

EXECUTIVE SUMMARY

A site-specific human health risk assessment (risk assessment) was conducted in 2007 and 2008 to address the potential that exposure to metals in soil might result in adverse health effects to children and adults living in the Northwest Study Area (Study Area). The Study Area is located in the Town of Superior, Arizona alongside the historic copper mine and ore processing facility currently referred to as the “West Plant Site.”

The Study Area encompasses approximately 45 acres. Although it is primarily residential in nature, the Study Area includes two business establishments, two churches, the Town of Superior’s police station, the Town of Superior’s vehicle maintenance facility, the Superior School District’s bus maintenance facility, the Arizona Department of Transportation’s district office, and a large number of vacant properties.

The risk assessment was conducted by Brown and Caldwell and Exponent on behalf of BHP Copper Inc. (BHP Copper). The risk assessment process and assumptions were developed in cooperation with the Arizona Department of Environmental Quality’s (ADEQ) Voluntary Remediation Program (VRP) and in accordance with the Arizona Soil Remediation Standards (Arizona Administrative Code [A.A.C.], Title 18, Chapter 7, Article 2).

Background

The risk assessment is referred to as the “Phase IV Risk Assessment” in recognition that it is based on the fourth phase of sampling and analysis conducted in the Study Area by Brown and Caldwell, on behalf of BHP Copper. The first three phases of sample collection and analysis were conducted in 2004 to characterize the distribution of metals in Study Area soil resulting in the collection of 283 samples.

The 2004 site characterization was precipitated by a report of elevated concentrations of arsenic and copper in a residential area

next to the West Plant Site. The report was prepared by ADEQ on behalf of the United States Environmental Protection Agency (USEPA). The report did not identify the source of the metals, but noted that a major tailings release had occurred in 1993 that had caused tailings to flow from the West Plant Site into an adjacent residential area.

Promptly following the 1993 release, the Magma Mining Company, owner of the West Plant Site, removed visible tailings from the residential area and capped the tailings that were stored on site to prevent future releases. The boundaries of the Study Area were selected to encompass the area where tailings were removed in 1993, as well as areas upstream and downstream of the tailings release.

A draft area-wide risk assessment conducted in 2004 indicated that the levels of cancer risk associated with the arsenic that had been detected in soil within the Study Area were within the acceptable risk range established in state and federal regulations. After discussing the results of the area-wide risk assessment with ADEQ personnel, BHP Copper volunteered to collect more soil samples and conduct a more detailed risk assessment on a property-by-property basis. A work plan for that assessment, the Phase IV Work Plan, was developed by Brown and Caldwell and approved by ADEQ in 2007.

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Phase IV Sampling

In accordance with the Phase IV Work Plan, BHP Copper attempted to obtain a signed access agreement from the owner or tenant of each property in the Study Area. Access agreements were obtained for 118 properties. Also in accordance with the Phase IV Work Plan, Brown

and Caldwell attempted to obtain three composite surface samples, each comprised of ten discrete samples, from each property covered by a signed access agreement. Brown and Caldwell also attempted to obtain three discrete samples (one surface and two subsurface) from borings at 27 locations within the Study Area.

Three composite samples were obtained from 109 of the 118 sampled properties. Due to limited accessibility, only two composite samples per property could be obtained from seven properties, and only one composite sample per property could be obtained from two properties. A total of 343 composite samples, consisting of 3,430 discrete samples, were collected in the Study Area. In addition, 73 samples were collected from the 27 boring locations. Due to subsurface rock formations, eight subsurface soil samples could not be obtained.

All samples were analyzed for arsenic. Samples were analyzed for copper, lead, and manganese if they were collected from areas where previous studies indicated a potential that the metals might be present at concentrations equal to or in excess of the residential soil remediation levels (SRLs) listed in Appendix A of the Arizona Soil Remediation Standards. Arsenic was detected at a concentration equal to or above its residential SRL in most composite samples; lead was detected at a concentration equal to or above its residential SRL in 7 of 93 composite samples; copper was detected at a concentration equal to or above its residential SRL in 5 of 110 composite samples; and manganese was detected at a concentration equal to or above its residential SRL in 2 of 38 composite samples.

Risk Assessment

Although residential SRLs are health-based concentrations considered safe for a lifetime of exposure by children and adults, the presence of concentrations above the residential SRLs does not necessarily indicate a concern for human health. Rather, the presence of concentrations above the residential SRLs indicates that further evaluation is warranted. Accordingly, arsenic, copper, lead, and

manganese were considered chemicals of potential concern (COPCs) and were evaluated in this risk assessment.

The Arizona Soil Remediation Standards provide that persons remediating soil may remediate to background remediation standards, to pre-determined remediation standards (SRLs), or to a site-specific remediation standard (A.A.C. R18-7-203(A)). BHP Copper has agreed to excavate copper, lead, and manganese to the pre-determined, residential SRLs and to excavate arsenic to a site-specific remediation standard. Pursuant to the requirements of A.A.C. R18-7-206(A), a site-specific remediation level must be derived from a site-specific risk assessment. The results of a site-specific risk assessment are to be expressed in terms of a cumulative excess lifetime cancer risk (CELCR) for carcinogenic chemicals or a hazard index (HI) for non-carcinogenic chemicals (A.A.C. R18-7-206(D)).

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Pursuant to A.A.C. R18-7-206(D), remediation to a site-specific remediation level requires that the contaminants in soil be remediated to an HI no greater than 1 and a CELCR of 1×10^{-6} (1 in 1,000,000) to 1×10^{-4} (1 in 10,000).

Arsenic is the only COPC identified in the Study Area that is carcinogenic. The calculated CELCR for each property in the Study Area is within the risk management range of 1×10^{-6} (1 in 1,000,000) to 1×10^{-4} (1 in 10,000) as set forth in A.A.C. R18-7-206(D). The highest CELCR was 8×10^{-5} (8 in 100,000). For comparison, an individual's lifetime probability of contracting cancer is 1 in 4.

Copper, lead, and manganese, as well as arsenic, exhibit non-carcinogenic effects. The results of the HI calculations are expressed

in terms of hazard quotients (HQs) because, as explained in Section 6, A.A.C. R18-7-201.20 specifies that an HI is the sum of HQs of chemicals acting by a similar mechanism and/or on the same target organ. Because arsenic, copper, and manganese do not affect the same organ or act by a similar mechanism at the levels found in the Study Area, their non-cancer hazard levels are reported in terms of HQs. Hazard quotient and HI calculations are not applicable to lead. The health effects for lead were assessed by comparing soil concentrations with the Arizona SRL. Additive effects for arsenic, copper, manganese, and lead were considered as well, and none of the chemicals were found to be additive according to USEPA guidance.

Site-Specific Factors

A.A.C. R18-7-206(D) requires evaluation of the following site-specific factors when determining a CELCR for site remediation:

- The presence of multiple contaminants.
- The existence of multiple pathways of exposure.
- The uncertainty of exposure.
- The sensitivity of the exposed population.
- Other program-related laws and regulations that may apply. Each of the above factors were addressed in a conservative manner in the risk assessment to obtain full use of the risk range and to ensure that actual risk, if any risk is present, will be less than the calculated risk. Each factor is briefly discussed below. ***The presence of multiple contaminants.*** There is a high level of confidence that additive and synergistic effects among the COPCs are minimal. First, the site characterization was designed to identify all relevant COPCs. In the soil samples that were analyzed for 19 metals and cyanide in 2004, only arsenic, copper, lead, and manganese were reported at concentrations

above their respective residential SRLs. Second, at the concentrations present in the Study Area, the COPCs (arsenic, copper, and manganese) do not affect the same organs or act by a similar mechanism. As discussed in Section 3.2, lead health effects are assessed differently from the other chemicals and are not considered additive. Therefore, additive or synergistic effects of the COPCs are not a concern at the levels present.

The existence of multiple pathways of exposure. All potentially complete exposure pathways (ingestion of outdoor soil and indoor dust, inhalation of soil, and dermal contact with soil) were included in the risk assessment. The scientific evidence indicates that soil ingestion is the dominant pathway of exposure. Thus, possible exposure from ES-3

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other pathways contributes little additional exposure. Even so, dermal absorption through the skin and inhalation of re-suspended dust were included in this risk assessment. Because all potentially complete exposure pathways were included in the risk assessment, there is a high level of confidence that the calculated risk levels do not underestimate actual risk.

The uncertainty of exposure.

The exposure concentrations used in the risk assessment are highly representative of concentrations to which people in the Study Area might be exposed. Composite samples were collected during the 2007/2008 sampling program to ensure that samples would be representative of all exposed soil on each property. The sampling density of the exposed surface soil is greater than 76 discrete samples per acre. With very few exceptions where the residents did not want portions of their yards sampled, the sampling grids covered all

accessible soil on every sampled property. Ten discrete samples were combined for each composite sample and three composite samples were typically collected from each property.

Exposure assumptions used in the risk assessment are realistic but may be biased high. For example, the value used in this risk assessment for dermal absorption (1 to 3 percent) is biased high according to recent scientific research. Furthermore, in accordance with A.A.C. R18-7-206(B)(2), the cancer risks represent the 95th percentile of the upper bound estimate of the distribution of risk generated by the probabilistic risk assessment. Thus, the estimates of risk are based on the upper end of calculated results, which are based on conservative exposure assumptions.

The representative sampling and conservative exposure assumptions described above provide a high level of confidence that the calculated risk levels do not underestimate actual risk.

The sensitivity of the exposed population.

USEPA risk assessment exposure equations and toxicity factors used in the risk assessment are designed to address certain sensitive populations including children. Furthermore, there is a high level of confidence that the USEPA toxicity factors over-estimate the toxicity of arsenic in people in the United States, including those in the Study Area.

Other program-related laws and regulations that may apply.

Brown and Caldwell and Exponent are not aware of program-related laws and regulations, other than those discussed in the risk assessment report, which may apply to the risk assessment.

CONCLUSIONS

BHP Copper has agreed to excavate copper, lead, and manganese to the pre-determined, residential SRLs, and to excavate arsenic to a site-specific remediation standard. Site-specific risk calculations have

been performed for each sampled property in the Study Area that address all site-specific factors as required in A.A.C. R18-7-206(D), and utilize conservative assumptions suggested by ADEQ's contract toxicologist. The risk calculations include all potentially complete exposure pathways and are based on representative exposure concentrations, conservative exposure assumptions, and conservative toxicity factors, thus minimizing the uncertainty and establishing a high level of confidence in the results. The risk assessment indicates that the CELCRs for all properties are within the allowable risk range set forth in A.A.C. R18-7-206(D) and that the allowable HQ of 1 is met for arsenic in all but two properties, on which the arsenic HQ is 2.