Arcadis) on behalf of Freeport-McMoRan Inc. Sierrita Operations (FMI) for the FMI Sierrita Mine, located at 6200 West Duval Mine Road in Green Valley, Arizona. The comments presented herein were prepared by the VRP and ADEQ's third party risk assessor, The Fehling Group, LLC, (TFG), with support from Neptune and Company, Inc. Please note, there is insufficient areal characterization to support a residential risk scenario[1]. However, if the following comments are addressed, VRP concurrence on the conclusions of the BHHRA for a worker scenario is attainable.

General Comment

The overarching concern identified in the BHHRA is the lack of background comparisons to specifically remove constituents of interest (COIs), identified as attributable to background, from the BHHRA. Consequently, the soil carcinogenic risk assessment for these specific areas includes uranium and radium isotopes, which have been identified as present near background levels in the 2018 *Background Soil Assessment Report*. The inclusion of these radionuclides in the risk calculations potentially conflates risks from naturally-occurring soil constituents with risk presented by Site-related contaminants and masks the impacts of operations-related contaminants of concern (COCs). This approach is inconsistent with United States Environmental Protection Agency (USEPA) guidance which states only contaminants identified as sourced from site-related operations/impacts should be included in risk assessment calculations[2]. As such, the BHHRA should remove COIs present at concentrations consistent with background from the risk calculations.

[1] The BHHRA will not be approved for a residential scenario given additional data gaps in the BHHRA which are not addressed in this letter.

[2] U.S. Environmental Protection Agency (USEPA), 1989. Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual (Part A), Interim Final. EPA, Office of Emergency and Remedial Response. December. http://www.epa.gov/oswer/riskassessment/ragsa/pdf/rags-vol1-pta_complete.pdf.

Specific Comments

1. **Radionuclides in the BHHRA**

The radionuclide COIs included in the BHHRA are [uranium isotopes] U-234, U-235, U-238, and [radium isotopes] Ra-226, and Ra-228. Given the emphasis of groundwater characterization on identification of COIs, as identified in the BHHRA, it is assumed the selection of the radionuclide COIs was driven by a need for evaluation of uranium and combined Ra-226 and Ra-228 pursuant to compliance with Arizona Administrative Code (A.A.C.) Title 18, Chapter 11. However, for the purposes of the BHHRA, a substantial basis for identifying the radionuclide COIs for the soil risk assessments, particularly Ra-228, has not been provided. Ra-228 is a member of the thorium (Th) decay series; specifically, Ra-228 is the relatively short-lived progeny of the primordial radionuclide Th-232. Because of its short half-life, Ra-228 exists in secular equilibrium with its parent (Th-232), and also with Th-228. It is therefore incorrect to evaluate risks related to Ra-228 in soil without considering Th-232 and Th-228, which will be present at approximately the same activity-concentration as Ra-228. If thorium-series radionuclides are potentially Site-related COIs in soil, then analytical data for Th-232 and Th-228 in soil should have been acquired to support the risk assessment.

However, as indicated in the **General Comment**, the inclusion of radionuclides in the BHHRA risk calculations, when supporting evidence has been provided to show they are likely present at background levels, is inappropriate and potentially masks risks presented by operations-related COCs.

2. Uranium Isotope Ratios

Section 2.4.1.4 of the BHHRA states, "*The uranium activity ratio (U-234/U-238) averaged 1.0 for all samples collected shallower than two ft bgs; deeper samples were not analyzed for isotopic uranium. This confirms that the materials sampled have not been appreciably affected by anthropogenic activities such as milling or leaching or undergone appreciable natural leaching due to meteoric precipitation.*" Milling, leaching, or other such processes will not impact the ratio of U-234 and U-238 in solid materials. The fact that U-234 and U-238 are in secular equilibrium cannot be used to infer background sampling locations have not been impacted by such activity. This is an erroneous statement that suggests a lack of understanding of radionuclide abundance, and anthropogenic effects. Differences in activities within a decay series are possible by element, but not in the case of isotopes of an element that are adjacent in the same decay series.

Any Site-related release of uranium would result in greater concentrations of all isotopes relative to background. As previously noted, the omission of Th-232 and Th-228 from the BHHRA (presumably due to primary focus on A.A.C. Title 18, Chapter 11 regulations in prior investigative efforts) could represent an evaluation gap if thorium-series radionuclides are plausible COIs. Isotopes in the uranium and thorium series might be expected to exist in approximate secular equilibrium in both Site and background samples, and any deviations from that expectation evident in the data would need to be explained in the BHHRA. However, as previously indicated, FMI would only need to address this concern if radionuclides were to remain in the BHHRA calculations.

3. Use of Background Data in the BHHRA

As indicated in the **General Comment**, only Site-related (operations-related) COCs should be included in the risk assessment calculations. Background data should be used to support a statistical and graphical comparison of Site-related concentrations to background concentrations to identify Site-related COCs in all relevant exposure media. The BHHRA should then be narrowed in focus to the Site-related COCs. Box-and-whisker plots, such as those provided in Figure 4 through Figure 13 of the 2018 *Background Soil Assessment Report*, and statistical comparisons of background and Site concentrations, should be used to identify Site-related contaminants. The usability of the data for background comparisons should

be described and applied in context of the many different geologic units described in the *Background Soil Assessment Report*. Furthermore, the comparability of data from the various sampling campaigns must be addressed, either in the BHHRA or by reference to previous data evaluation.

4. Evaluation of Background Risks and Choice of UCLs

Although appropriate, pursuant to A.A.C. R18-7-204 (the "Soil Rule"), to use the 95th percentile upper confidence limit (UCL) for remediation to background levels, it is not appropriate to use 95th UCLs in background risk calculations. Per the USEPA guidance cited in Section 4 of the BHHRA, the purpose of using a UCL in a deterministic risk calculation is to provide a protective estimate of the average Site exposure point concentration (EPC). There is no comparable purpose to using a UCL to represent background. The simple average should be used in the calculation of background risks. As an alternative to separate calculations of Site and background risk, statistical methods could be employed to develop distributions of the increment of Site concentrations above background from which a statistic analogous to a 95th UCLs can be derived. This would require a probabilistic risk assessment, at least where concentrations are concerned.

In its 1989 guidance, USEPA understood the complicating issue that UCLs are driven in part by sample size, and hence disavowed direct subtraction of background risks from Site risks using UCLs. However, in the BHHRA, statements are made regarding the increment of Site risk above background based on UCLs. It is perhaps reasonable to compare risk estimates based on the means, but it is not appropriate to subtract background risks from Site risks derived from UCLs, as is implied in the BHHRA.

Specifically, the UCL estimates of average background concentrations are likely to be biased high in comparison to Site shallow soil UCL estimates of the average as an artifact of sample sizes. For example, the background sample size for the 0 to 0.5 foot interval (13 samples, Section 3.1.5) is much smaller than sample sizes for 0 to 0.5 foot and 0 to 2 foot surface soil intervals used in the Site risk assessment calculations for COCs (Table 5-4, 46 samples; Table 5-5, 32 samples; Table 5-6, 89 samples; Table 5-7, 66 samples; Table 5-8, 149 samples; Table 5-9, 33 samples; Table 5-10, 195 samples; Table 5-11, 68 samples). Because of the disparity in sample size, the magnitude of UCL concentrations relative to the mean for background soil could be larger than for Site soils.

Lastly, the BHHRA does not make it clear which UCLs were selected from the ProUCL software. Perhaps the recommended value was always used, but sometimes there is more than one recommended value. In general, ProUCL recommends conservative estimates of the mean (selection of high estimates of a 95th % UCL of the mean from among multiple such estimates calculating using different assumptions and statistical methods). Use of a high estimate of the 95th UCL would be particularly inappropriate for representing background EPCs, and as described in the preceding paragraph this could be exacerbated by the fact that background UCLs were generally estimated using fewer samples than Site UCLs.

5. Soil Adherence Rate: Table 6-1

A soil adherence rate of 0.3 milligrams per square centimeter should be used for consistency with Section 3.2.3 of the Arizona Department of Health Services' 2003 *Deterministic Risk Assessment Guidance*.

6. Adult Lead Evaluation

The reference to background blood lead concentration (PbBo) and geometric standard deviation parameter (GSDi) is incorrect in the tables from Appendix E. The reference is to National Health and Nutrition Examination Survey (NHANES) 1999-2004, but the values are actually from NHANES 2009-2014, which is appropriate as it is the most recent set of values.

Upon review of the comments presented herein, FMI and Arcadis are urged to bring any questions or concerns to the meeting scheduled at ADEQ on March 12, 2019. Revisions and responses to the BHHRA may be made on a schedule developed by FMI, and can be provided to the VRP in future communications.

Regards,

Joey Pace, Project Manager
Voluntary Remediation Program

cc: Dave Gosen, FMI – *sent via email*
William Hart, FMI – *sent via email*
Katy Brantingham, ARCADIS – *sent via email*
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