UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 7
11201 Renner Boulevard
Lenexa, Kansas 66219

ACTION MEMORANDUM

SUBJECT: Approval for Time-Critical Removal Action at the Missouri Mining Investments Property Portion of Operable Unit 2, Former Anschutz Mine Site, Madison County Mines Superfund Site, Madison County, Missouri

FROM: Kurt Limesand, Remedial Project Manager
Lead Mining and Special Emphasis Branch

THRU: Preston Law, Chief
Lead Mining and Special Emphasis Branch

TO: Mary P. Peterson, Director
Superfund Division

Site Name:	Missouri Mining Investments Property Portion of Operable Unit 2, Former Anschutz Mine Site, Madison County Mines Superfund Site
CERCLIS ID:	MOD098633415
Lat/Long:	37.550761, -90.278753
Category of Removal:	Respondent-Lead Time-Critical

I. PURPOSE

The purpose of this Action Memorandum is to request and document management approval of a Respondent-Lead Time-Critical Removal Action at a portion of the Anschutz Mine sub-site in Madison County, Missouri, identified as Operable Unit 2, or OU2, of the Madison County Mines Site. The Respondent, Missouri Mining Investments, LLC, a Missouri Corporation, has purchased the property with the intent of performing surface cleanup on the portion of the property it acquired and redeveloping the mine on a short timeline. The Respondent has tasked Environmental Operations Inc., or EOI, with the characterization and cleanup actions within the boundaries of its purchased property (hereinafter, "the Site"), a subset of the overall OU2 of the Madison County Mines National Priorities List Site. EOI has developed a Supplemental Investigation Work Plan and a Preliminary Early Removal Action Work Plan to characterize, consolidate and cap wastes including contaminated soils and contaminated sediments on site at OU2 to stabilize the contaminants and mitigate their migration off site via surface water runoff and wind erosion.

II. SITE CONDITIONS AND BACKGROUND

A. Site Description

Mining at the Southeast Missouri Lead Mining District began in the 1700s following the discovery of shallow surface deposits by French explorers. Sporadic mining occurred throughout the 18th century by hand digging of deposits near the surface. The Madison Mine was first developed for mining copper in 1844 but later was developed to produce lead, cobalt, nickel, iron and small amounts of zinc and silver. In 1902 the North American Lead Company was formed and took over the operations of the Madison Mine, and in 1903 constructed a 500-ton-per-day mill to produce lead. In 1907 a smelter and refinery were constructed at the Madison Mine to produce lead.

Missouri Cobalt Company purchased the Madison Mine in 1916. The mine was shut down during the depression in the 1930s. The National Lead Company, or NL, and its subsidiary, St. Louis Smelting and Refining Company, operated the Madison Mine through a combination of owned land and lease agreements with Missouri Cobalt from about 1943 until 1961. NL eventually acquired the holdings of Missouri Cobalt and connected the mines with a drift. NL constructed and operated an experimental metals refinery in a project with the U.S. Department of Defense Defense Plant Corporation, which held certain leasehold and surface rights at the refinery property.

Anschutz Mining Corporation purchased approximately 1,750 acres of the NL mining property southeast of the city of Fredericktown, Missouri, in 1979. The 200-acre area where most ore processing and milling operations have historically taken place is on the northern edge of the property and includes five main mine waste tailings piles, underground mine shafts, a wastewater pond, the remnants of an ore mill, roaster, smelter, and a metals refinery complex located outside of the property purchased by Anschutz and, in turn, by the Respondent.

In 1977, during NL's ownership, the D Tailings dam failed during a heavy rainfall event, causing tailings and floodwaters to flow down the Tollar Branch and through residential neighborhoods in Cobalt Village and Fredericktown, eventually flowing into Saline Creek. The breach was repaired, and in 1982 Anschutz constructed a new dam and outlet works after the Corps of Engineers determined the D Tailings dam was classified as an unsafe, emergency category structure.

The Respondent purchased the Anschutz property in February of 2018 and proposes to perform cleanup on that portion of OU2, "the Site", that falls within their property boundary as an initial step to redeveloping and re-opening the mine for metals production.

1. Removal Site Evaluation

Principal features of the Site include:

<u>Five Main Tailings Piles</u>: Tailings piles A, B, C, D and E are the primary sources of contamination at the Madison County Mines OU2 Site. The principal contaminants associated with the Site are elevated levels of metals, with lead being the primary contaminant. Anschutz, the former owner, performed unilateral capping of tailings piles A, B, C and E with clay but performed no subsequent maintenance. These tailings piles are heavily overgrown, and erosional features are apparent throughout the piles.

D Tailings Pile, Stormwater Pond, and Dam: The D Tailings Pile impoundment has a stormwater collection pond and dam with a constructed outfall outlined in the National Pollutant Discharge Elimination System, or NPDES, permit as Outfall 001. Outfall 001 is the headwaters for Tollar Branch that flows through Cobalt Village and Fredericktown into Saline Creek. A new containment dam at the D Tailings Pile was constructed to replace the original dam that failed in 1977, flooding the sections of Cobalt Village and Fredericktown along Tollar Branch and impacting residential and commercial properties. The D Tailings Pile dam is 40 feet tall and is inspected and permitted by the Missouri Department of Natural Resources, or MDNR.

Metallurgical Pond: The Metallurgical Pond has been receiving process wastes and contaminated surface runoff since 1885 and represents a significant ecological risk. Three separate seeps have been observed in the area, two approximately 100 yards below the dam and the other discharging from the base of the dam itself. All discharges and the constructed outfall combine at the NPDES Outfall 002 and form the headwaters of the unnamed tributary that flows through Fredericktown to Saline Creek. The Metallurgical Pond dam is 33 feet tall and does not meet the height requirements for an MDNR dam permit or inspection.

Historical Structures: The mill, smelter, smokestack and refinery complex date back to the early- to mid-1900s. Contamination from the historical use of the buildings and stack could add to the migration of hazardous substances off site. The mill is the only building still standing.

Miscellaneous Features: Other Site features of potential environmental interest have been identified by Anschutz and NL within the property now owned by the Respondent. Two dump areas, the "Top of Hill Dump Area" and "Snake Pit" area are identified in historical reports prepared for Anschutz, but little additional information on the exact location or nature of materials historically disposed in these features is available. Several ponds are also present, but the use of or potential disposal in these ponds is unknown. Piles of gangue rock are present around some of the newer mine shafts in the southern portion of the Respondent's property.

Investigations by the U.S. Environmental Protection Agency (the EPA), MDNR, the University of Missouri-Rolla, NL Industries Inc., and Anschutz have revealed significant lead levels in tailings on the Site and in soils adjacent to the Site. In addition, lead has been found in sediment, surface water, and aquatic life adjacent to the Site in the Tollar Branch, the unnamed tributary flowing off site from NPDES Outfall 002, Saline Creek, and the Little Saint Francis River. Other constituents of potential concern include aluminum, antimony, arsenic, cadmium, hexavalent chromium, cobalt, copper, iron, manganese, nickel, silver, thallium, vanadium, zinc, polynuclear aromatic hydrocarbons, polychlorinated biphenyl compounds and cyanide.

2. Physical Location

The Madison Mine is situated on the eastern edge of the Ozark Uplift within the Saint Francois Mountains, which exhibit a geologically mature landscape with rounded, poorly defined ridges. The Site is on the southeastern corner of the city of Fredericktown, Missouri, and is accessed from the business loop of Highway 67 and by Chambers Drive.

Based on the EPA Environmental Justice Screen tool and 2010 U.S. Census Bureau data, 2,635 persons live within a one-mile radius of the tailings piles, and the majority of those are downhill and downstream of the Metallurgical Pond or D Tailings dam. The nearest residence is within 500 feet of the tailings, and a day care facility is located less than 1,000 feet downstream of NPDES Outfall 002, along the unnamed tributary that drains the northern portion of the Site, including the former operations areas, the Metallurgical Pond, and the A, B, C and E Tailings. Cobalt Village and a portion of Fredericktown are downhill from the D Tailings dam. Tollar Branch Creek and the unnamed tributary at NPDES Outfall 002 originate on the property and drain through town to Saline Creek, which flows to its confluence with the Little Saint Francis River on the west side of Fredericktown.

The climate of Fredericktown is characterized by hot, humid summers and cold winters. In winter, the average temperature is 31.8° F and the average daily minimum is 20°. In summer, the average temperature is 74.5° and the average daily maximum is 88°. The total annual precipitation is about 43.45 inches. Of this, about 44 percent falls from May through September. The average seasonal snowfall is 14.8 inches. The prevailing wind is from the south between May and November and from the northwest the remainder of the year.

3. Site Characteristics

The primary features of interest are the heavily vegetated and partially covered A, B, C and E Tailings Piles and the uncapped D Tailings Pile. The D Tailings Pile consists of fine sand- and silt-sized material that is easily suspended in the air by wind erosion and airborne dust, and is highly erodible during rain events, which contributes to the spread of contamination at the Site. Similar material is exposed throughout the other piles due to deterioration of the caps.

4. Release or Threatened Release into the Environment of a Hazardous Substance, or Pollutant or Contaminant

The primary contaminants of concern at the Site are lead, cobalt, nickel and other metals. Terranext has reported on behalf of NL and Anschutz that an estimated 4,960,000 tons of mine tailings have been disposed on the property.

Releases of hazardous substances from the Site could occur because of wind and water erosion, sediment transport, catastrophic dam failures and leaching to groundwater.

5. National Priorities List Status

The Site is a portion of OU2 of the Madison County Mines Site. The Madison County Mines Site was placed on the National Priorities List, or NPL, in August 2003. OU2 includes the A, B, C, D and E Tailings Piles; the Metallurgical Pond; remnants of an old mill and smelter; headframe and abandoned shafts; a mine decline; a refinery complex; a chat pile; the abandoned Black Mountain spur right-of-way through Fredericktown; and all other areas affected by these mining activities. The Respondent has committed to address only issues within the purchased property pursuant to this Removal Action, which does not include the refinery complex, the railroad right-of-way, or off-site and downstream impacts to surface water, sediment or groundwater.

6. Map, Pictures, and Other Graphic Representations

A map depicting the Site is included as Attachment A.

B. Other Actions to Date

The original D Tailings Pile dam breached during heavy rainfall in 1977, releasing an estimated 20,000 tons of tailings down Tollar Branch Creek and inundating low-lying areas in Cobalt Village and Fredericktown.

In 1982, Anschutz constructed a new dam and outlet works in response to the U.S. Army Corps of Engineers determination that the Area D dam was classified as an unsafe emergency category structure. The improvements included construction of a downstream earthen sand wick dam for the D Tailings Pile, a concrete spillway, and a diversion berm to divert storm water runoff around the tailings area and through a diversion spillway.

In 1998, Anschutz performed site stabilization activities over the southern portion of the tailings piles. Implementation of the site stabilization was in response to the U.S. District Court Memorandum Opinion and Order in the matter between Anschutz and NL. In that order, the court ruled that "the site poses a significant threat to human health and the environment," "the parties must contain the contaminants," "the court finds no justification for a complete removal," and "both parties are compelled to prevent the spread of this contamination so that further damage ... will not occur." Principle features of the construction activities included slope and erosion reduction on Area C tailings; construction of a minimum four-inch clay cap on Areas A, B, C, and E; construction of drainage diversion berms to divert drainage from Area C to Area D; vegetation establishment in Areas A, B, C and E; and construction of security fencing around Areas A, B, C and E. Subsequent maintenance was not performed; much of the fencing has been stolen, and the caps are overgrown and heavily eroded.

In 2000, Anschutz undertook additional stabilization activities, including construction of an extension to the Metallurgical Pond to replace reservoir volume lost to sedimentation, and construction of stormwater diversion channels to direct runoff from the former metals refinery property (not owned by Anschutz) away from NPDES Outfall 002.

In 2003, Anschutz and NL entered into an Administrative Order on Consent to evaluate the need for a removal action along Tollar Branch Creek as a result of the 1977 D Tailings Pile dam breach.

C. State and Local Authorities' Roles

The EPA has a history of close coordination with MDNR and the Madison County Health Department. Quarterly Madison County Environmental Round Table meetings have been occurring since the late 1990s, are open to the public, and include representatives from multiple agencies including MDNR; the Missouri Department of Health and Senior Services, or MDHSS; the EPA; the Madison County Health Department; and Madison County and City of Fredericktown officials.

The Madison County Health Department officials oversee health education and blood-lead testing of local children. The EPA; the Agency for Toxic Substances and Disease Registry, or ATSDR; and MDHSS are assisting the Madison County Health Department in conducting health education on lead prevention via an interagency agreement.

MDNR administers the NPDES permit at the Site. The D Tailings Pile Dam permit will expire in December 2018 and a state inspection of the dam is scheduled for 2018. The Respondent has proposed to reprocess some existing tailings piles for metals recovery, and to eventually rehabilitate and reopen the mine. MDNR would oversee active mining operations through a state mineral processing permit and other applicable state programs.

Following the proposed consolidation and capping of wastes by the Respondent, post-removal site controls will be required. A Missouri Environmental Covenant between the Respondents and MDNR or an enforceable common law restrictive covenant will be required for areas of the Site with soil contamination above the proposed cleanup goals in Attachments B and C.

III. THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT AND STATUTORY AND REGULATORY AUTHORITIES

A. Threats to Public Health or Welfare

At any release, regardless of whether the site is included on the NPL, where the lead agency makes the determination, based on factors in 40 C.F.R. § 300.415 (b)(2) that there is a threat to the public health or welfare of the United States, or the environment, the lead agency may take any appropriate removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release, or threat of release. The factors in 40 C.F.R. § 300.415 (b)(2) which apply to this Site are:

300.415 (b)(2)(i) – Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, or pollutants, or contaminants.

Elevated concentrations of lead have been found throughout the Site. The 1995 Expanded Site Investigation documented lead concentrations in tailings as high as 23,400 milligrams per kilogram, or mg/kg. Children playing in and around the contaminated areas have the highest potential to be exposed and the highest vulnerability to the negative health effects of exposure. In addition, sampling has determined that surface water and sediment are contaminated with lead and other metals, including arsenic, nickel and cobalt.

Lead is a metal and has been listed as a hazardous waste (D008) in the regulations for the Resource Conservation and Recovery Act, or RCRA. Lead is classified by the EPA as a probable human carcinogen and is a cumulative toxicant. The early effects of lead poisoning are nonspecific and difficult to distinguish from the symptoms of minor seasonal illnesses. Lead poisoning causes decreased physical fitness, fatigue, sleep disturbance, headache, aching bones and muscles, digestive symptoms (particularly constipation), abdominal cramping, nausea, vomiting, and decreased appetite. With increased exposure, symptoms include anemia, pallor, a "lead line" on the gums, and decreased hand grip strength. Alcohol and physical exertion may exacerbate these symptoms. The radial nerve is affected most severely causing weakness in the hands and wrists. Central nervous system effects include severe headaches, convulsions, coma, delirium, and possibly death. The kidneys can also be damaged after long periods of exposure to lead, with loss of kidney function and progressive azotemia. Reproductive effects in women include decreased fertility, increased rates of miscarriage and stillbirth, decreased birth weight, premature rupture of membrane, and/or pre-term delivery. Reproductive effects in men include erectile dysfunction, decreased sperm count, abnormal sperm shape and size, and reduced semen volume. Lead exposure is associated with increases in blood pressure and left ventricular hypertrophy. A significant amount of lead that enters the body is stored in the bone for many years and can be considered an irreversible health effect.

In December 2005, MDHSS released a Public Health Assessment for the Madison County Mines Site. The MDHSS study, funded by ATSDR and the EPA, included sampling children's blood, sampling environmental media such as soil and dust, and questioning residents about their lifestyle as it related to lead exposure. The study compared the results of blood lead levels collected from children in the Old Lead Belt of Madison County to blood lead level test results collected from children during the study on a control area (Salem, Missouri) located outside the area of concern. In 2005, about 6 percent of the children tested in Madison County showed a blood lead level of more than 10 micrograms/deciliter compared to about 3 percent of the children in the control area. Data collected prior to 2001 indicated approximately 13 percent of the children tested possessed elevated blood lead levels in the county.

Children are more vulnerable to lead poisoning than adults. For children, lead can damage the central nervous system, kidneys and reproductive system. At higher levels, it can cause comas, convulsions and death. Even low levels of lead are harmful and are associated with decreased intelligence, impaired neurobehavioral development, decreased stature and growth, impaired hearing acuity, and possibly high blood pressure.

EPA Region 7's Environmental Sciences and Technology Division, or ENST, risk assessment staff developed proposed ecological and human health cleanup goals for the proposed project (Attachments B and C). The human health risk evaluation determined a potential unacceptable risk for industrial worker and all-terrain vehicle rider exposure scenarios.

300.415 (b)(2)(iv) – High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate.

Lead has been detected in surface soils above the proposed action level of 800 mg/kg (see Attachment B), with detections of up to 23,400 mg/kg lead in mine waste at OU2 during the 1995 ESI. Lead-contaminated soils may migrate via airborne dusts, surface runoff, percolation into groundwater, construction activity, off-road vehicle traffic, by children transporting soils/dusts into their homes after playing in the affected areas, or tracked in by foot traffic.

300.415 (b)(2)(v) – Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.

Weather conditions may cause the contaminated mine tailings to migrate. High wind events could cause the tailings and contaminated soil to migrate via airborne dust. Rain may cause contamination via surface runoff. Historic catastrophic releases have occurred from the Site as a result of heavy rain events, with the 1977 D Tailings Pile dam failure resulting in inundation of low-lying residential areas in Cobalt Village and Fredericktown with contaminated runoff, tailings and sediment. An estimated 20,000 tons of tailings were released during that event. Past testing by the EPA and MDNR has demonstrated historic and ongoing impacts to streams leaving the Site as a result of contaminated stormwater runoff.

IV. ENDANGERMENT DETERMINATION

The actual release of a hazardous substances from the Site, if not addressed by implementing the response action selected in this Action Memorandum, presents an imminent and substantial endangerment to public health, or welfare, or the environment.

V. PROPOSED ACTIONS AND ESTIMATED COST

A. Proposed Actions

1. Proposed Action Description

The EPA and EOI (on behalf of Missouri Mining Investments) have negotiated a Supplemental Investigation Work Plan for further characterization of the Site, and a Preliminary Early Removal Action Work Plan that outlines conceptual plans for cleanup. Detailed design documents will be submitted for EPA review based on the supplemental characterization findings.

<u>SOIL/WASTE REMEDIATION</u>

EOI will characterize the Site by use of borings and test pits. Some tailings may be removed for reprocessing for metals recovery prior to capping. Tailings will generally be capped in place with 18 inches of clay and 12 inches of topsoil. Transition zones beyond the limits of the existing tailings piles will be characterized at the surface and shallow subsurface on 100-foot grids, and areas exceeding 800 parts per million lead or the final cleanup goals for other contaminants of concern will be either consolidated into the tailings footprint for capping or capped in place and considered part of the tailings footprint. Confirmation sampling will be conducted to verify remedial goals have been attained.

<u>SEDIMENT/SURFACE WATER REMEDIATION</u>

Surface and subsurface soil samples and sediment samples which could potentially be affected by surface runoff will be collected in locations downgradient of the Metallurgical Pond dam and the D Tailings Pile dam, and materials exceeding the cleanup goals will be excavated and consolidated on the D Tailings Pile prior to capping. Confirmation sampling will be conducted to verify remedial goals have been achieved.

Water from existing impoundments on the Site, including the Metallurgical Pond, will be removed, treated as necessary, and used for dust control on the Site in a manner to prevent off-site discharge. Contaminated sediment and materials within the ponds will be excavated and disposed on the D Tailings Pile prior to capping. Confirmation sampling will be conducted to verify remedial goals have been attained in the impoundments. The Meteorological Pond will be utilized for on-site water storage and sediment control.

<u>POST REMOVAL SITE CONTROL</u>

It is the policy of the EPA that post-removal site control, or PRSC, shall be the responsibility of the responsible parties, in this case the Respondent. PRSC will be required at the Site. Administrative controls will be required to prevent public access to the vegetated cap areas. Monitoring and maintenance of the engineered cover will be required to ensure the remedy remains protective of human health and the environment. The Respondent has proposed placement of a formal restrictive control under the Missouri Environmental Covenant Act on the property to prevent residential use of the property, to prevent the installation of potable drinking water wells on or near affected portions of the property, and to ensure proper handling and management of impacted materials encountered during any future on-site construction activities. A Removal Site Control Plan will also require routine inspections, repairs, long-term site security, vegetation care, and other tasks related to ensuring the effectiveness and permanence of the removal action.

2. Contribution to Remedial Performance

The planned action is expected to be the long-term response action for the Respondent's property portion of OU2. After the action is complete, no significant releases under normal circumstances are projected. Further evaluation of the impacts from the Site to the vicinity and downstream surface water, sediment, biota, and groundwater will be assessed as part of the OU2 Remedial Investigation and Feasibility Study and will be addressed under the Record of Decision for OU2.

3. Action/Cleanup Level

The EPA Region 7 ENST staff have developed proposed cleanup goals based on assessment of potential human health and ecological risks posed by the Site (see Attachment B). The default Regional Screening Level of 800 mg/kg for lead in soil in an industrial exposure setting will be used throughout the Site, except in the areas below the Meteorological Pond and the D Tailings Pile dam, where the ecological goals for soil and sediment will guide cleanup. ENST developed the preliminary human health cleanup goals for contaminants of potential concern other than lead based on a target non-cancer hazard index of 1.0 or a target excess cancer risk of 1E-06, whichever is more protective. Final remediation objectives for constituents other than lead may be refined in consultation with the EPA based on the results of the Supplemental Investigation Work Plan characterization activities.

4. Applicable Relevant and Appropriate Requirements

The Applicable or Relevant and Appropriate Requirements for the removal action include the following:

- National Ambient Air Quality Standards, or NAAQS – Clean Air Act, 42 U.S.C. §7401 et seq., 40 CFR Part 250 and 10 CSR 10-6.010. Air monitoring and controls such as dust suppression will be implemented as necessary to ensure that airborne emissions of particulates and lead during removal activities are below the NAAQS.

- Fugitive Particulate Matter Regulations – 10 CSR 10-6.170. Air monitoring and controls such as dust suppression will be implemented as necessary to ensure that fugitive particulate matter is controlled.

- Surface Mining Control and Reclamation Act, or SMCRA – Sediment Control Measures (§816.45), Siltation Structures (§816.46), Grading Requirements (§816.102), and Revegetation (§816.111 through §816.116). The SMCRA requirements will be implemented to ensure compliance.

- Missouri Dam and Reservoir Safety Council - 236.400 through 236.500 RSMo and 10 CSR 22-1 through 10 CSR 22-4. The Respondent operates and maintains a Missouri Registration Permit #R-264 issued by the Missouri Dam and Reservoir Safety Council for a site dam, reservoir, spillway and emergency spillway with Missouri ID #MO31082 (D Tailings Pile dam). Per the requirements of the permit, the dam system will be maintained and actions taken to prevent damage to any person or property. A construction permit will be obtained prior to any activities resulting in altering, enlarging, reducing, repairing or removing the dam, reservoir or appurtenances.

• Clean Water Act, or CWA, Direct Discharge Requirements – Sections 301(b) and 404 of the CWA and 10 CSR 20-7.015 and 10 CSR 20-7.031. On-site discharges from CERCLA sites to surface waters must meet the substantive requirements of the NPDES program. The Site will be monitored to ensure compliance with the CWA.

• Stormwater Requirements – 10 CSR 20-6.200. The State of Missouri has promulgated regulations that are applicable to stormwater discharges associated with industrial activities, including mining. The substantive requirements of the stormwater program must be complied with at the Site so long as runoff from the Site comes into contact with contamination.

• Protection of Flood Plains – Executive Order 11990 and 40 CFR 6, Appendix A. If a proposed federal government action is located in or affects a 100-year floodplain, the action must be designed and carried out to avoid adversely impacting the floodplain wherever possible.

• Endangered Species Act of 1973 (16 USC 1531-1543; 50 CFR Part 17; 40 CFR 6.302); Federal Migratory Bird Act (16 USC 703-712); Fish and Wildlife Conservation Act of 1980 (16 USC Part 2901 et seq.; 50 CFR Part 83.9 and 16 USC Part 661, et seq.) The remedial alternatives will be designed to mitigate or eliminate potential interference with endangered or threatened species and will promote conservation of non-game fish and wildlife and the conservation of their habitats. If such areas are affected, activities will include consultation with the Department of the Interior and U.S. Fish and Wildlife Service.

• RCRA Subtitle D Solid Waste Disposal Regulations – 40 CFR Part 257 and the state of Missouri Solid Waste Management Law and Regulations. These regulations require that the facility be maintained to prevent a washout of solid waste and that the public not be allowed uncontrolled access to the facility. The Site will be properly maintained and will be monitored to ensure compliance with these regulations.

5. Project Schedule and Cost

This Action Memorandum assumes that the proposed actions will be performed by the Respondent. A detailed explanation of anticipated EPA project costs is therefore not included in this Action Memorandum. If a future EPA fund-lead removal action is required, the Action Memorandum will be amended to recognize the change of Site status and will include projected EPA removal action costs to complete the removal action at the Site. The construction is estimated to take from 2 to 3 years following completion of the Removal Action Work Plan, and is dependent on the workforce and equipment dedicated to the project.

VI. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

Conditions at this Site will continue to pose a threat to public health and the environment until response actions are implemented.

VII. OUTSTANDING POLICY ISSUES

None.

VIII. ENFORCEMENT

An Administrative Order on Consent, which became effective on the same date this Action Memorandum is signed, is in place for this Time-Critical Removal Action. An Enforcement Addendum, which is not part of the publicly-available Administrative Record for this action, is attached.

IX. RECOMMENDATION

This decision document represents a selected Time-Critical Removal Action for Respondent's portion of the OU2-Anschutz Mine Subsite of the Madison County Mines NPL Superfund Site, developed in accordance with CERCLA as amended and is consistent with the NCP. This decision is based on the Administrative Record for the Site. Conditions at the Site meet the criteria for a Removal Action set forth in Section 300.415(b)(2) of the NCP. I recommend your approval of the proposed Removal Action.

Approved:

Mary P. Peterson

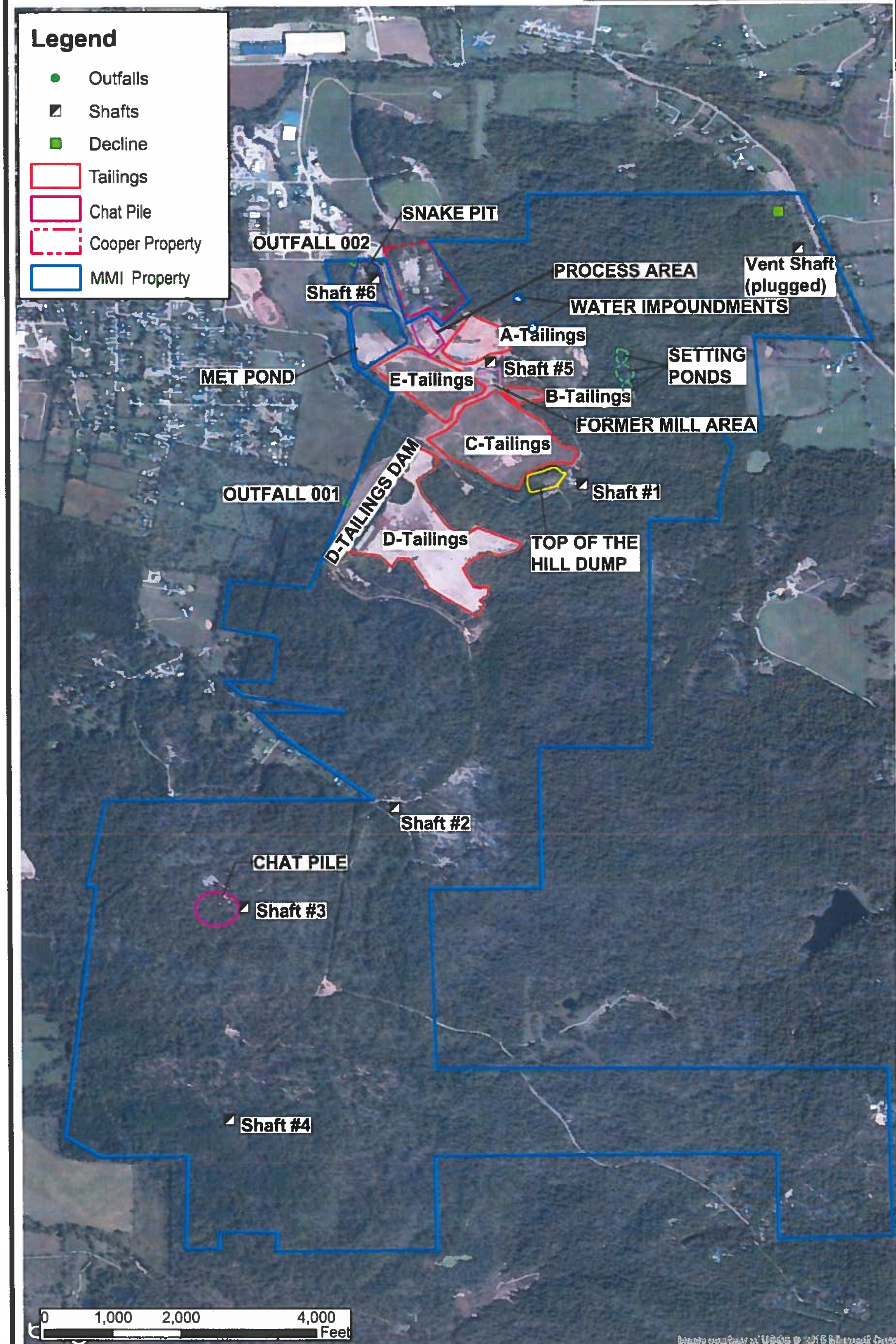
Mary P. Peterson, Director
Superfund Division

2/28/2019
Date

Attachments
A. Site Map
B. Preliminary Human Health and Ecological Remedial Action Objectives
C. Confidential Enforcement Addendum

Project #9229

Environmental Operations, Inc.



North

Detailed Site Map

Madison Mine

Fredricktown, Missouri

Modified from Original by US EPA Feb. 28, 2019

Attachment A

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 7
11201 Renner Boulevard
Lenexa, Kansas 66219

MAY 23 2018

MEMORANDUM

SUBJECT: Remedial Action Objectives
Madison County Mines Site
Operable Unit 2 Modified
Fredericktown, Missouri

FROM: Kelly Schumacher, Toxicologist
Environmental Data and Assessment Branch
Environmental Sciences and Technology Division

TO: Kurt Limesand, Remedial Project Manager
Lead Mining and Special Emphasis Branch
Superfund Division

As requested, this memorandum provides soil remedial action objectives for an industrial use scenario at Operable Unit 2 Modified of the Madison County Mines Site, located in Fredericktown, Missouri. Also included are remedial action objectives protective of exposure to an all-terrain vehicle rider using a range of site-specific assumptions documented in the 2007 human health risk assessment for this site (EPA, 2007). If you have any questions or need further assistance, please contact me at x7963.

Remedial Action Objectives
Madison County Mines Site
Operable Unit 2 Modified
Fredericktown, Missouri

INTRODUCTION

A Preliminary Early Removal Action Work Plan for Tailings Capping and a Supplemental Investigation Work Plan have been submitted for Operable Unit 2 Modified of the Madison County Mines Site, located in Fredericktown, Missouri. These work plans propose site characterization and remediation activities at Areas of Environmental Concern to prepare the property for re-opening of mining operations. The AECs include Tailings A, B, C, D, and E, the "Top of Hill Dump", the Former Processing (Roaster) Area, the Former Mill Area, the Chat Pile Near Shaft 3, the "Snake Pit" area downgradient of the MET Pond, and the Former Water Impoundments. Capping of areas exceeding remedial action objectives is planned, along with institutional controls, an operation and maintenance plan, and a soil management plan. The objective of this document is to provide remedial action objectives for soil, sediment, and mine waste that are protective of human health under a future industrial use scenario as an operating mine.

CONSTITUENTS OF CONCERN

The Madison County Mines Site has historically been mined for copper, lead, cobalt, nickel, iron, zinc, silver, and pyrites, beginning in the 1840s. Because existing data across Operable Unit 2 Modified is limited, the Supplemental Investigation Work Plan proposes additional sampling to further characterize metals, SVOCs, PCBs, and cyanide in surface and near-surface soil. Specifically, the work plan proposes the following soil and tailings constituents of concern: arsenic, cobalt, copper, lead, nickel, zinc, manganese, hexavalent chromium, priority pollutant semi-volatile organic compounds, polychlorinated biphenyls, and cyanide. However, Table 5-1 of the 2011 Draft Supplemental Remedial Investigation Report indicates that cadmium, iron, and silver were also detected above screening values in Operable Unit 2 soil, sediment, and/or mine waste. Table 6-1 of the draft SRI identified the following constituents of potential concern in Anschutz Mine tailings, soil, and/or sediment for the supplemental human health risk assessment: aluminum, antimony, arsenic, cadmium, cobalt, copper, iron, lead, manganese, nickel, silver, thallium, vanadium, and polycyclic aromatic hydrocarbons.

Taking existing data, past assessments, and proposed plans into consideration, remedial action objectives are provided in this document for the following constituents of concern: aluminum, antimony, arsenic, cadmium, hexavalent chromium, cobalt, copper, iron, lead, manganese, nickel, silver, thallium, vanadium, zinc, benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, indeno[1,2,3-cd]pyrene, pyrene, PCBs, and cyanide. Operable Unit 2 Modified is large, with distinctly different and heterogeneous contamination expected within and across the AECs due to different mining and processing techniques used over many years, so site characterization should include these COCs, at a minimum.

EXPOSURE SCENARIOS

Past human health risk assessments for this site have evaluated residential exposure to soil and groundwater, commercial worker exposure to soil and groundwater, recreational visitor exposure to waste piles (represented by an all-terrain vehicle rider), and recreational visitor exposure to floodplain soil, sediment, surface water, and fish tissue at area streams and ponds. In this document, remedial action objectives are presented only for industrial worker exposure to soil (including mine waste and sediment) and for ATV rider exposure to waste piles. RAOs are not presented for a residential scenario because institutional controls will prohibit this land use, limiting future use of the site to industrial. However, page ix of the Supplemental Investigation Work Plan acknowledges that the planned surficial cap is intended to prevent exposure to both industrial site workers and to trespassers. Because the proposed initial characterization and remedial activities focus on soil, including mine waste and sediment, only the ATV rider trespasser scenario is considered at this time, not the fisherperson. Because exposure to floodplain soil and sediment by a trespasser visiting area surface water bodies (e.g., to fish) is less than exposure to soil and mine waste by industrial workers and ATV riders, the RAOs derived in this document apply to area soil, mine waste, floodplain soil, and sediment. Additional sampling is needed to identify groundwater COCs, but the work plan proposal to base groundwater RAOs on Maximum Contaminant Levels, if available, or the U.S. Environmental Protection Agency's tapwater Regional Screening Levels is appropriate.

DERIVATION OF REMEDIAL ACTION OBJECTIVES

Carcinogenic RAOs for Non-Lead COCs

The following equations were used to derive RAOs representing an excess individual lifetime cancer risk of 1E-06, which is the lower bound of the EPA's target cancer risk range, to industrial workers and ATV riders exposed to surface soil via incidental ingestion, dermal contact, and inhalation of particulates or volatiles. Note that the only carcinogenic COCs at this site that are classified as volatile (EPA, 2018) and for which volatilization factors are used instead of particulate emission factors are benz[a]anthracene and PCBs. The EPA's current standard exposure parameters were used for the industrial worker calculations, while the parameters for the ATV rider generally reflect the values used in the 2007 risk assessment, with updated values used for body weight and skin surface area. Current toxicity values and chemical-specific data, as presented in EPA (2018) and based on the hierarchy outlined in EPA (2003a) were used. The definitions and values of the parameters used in these equations for both receptors are presented in Table 1.

$$RAO_{total-ca}(mg/kg)=\frac{1}{\frac{1}{RAO_{ing-ca}}+\frac{1}{RAO_{der-ca}}+\frac{1}{RAO_{inh-ca}}}$$

Where:

$$RAO_{ing-ca}(mg/kg)=\frac{TR\cdot AT_{ca}\cdot BW}{EF\cdot ED\cdot CSF_{o}\cdot RBA\cdot IR\cdot 10^{-6}\frac{kg}{mg}\cdot ADAF}$$

$$RAO_{der-ca}(mg/kg)=\frac{TR\cdot AT_{ca}\cdot BW}{EF\cdot ED\cdot \frac{CSF_{o}}{GIABS}\cdot SA\cdot AF\cdot ABS_{d}\cdot 10^{-6}\frac{kg}{mg}\cdot ADAF}$$

$$RAO_{inh-ca}(mg/kg)=\frac{TR\cdot AT_{ca}}{EF\cdot ED\cdot ET\cdot \frac{1day}{24hrs}\cdot IUR\cdot 1000\frac{\mu g}{mg}\cdot \frac{1}{PEForVF}\cdot ADAF}$$

Non-Carcinogenic RAOs for Non-Lead COCs

The following equations were used to derive RAOs representing a target non-cancer hazard index of 1 to industrial workers and ATV riders exposed to surface soil via incidental ingestion, dermal absorption, and inhalation of particulates or volatile. Note that the only non-carcinogenic COC at this site that is classified as volatile (EPA, 2018) and for which the volatilization factor is used instead of the particulate emission factor is cyanide. The EPA's current standard exposure parameters were used for the industrial worker calculations, while the parameters for the ATV rider generally reflect the values used in the 2007 risk assessment, with updated values used for body weight and skin surface area. Current toxicity values and chemical-specific data, as presented in EPA (2018) and based on the hierarchy outlined in EPA (2003a) were used. The definitions and values of the parameters used in these equations for both receptors are presented in Table 1.

$$RAO_{total-nc}(mg/kg) = \frac{1}{\frac{1}{RAO_{ing-nc}} + \frac{1}{RAO_{der-nc}} + \frac{1}{RAO_{inh-nc}}}$$

Where:

$$RAO_{ing-nc}(mg/kg) = \frac{THQ \cdot AT_{nc} \cdot BW}{EF \cdot ED \cdot \frac{RBA}{RfD} \cdot IR \cdot 10^{-6}\frac{kg}{mg}}$$

$$RAO_{der-nc}(mg/kg) = \frac{THQ \cdot AT_{nc} \cdot BW}{EF \cdot ED \cdot \frac{1}{RfD \cdot GIABS} \cdot SA \cdot AF \cdot ABS_d \cdot 10^{-6}\frac{kg}{mg}}$$

$$RAO_{inh-nc}(mg/kg) = \frac{THQ \cdot AT_{nc}}{EF \cdot ED \cdot ET \cdot \frac{1day}{24hrs} \cdot \frac{1}{RfC} \cdot \frac{1}{PEForVF}}$$

Table 1. Variables Used to Derive Remedial Action Objectives for Non-Lead COCs.			
Variable	**Definition (Units)**	**Value**	**Reference**
ABS_d	Fraction Absorbed Dermally from Soil (unitless)	Chemical-specific	EPA, 2018
$ADAF_{atv}$	Age-Dependent Adjustment Factor (Mutagens only) – ATV Rider (unitless	3	EPA, 2005
$ADAF_w$	Age-Dependent Adjustment Factor (Mutagens only) – Industrial Worker (unitless)	1	EPA, 2005
AF_{atv}	Soil Adherence Factor – ATV Rider (mg/cm^2)	0.2	EPA, 2007
AF_w	Soil Adherence Factor – Industrial Worker (mg/cm^2)	0.12	EPA, 2011
$AT_{atv\text{-}ca}$	Averaging Time – ATV Rider, Cancer (days)	25,550	EPA, 1989
$AT_{atv\text{-}nc}$	Averaging Time – ATV Rider, Non-Cancer (days)	3,650	EPA, 2007
$AT_{w\text{-}ca}$	Averaging Time – Industrial Worker, Cancer (days)	25,550	EPA, 1989
$AT_{w\text{-}nc}$	Averaging Time – Industrial Worker, Non-Cancer (days)	9,125	EPA, 1989
BW_{atv}	Body Weight – ATV Rider (kg)	44.3	EPA, 2011[a]
BW_w	Body Weight – Industrial Worker (kg)	80	EPA, 2011
CSF_o	Cancer Slope Factor, Oral (mg/kg-day)$^{-1}$	Chemical-specific	EPA, 2018
ED_{atv}	Exposure Duration – ATV Rider (years)	10	EPA, 2007
ED_w	Exposure Duration – Industrial Worker (years)	25	EPA, 2014
EF_{atv}	Exposure Frequency – ATV Rider (days/year)	68	EPA, 2007
EF_w	Exposure Frequency – Industrial Worker (days/year)	250	EPA, 2014
ET_{atv}	Exposure Time (hours/day)	2	EPA, 2007
ET_w	Exposure Time (hours/day)	8	EPA, 2014
GIABS	Fraction Absorbed in Gastrointestinal Tract (unitless)	Chemical-specific	EPA, 2018
IR_{atv}	Ingestion Rate of Soil – ATV Rider (mg/day)	200	EPA, 2007
IR_w	Ingestion Rate of Soil – Industrial Worker (mg/day)	100	EPA, 2014
IUR	Inhalation Unit Risk (µg/m^3)$^{-1}$	Chemical-specific	EPA, 2018
PEF_{atv}	Particulate Emission Factor – ATV Rider (m^3/kg)	1.39E+05	EPA, 2007
PEF_w	Particulate Emission Factor – Industrial Worker (m^3/kg)	1.36E+09	EPA, 2002
RfC	Reference Concentration (mg/m^3)	Chemical-specific	EPA, 2018
RfD	Reference Dose (mg/kg-day)	Chemical-specific	EPA, 2018
RBA	Relative Bioavailability (unitless)	Arsenic = 0.6 Other = 1	EPA, 2012 EPA, 2018
SA_{atv}	Skin Surface Area for Dermal Contact – ATV Rider (cm^2)	3,749	EPA, 2011[b]
SA_w	Skin Surface Area for Dermal Contact – Industrial Worker (cm^2)	3,527	EPA, 2014
THQ	Target Non-Cancer Hazard Quotient (unitless)	1	-
TR	Target Cancer Risk (unitless)	1E-06	-
VF	Volatilization Factor (m^3/kg)	Chemical-specific	EPA, 2018

[a] EPA (2007) used the mean body weight for 7 – 17 years from the 1997 Exposure Factors Handbook. The revised value is the mean body weight for 6 – 16 years from the 2011 Exposure Factors Handbook, because the age stratification changed.

[b] EPA (2007) used the mean skin surface area of the head, forearms (0.45*arms), hands, and lower legs (0.4 arms) for 7 – 17 years from EPA (2004). The revised value is the mean skin surface area of these body parts for 6 – 16 years from the 2011 Exposure Factors Handbook, using the same fractions for forearms and lower legs, because the age stratification changed.

RAOs for Lead

Remedial Action Objectives for lead were derived using the standard approach developed by the EPA to assess potential health risks associated with non-residential exposure to lead in soil, as shown in the equations below. This approach uses the Adult Lead Methodology (EPA, 2003b) to estimate fetal blood concentrations in women workers or ATV riders who could be exposed to the lead-contaminated soils at the site. The subpopulations of main concern are pregnant women and women of child-bearing age, because the fetal blood lead level is nearly equivalent to the blood lead level of the mother.

$$RAO_{lead}\left(\frac{mg}{kg}\right) = \frac{\left(PbB_{adult,central,goal} - PbB_{adult,0}\right) \cdot AT}{BKSF \cdot IR \cdot AF \cdot EF}$$

$$PbB_{adult,central,goal}\left(\frac{\mu g}{L}\right) = \frac{PbB_{fetal,0.95,goal}}{GSD_i \cdot R_{fetal/maternal}}$$

The definitions and values of the parameters used in the ALM for both types of receptors are presented in Table 2. In general, the EPA's currently recommended default values were used. However, consistent with the 2007 risk assessment, a site-specific absorption fraction of 0.14 was used, which represents the site-specific relative bioavailability of lead in soil and mine waste of 0.70. Note that mine waste is slightly more bioavailable (0.73) than soil (0.66) at this site (EPA, 2007). The ATV rider scenario also incorporates site-specific parameters used in the 2007 risk assessment, including a higher soil ingestion rate and a shorter exposure frequency and averaging time.

Table 2. Variables Used to Derive Remedial Action Objectives for Lead.

Variable	Definition	Units	Industrial Worker		ATV Rider	
			Value	Reference	Value	Reference
AF	Absolute gastrointestinal absorption fraction for ingested lead in soil and lead in dust derived from soil (0.2 * RBA)	-	0.14	EPA, 2007	0.14	EPA, 2007
AT	Averaging Time	days	365	EPA, 2017	238	EPA, 2007
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	EPA, 2017	0.4	EPA, 2017
EF	Exposure Frequency	days/yr	219	EPA, 2017	34 - 68	EPA, 2007
GSD_i	Geometric Standard Deviation	-	1.8	EPA, 2017	1.8	EPA, 2017
IR	Ingestion Rate of Soil	g/day	0.050	EPA, 2017	0.100 - 0.200	EPA, 2007
$PbB_{adult,0}$	Baseline blood lead concentration of women of child-bearing age in absence of exposure at the site	µg/dL	0.6	EPA, 2017	0.6	EPA, 2017
$PbB_{fetal,0.95,goal}$	Goal for 95th percentile blood lead concentration among fetuses born to women with exposures to the specified soil lead concentration	µg/dL	5	EPA, 2017	5	EPA, 2017
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	-	0.9	EPA, 2017	0.9	EPA, 2017

CONCLUSIONS

Table 3, below, provides Remedial Action Objectives for Operable Unit 2 Modified of the Madison County Mines Site for all constituents of concern identified above. Note that RAO values are rounded to two significant digits. For compounds other than lead, a target excess cancer risk of 1E-06 was used, which is the lower end of the EPA's target cancer risk range of 1E-06 to 1E-04. A target non-cancer hazard index of 1 was also used.

The industrial worker RAOs are protective of the intended future use of the site as industrial. RAOs were also derived for an ATV rider because the work plans state that the planned caps are intended to be health-protective of trespassers, suggesting access by trespassers on the site may not be well-controlled. The ATV rider exposure scenario, although more intermittent than a worker scenario, results in highly intensive contact with soil and dust via ingestion, dermal contact, and inhalation. In general, the resulting industrial worker RAOs are lower, and thus health-protective, of an ATV rider. However, there are a few compounds in which lower RAOs are necessary to protect both types of receptors from cancer or non-cancer health effects. Notably, the lower end of the range of lead RAOs derived for an ATV rider using the site-specific parameters documented in the 2007 risk assessment (470 mg/kg) is well below the RAO derived for an industrial worker (900 mg/kg; also see below), suggesting significant additional work may be necessary to ensure the remediated site is health-protective for trespassers. Further, the ALM solely considers ingestion exposure; if the inhalation pathway had been incorporated, the lead RAOs for the ATV rider would have been even lower. Our recommendation is to examine the possibility of instituting better controls to prevent trespassing and ATV riding from occurring at this site.

The lead RAO calculated for an industrial worker (900 mg/kg) is greater than the default industrial soil Regional Screening Level (800 mg/kg), but 900 mg/kg incorporates a mean relative bioavailability of 0.70 that was based on residential soil and mine waste samples collected from across the overall Madison County Mines Site. The 2007 risk assessment notes that the RBA measured specifically in the mine waste samples (0.73) was greater than that of soils (0.66). When the mine waste RBA was used in the ALM, the resulting RAO was 860 mg/kg, which approaches the industrial soil RSL. Due the uncertainty in the RBA value and its impact on the RAO calculations, we recommend either relying upon the RSL of 800 ppm or collecting additional samples to better characterize the site-specific lead bioavailability. Based on the long duration of mining with varied practices that has occurred at this site, it would not be unexpected to have distinct RBA values associated with each Area of Environmental Concern, resulting in different RAOs for various AECs.

Finally, as additional data is collected under the Supplemental Investigation, the RAOs for some compounds may need to be refined. It may be possible that naturally-occurring background concentrations of some COCs (e.g., arsenic) may exceed the RAOs presented below. It also may not be possible to attain RAOs based on the lower end of the target cancer risk range for some compounds (e.g., hexavalent chromium). For these, RAOs may need to be based on higher target cancer risks while ensuring that the total cancer risk from exposure to all compounds does not exceed 1E-04 and that the total non-cancer hazard index does not exceed 1.

Table 3. Remedial Action Objectives for Madison County Operable Unit 2 Modified (mg/kg).

Constituent of Concern	Industrial Worker			ATV Rider		
	TR=1E-06	THI = 1	RAO	TR=1E-06	THI = 1	RAO
Aluminum	-	1.12E+06	1.1E+06 nc	-	4.32E+04	4.3E+04 nc
Antimony (metallic)	-	4.67E+02	4.7E+02 nc	-	4.76E+02	4.8E+02 nc
Arsenic, Inorganic	3.00E+00	4.79E+02	3.0E+00 ca	5.60E+00	1.09E+02	5.6E+00 ca
Benz[a]anthracene	2.06E+01	-	2.1E+01 ca	2.64E+01	-	2.6E+01 ca
Benzo[a]pyrene	2.11E+00	2.22E+02	2.1E+00 ca	2.45E+00	1.70E+01	2.5E+00 ca
Benzo[b]fluoranthene	2.11E+01	-	2.1E+01 ca	2.45E+01	-	2.5E+01 ca
Benzo[k]fluoranthene	2.11E+02	-	2.1E+02 ca	2.45E+02	-	2.5E+02 ca
Cadmium (Diet)	9.26E+03	9.82E+02	9.8E+02 nc	3.48E+01	8.32E+01	3.5E+01 ca
Chromium(VI)	6.33E+00	3.48E+03	6.3E+00 ca	2.38E-01	7.16E+02	2.4E-01 ca
Chrysene	2.11E+03	-	2.1E+03 ca	2.45E+03	-	2.5E+03 ca
Cobalt	1.85E+03	3.47E+02	3.5E+02 nc	6.97E+00	4.68E+01	7.0E+00 ca
Copper	-	4.67E+04	4.7E+04 nc	-	4.76E+04	4.8E+04 nc
Cyanide (CN-)	-	1.47E+02	1.5E+02 nc	-	5.67E+02	5.7E+02 nc

Dibenz[a,h]anthracene	2.11E+00	-	2.1E+00 ca	2.45E+00	-	2.5E+00 ca
Fluoranthene	-	3.01E+04	3.0E+04 nc	-	4.54E+04	4.5E+04 nc
Indeno[1,2,3-cd]pyrene	2.11E+01	-	2.1E+01 ca	2.45E+01	-	2.5E+01 ca
Iron	-	8.18E+05	8.2E+05 nc	-	8.32E+05	8.3E+05 nc
Manganese (Non-diet)	-	2.56E+04	2.6E+04 nc	-	4.41E+02	4.4E+02 nc
Nickel Soluble Salts	6.41E+04	2.24E+04	2.2E+04 nc	2.41E+02	7.81E+02	2.4E+02 ca
Polychlorinated Biphenyls (high risk)	9.42E-01	-	9.4E-01 ca	3.92E+00	-	3.9E+00 ca
Pyrene	-	2.26E+04	2.3E+04 nc	-	3.40E+04	3.4E+04 nc
Silver	-	5.84E+03	5.8E+03 nc	-	5.94E+03	5.9E+03 nc
Thallium (Soluble Salts)	-	1.17E+01	1.2E+01[a] nc	-	1.19E+01	1.2E+01 nc
Vanadium and Compounds	-	5.83E+03	5.8E+03 nc	-	7.79E+02	7.8E+02 nc
Zinc and Compounds	-	3.50E+05	3.5E+05 nc	-	3.57E+05	3.6E+05 nc
Lead (RBA = 0.7)	900[b]			470 – 1,900		

TR = target cancer risk; THI = target non-cancer hazard index; ca = cancer; nc = non-cancer; yellow = lowest RAO

[a] The thallium RAO is based upon a Provisional Peer-Reviewed Toxicity Value appendix screening toxicity value, which has a high degree of uncertainty and may be inadequate as the basis for a RAO (EPA, 2003).

[b] The lead RAO for an industrial worker is 900 mg/kg, when based on a relative bioavailability value of 0.70, which is the mean from existing site-specific soil and mine waste across the overall Madison County Mines Site. Had the RBA of 0.73 for mine waste been used, the RAO would be 863 ppm. The currently recommended industrial soil Regional Screening Level is 800 mg/kg, which approximates this value.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 7
11201 Renner Boulevard
Lenexa, Kansas 66219

MAY 0 7 2018

MEMORANDUM

SUBJECT: Proposed Ecological Cleanup Levels for Soil and Sediment, and Surface Water Remedial Action Objectives for Madison County Mines Site OU2 (The Anshutz Mine Property)

FROM: Catherine Wooster-Brown, Ecological Risk Assessor
Environmental Data and Assessment Branch
Environmental Sciences and Technology Division

TO: Kurt Limesand, Remedial Project Manager
Lead, Mining and Special Emphasis Branch
Superfund Division

As requested, we have provided ecological cleanup levels for OU2 soil and sediment for the protection of ecological receptors. Further, we included ambient surface water criteria as Remedial Action Objectives to prevent further contamination of surface water at the Madison County Mine Site (Anshutz Mine Property). Please contact me if you have any further questions at x7425.

Background

Madison County Mines

OU2 consists primarily of the Anschutz property (the original Madison Mine site) and has been used for mining since the mid-1840s when the property was first mined for copper. The land has also been mined for lead, cobalt, nickel, iron, zinc, and silver. There are tailings piles and ponds on-site, including the Metallurgical Pond (Met Pond), and remnants of a mill, smelter, and refinery complex.

There are five main tailings piles (totaling approximately 200 acres) on the northern portion of the property and four of the piles have reportedly been covered with clay caps and are currently vegetated. The tailings piles are all generally characterized by fine brown-orange tailings. There are two intermittent creeks which flow through the Anschutz property, Tollar Branch and an unnamed tributary of Saline Creek. Tollar Branch originates south of the Anschutz property, flows through the Anschutz property and ultimately discharges into Saline Creek. The unnamed tributary also flows into Saline Creek. A map shows one other tributary that originates on-site and flows east into Goose Creek, located east of the property line, this tributary may be intermittent.

Summary of the Screening Level Ecological Risk Assessment

The following three sections provide a screening level ecological risk assessment summary from information within the Madison County Mines Draft Supplemental Remedial Investigation Report (EPA, 2011).

Soil

In OU2 maximum detected lead concentrations in soil were 20,300 mg/kg, arsenic 299 mg/kg, cobalt 15,300 mg/kg, copper 39,700 mg/kg, and nickel 6840 mg/kg. Hazard quotients were elevated for all ecological receptors when compared to ecological soil screening levels (Table 1 below).

Table 1. Metals in Soil and Tailings Collected from OU2 (EPA 2011)				
Receptor	Plant	Avian	Mammalian	Hazard Quotient (HQ)
Eco-SSL for Arsenic (mg/kg)	18	43	46	
Sample from barren hill slope, NE side of former smelter	299			Plant, 17 Avian, 7 Mammal, 6.5
Sample from water collection area adjacent to furnace stack	289			Plant, 16 Avian, 7 Mammal, 6
Sample from berm adjàcent to concrete foundation	191			Plant, 11 Avian, 4 Mammal, 4
Anshutz Tailings D	76.4			Plant, 4 Avian, 2 Mammal, 2
Anshutz Tailings E	253			Plant, 14 Avian, 6 Mammal, 5.5
Receptor	Avian Herbivore (Dove)	Avian Vermivore (Woodcock)	Avian Carnivore (Hawk)	HQ
Eco-SSL for Cobalt (mg/kg)	270	120	1300	
Sample 32012 (maximum concentration)	15,300			Dove, 57 Woodcock, 127 Hawk, 12

Table 1. Cont.				
Receptor	Mammalian Herbivore (Vole)	Mammalian Vermivore (Shrew)	Mammalian Carnivore (Weasel)	HQ
Eco-SSL for Cobalt (mg/kg)	2100	230	470	
Sample 32012 (maximum concentration)	15,300			Vole, 7 Shrew, 66.5 Weasel, 32.5
Receptor		Avian Vermivore (Woodcock)		HQ
Eco-Cleanup Levels for Lead (Pb) in Soil (EPA 2018b) (mg/kg)	Based on the Lowest Observed Adverse Effect Level (LOAEL)	730		
Sample 32013 (maximum concentration)	20,300			Woodcock, 28
Receptor	Avian Herbivore (Dove)	Avian Vermivore (Woodcock)	Avian Carnivore (Hawk)	HQ
Eco-SSL for Copper (mg/kg)	76	28	1600	
Sample 32013 (maximum concentration)	39,700			Dove, 522 Woodcock, 1418 Hawk, 25
Receptor	Mammalian Herbivore (Vole)	Mammalian Vermivore (Shrew)	Mammalian Carnivore (Weasel)	HQ
Eco-SSL for Copper (mg/kg)	1100	49	560	
Sample 32013 (maximum concentration)	39,700			Vole, 36 Shrew, 810 Weasel, 71
Receptor	Soil Invertebrates	Avian	Mammal	HQ
Eco-SSL for Nickel (mg/kg)	280	210	130	
Sample 32013 (maximum concentration)	6840			Soil Inverts, 24 Avian, 32.5 Mammal, 53

Surface Water

Surface water samples were greater than chronic aquatic life criteria for lead and nickel in the Met Pond and lead in the D-Tailings Pond (Table 2). The seep from the pond that flows into Unnamed Creek, which then flows into Saline Creek, has high concentrations of cobalt in surface water; however, the water hardness ($CaCO_3$) is also high (1900). The toxicity of some metals (cadmium, copper, lead, nickel, silver, zinc and chromium VI) decreases with increasing water hardness. Currently, the U.S. Environmental Protection Agency (or MDNR) does not have standard criteria for cobalt due to lack of toxicological data. Therefore, we used an ecological screening level developed by the State of Ohio to provide some reference, but screening levels are meant to be conservative and do not necessarily mean a significant risk exists.

Table 2. Surface Water Samples from OU2 (EPA 2011). Highlighted cells are greater than the one or both of the Water Quality Criteria (WQC) or ecological screening value.

Site	Lead µg/L (not dissolved)	Lead µg/L (dissolved)	Nickel µg/L (not dissolved)	Nickel µg/L (dissolved)	Cobalt µg/L (not dissolved)	
Acute WQC	524	303	1016	1018	n/a	24 This value is an eco-screening level
Chronic WQC	20	11	113	113	n/a	
D-Tailings Pond Dam $CaCO_3$-431	26.1					
West Side of Met Pond	44.5		236	157		
East Side of Met Pond	17.4		257	200		
Downstream of OU2 Seep $CaCO_3$-1900					2260	2290

Sediment

Lead in sediment at all OU2 sites sampled are greater than the cleanup levels derived for neighboring Big River in St. Francois County for the protection of the benthos (Table 3) (EPA 2018a). Arsenic, nickel, and copper are all greater than their respective PECs (Table 3). Cadmium is greater than the Tri-State Mining District (TSMD) T_{20} value. For the TSMD ecological risk assessment, MacDonald *et al.* (2010) derived two toxicity thresholds for each chemical of concern, including cadmium. The cadmium threshold selected as a cleanup level for Madison County Mines OU2 is the T_{20} value (17.3 mg/kg Cd), associated with a 20% reduction in survival or biomass of the benthos.

Table 3. Sediment Samples and Sediment Toxicity Tests (EPA 2011).						
	Lead mg/kg	Arsenic mg/kg	Nickel mg/kg	Cadmium mg/kg	Copper mg/kg	Cobalt mg/kg
Big River Cleanup Level (EPA, 2018a)	325					
TSMD* T_{20} values				17.3		
PEC**		33	48.6		149	
Region 5 ecological screening level based on Ontario sediment quality guidelines.						50
Site						
59001 D-Tailings Pond Sieved with #35	3000	257	2300	34.6	2490	
Hazard Quotient (HQ)	9	8	47	2	17	
59002	3680	109	5700	24.2	10900	
HQ	11	3	117	1.4	73	
59003 Met Pond	1830	37.9	2990	10.7	2540	
HQ	6	1.1	61.5	0.6	17	
59004/5 DNstream of OU2 Seep	2180	40.5	890	14.3	5220	
HQ	7	1.2	18	0.8	35	
0% survival in the sediment toxicity tests for each waterbody listed above (EPA 2011).						

*TSMD-Tri-State Mining District (MacDonald *et al.* 2010).

**Probable Effect Concentration (PEC) above which harmful effects to the benthos is likely (MacDonald 2000).

Summary

The supplemental ERA (EPA 2011) indicated there is ample evidence that both the aquatic and the terrestrial environments are contaminated by mining-related wastes; that ecological receptors in both ecosystems have elevated exposure to mining-related metals; and that the metals cause adverse effects on at least some receptors in each ecosystem. Therefore, we recommend the following cleanup levels and Remedial Action Objectives for the Madison County Mines OU2 site:

Table 4. Cleanup Levels for Soil and Sediment and Remedial Action Objectives for Surface Water at Madison County Mines OU2.						
	Lead	Arsenic	Cadmium	Nickel	Copper	Cobalt
Soil	730 mg/kg	46 mg/kg (Eco-SSL)	140 mg/kg (Eco-SSL)	280 mg/kg (Eco-SSL)	1600 mg/kg (Eco-SSL)	2100 mg/kg (Eco-SSL)
Surface Water Remedial Action Objectives ($CaCO_3$=431)	11.8 µg/l dissolved	150 µg/l dissolved	0.7 µg/l dissolved	52.0 µg/l dissolved	32.0 µg/l dissolved	n/a
Sediment	325 mg/kg	33 mg/kg (PEC)	17.3 mg/kg	48.6 mg/kg (PEC)	149 mg/kg (PEC)	n/a

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