

**U.S. ENVIRONMENTAL PROTECTION AGENCY REGION VII
SUPERFUND TECHNICAL ASSESSMENT AND RESPONSE TEAM CONTRACT**

**HAZARD RANKING SYSTEM
NATIONAL PRIORITIES LIST CANDIDATE SITE
DOCUMENTATION RECORD
FOR THE
ANNAPOLIS LEAD MINE
ANNAPOLIS, MISSOURI**

CERCLIS ID No.: MO0000958611

ORIGINALLY PREPARED BY:

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TDD: S07-0005-024**

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Work Assignment No.: G9011.L.01.0051.00**

February 2004

**Annapolis Lead Mine
Annapolis, Missouri**

Site Summary

**ANNAPOLIS LEAD MINE
ANNAPOLIS, MISSOURI
SITE SUMMARY**

Site CERCLIS No.: MO0000958611

Site Location: Annapolis, Iron County, Missouri

Site Description:

The Annapolis Lead Mine (ALM) facility is located approximately 1 mile east and 3/8 mile north of Annapolis, Iron county, Missouri. The total area of the former mining facility is approximately 50 acres. Lead-bearing ore was mined from the former mining facility sporadically from approximately 1920 through 1940. Currently, the site is composed of derelict buildings used during the mining operation, most of which only have foundations remaining. One structure, however, was formerly used as a single family residence. The dominant site feature is a chat/tailings pile that occupies approximately 10 acres in the southern portion of the site. The material in the pile is highly erodible, which has resulted in steep-sided features and an outwash area that fans westward to Sutton Branch Creek. The property is currently divided among several landowners.

According to product figures for a portion of the mine's operational history, over 1 million tons of mining wastes were generated. The mining wastes, composed of overburden and milling residue, contain heavy metals. The primary metals of concern are lead, cadmium, zinc, and arsenic.

Previous sampling activities at the ALM facility have included efforts by MDNR, an SI, and an emergency response (due to the occurrence of high blood lead levels in children who have since been removed from the site). The analytical results associated with these sampling activities indicated the presence of heavy metals in the on-site ground water, surface water, sediment, and on-site surface soil. Dust and wipe samples were also collected within the former residence and were found to have lead concentrations up to 0.625 micrograms per square centimeter ($\mu\text{g}/\text{cm}^2$) and 1,170 mg/kg, respectively.

On November 17–21, 1997, and January 26–27, 1998, START personnel conducted ESI/RA activities at the ALM facility. Nineteen ground water, 11 surface water, 19 surface and subsurface soil, and 13 sediment samples were collected during the sampling activities, including background and QC samples. The requested analytical parameters for all samples included total metals. In addition, water samples were also analyzed for dissolved metals.

In addition, over 100 *in situ* readings were collected with an XRF for lead concentrations. Analysis of confirmation samples indicated the XRF accurately estimated lead concentrations. At-depth soil profile samples utilizing the Geoprobe™ were also conducted in waste source areas, including portions of the chat/tailings pile, to determine approximate depths of mining wastes across the site.

Several techniques were employed during this sampling activity to estimate volumes of lead-contaminated soils that may require excavation and/or stabilization. A map of the site and vicinity was produced by Walker Associates, Inc., through land-based surveying (conducted by EPA) and stereoscopic mapping. Quantity calculations were derived from integrating visual inspection and screening and analytical data, with the land surveying and Walker Associates, Inc., mapping techniques. Based on this information and historical documentation, four lead-contaminated source areas were delineated for removal assessment purposes: the heavily eroded chat/tailings waste pile, the outwash area of the chat/tailings waste pile, the former mining operations area, and the mill slime pond.

EPA analytical results have identified heavy metals at all four delineated source areas. Elevated levels of metals, particularly lead, were found throughout the site, with the highest concentration being found at 20,000 mg/kg in surface soils adjacent to the former residence. Other metals, such as arsenic, cadmium, and zinc, were also found at three or more times above background concentrations in all four delineated waste/source areas; however, only arsenic and lead were found to exceed health-based benchmarks. Samples collected at the chat/tailings pile during the EPA SI in April 1996 found lead and cadmium concentrations as high as 2,570 mg/kg and 4.67 mg/kg, respectively. Based on EPA analytical results two sources were evaluated for HRS scoring and include the

chat/tailings pile and contaminated soils within the outwash and former mining areas, which include the former on-site residence.

Visual observations of mining waste in Sutton Branch Creek and Big Creek were substantiated with laboratory analysis. Elevated levels of arsenic, cadmium, lead, and zinc were found during the ESI/RA sampling activity in the surface waters of Sutton Branch Creek and Big Creek. Heavy metals were found above designated background concentrations as well as designated benchmarks. Lead was found as high as 2,600 mg/kg in sediment samples at the chat/tailings pile outfall and as high as 1,700 mg/kg at the confluence of Sutton Branch Creek and Big Creek (designated wetland area), located about 0.75 miles downstream of the site. Other contaminants including, arsenic, cadmium, and zinc were also found in sediment samples collected along Sutton Branch and Big Creek at levels above background and ecological-based screening levels.

Elevated concentrations of contaminants attributable to the site were also found in the furthestmost downstream sample location in Big Creek, which was approximately 0.38 miles downstream of the confluence with Sutton Branch Creek. This area is a known fishing and recreational location for local residents. In addition, total and dissolved lead were found in surface water samples collected at Sutton Branch Creek and Big Creek at levels above background and the AWQC screening level. Further, total cadmium was identified above background and the AWQC level in one surface water sample at Big Creek collected about 100 feet downstream of the confluence with Sutton Branch.

Several edible fish and crayfish species are known to exist in Big Creek. MDNR classifies Big Creek as an Outstanding State Resource Water that contains high quality waters with a significant aesthetic, recreational, or scientific value. Local residents may also eat crayfish from Sutton Branch Creek but this has not been confirmed. Previous fish studies conducted at Big Creek in early 1993 and 1997 have indicated cadmium, lead, and zinc in fish in Big Creek. The most recent study also noted that the same heavy metals appear to be rising in concentrations and may warrant further monitoring. The 1997 study also indicated that the ALM facility is a contributing factor of the contamination in Big Creek and fish species. Currently, a fish advisory is in affected for consumption of sunfish species along Big Creek. In addition, MDOC have conducted other studies in 2000 concerning other edible fish species (i.e., bass) in Big Creek. Information concerning these current studies was not made available to E & E/START for inclusion into this HRS documentation record.

Data obtained during the ESI/RA and the SI show that the ALM facility has had an impact on the environment, primarily through the surface water pathway. Big Creek is a known fishery and at the confluence of Sutton Branch and Big Creek, an HRS-eligible wetland exists. Surface water populations (food chain and wetlands) identified within the designated in-water segment of Big Creek are subject to Level II concentrations.

Currently, a minimal threat exists for the ground water pathway. None of the domestic wells sampled within a 1-mile radius had concentrations exceeding the designated MCLs. An on-site irrigation well was also found to be contaminated with total lead and cadmium, indicating that shallow ground water at the site is contaminated and is most likely attributable to the source(s) on site. However, the construction of the well (corrugated pipe with no surface seal) causes doubt on the representativeness of the well water to the local ground water. Lead and cadmium were identified in several wells sampled on and adjacent to the site during the EPA SI and indicate seasonal variation. Additional ground water sampling may be required to determine the threat posed to the ground water.

The soil exposure pathway poses a threat at the ALM facility, due to the lack of vegetation on exposed contamination, large amounts of mine residuals, former residents on the site, lack of access restriction, and use of the site for recreation. During the ESI/RA three persons (2 adults and 1 child (about 15 years old)) were documented to be living at the residence located on site. The smaller children evaluated as having high lead blood levels during the previous EPA emergency response no longer live at the site. The potential for a release for the air pathway is considered relatively high during windy periods because of the physical conditions of the site; however, this pathway was not scored because air sampling at the site was not conducted.

**Annapolis Lead Mine
Annapolis, Missouri**

HRS Documentation Record Cover Sheet

HRS DOCUMENTATION RECORD COVER SHEET

Name of Site: Annapolis Lead Mine (ALM)
EPA ID No. MO0000958611

Contact Persons

Site Investigation: Tim Curry, U.S. EPA Region 7
Randy Schademann, E & E/START
Patty Roberts, E & E/START

Documentation Record: Patty Roberts, E & E/START
Jeff Gadt, E & E/START
Kumud Pyakuryal/E & E START

Pathways, Components, or Threats Not Scored

Air Migration Pathway

The Air Migration Pathway was not scored for the ALM facility because the surface water pathway generates a score high enough to produce an overall site score above 28.5. In addition, samples have not been collected to characterize the air migration pathway. However, the potential for a release via the air pathway is considered relatively high because contamination during windy periods can be dispersed several miles from the site because the majority of the mining/milling waste pile is not covered by vegetation.

Ground Water Pathway

The Ground Water Pathway was not scored for the ALM facility because the surface water pathway and soil exposure pathway generate a score high enough to produce an overall site score above 28.5. The ground water pathway score would be based on potential contamination and would affect the overall site score minimally. However, ground water contamination remains a potential threat for the site and continued monitoring of the nearby drinking water wells should be conducted during the RI/FS.

Surface Water Drinking Water Threat, Potential Human Food Chain Targets, Potential Environmental Targets, and Soil Exposure Nearby Targets

Threats to these targets were not evaluated for the ALM facility because the generated HRS factor values do not significantly increase the overall HRS score. The surface water pathway receives a maximum value of 100 by evaluating the nearest food chain individual for potential contamination, and sensitive environments subject to Level II contamination. The nearby targets add minimal points (<10) to the overall soil exposure pathway. This is because the site area is in a relatively rural area.

HRS DOCUMENTATION RECORD

Name of Site: Annapolis Lead Mine (ALM)
EPA Region: 7
Date Prepared: February 2001
Street Address of Site: Iron County Road No.138 (North of Missouri Highway 49)
City, County, State: Annapolis, Iron County, Missouri
General Location in the State: Southeast Missouri
Topographic Map: United States Geological Survey (USGS), 1980, 7.5 Minute Quadrangle Des Arc, Missouri
Latitude: 37° 21' 20.0" North
Longitude: 90° 40' 30" West
Reference: 3

Scores

Air Pathway	NS
Ground Water Pathway	NS
Soil Exposure Pathway	53.33
Surface Water Pathway	100.00
HRS SITE SCORE	56.67

WORKSHEET FOR COMPUTING HRS SITE SCORE

	<u>S</u>	<u>S²</u>
1. Ground Water Migration Pathway Score (S _{gw})	NS	---
2a. Surface Water Overland/Flood Migration Component (from Table 4-1, line 30)	100.00	10,000
2b. Ground Water to Surface Water Migration Component (from Table 4-25, line 28)	NS	---
2c. Surface Water Migration Pathway Score (S _{sw}) Enter the larger of lines 2a and 2b as the pathway score.	100.00	10,000
3. Soil Exposure Pathway Score (S _s) (from Table 5-1, line 22)	53.33	2,844.09
4. Air Migration Pathway Score (S _a) (from Table 6-1, line 12)	NS	---
5. Total of S _{gw} ² + S _{sw} ² + S _s ² + S _a ²		12,844.09
6. HRS Site Score Divide the value on line 5 by 4 and take the square root.	56.67	

NS = Not scored

TABLE 4-1. SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET

Factor categories and factors	Maximum value	Value assigned
Drinking Water Threat		
Likelihood of Release:		
1. Observed Release	550	<u>550</u>
2. Potential to Release by Overland Flow		
2a. Containment	10	<u>NS</u>
2b. Runoff	25	<u>NS</u>
2c. Distance to Surface Water	25	<u>NS</u>
2d. Potential to Release by Overland Flow (lines 2a x [2b + 2c])	500	<u>NS</u>
3. Potential to Release by Flood:		
3a. Containment (Flood)	10	<u>NS</u>
3b. Flood Frequency	50	<u>NS</u>
3c. Potential to Release by Flood (lines 3a x 3b)	500	<u>NS</u>
4. Potential to Release (lines 2d + 3c, subject to a maximum of 500)	500	<u>NS</u>
5. Likelihood of Release (higher of lines 1 and 4)	550	<u>550</u>
Waste Characteristics:		
6. Toxicity/Persistence	(a)	<u>NS</u>
7. Hazardous Waste Quantity	(a)	<u>NS</u>
8. Waste Characteristics	100	<u>NS</u>
Targets:		
9. Nearest Intake	50	<u>NS</u>
10. Population		
10a. Level I Concentrations	(b)	<u>NS</u>
10b. Level II Concentrations	(b)	<u>NS</u>
10c. Potential Contamination	(b)	<u>NS</u>
10d. Population (lines 10a + 10b + 10c)	(b)	<u>NS</u>
11. Resources	5	<u>NS</u>
12. Targets (lines 9 + 10d + 11)	(b)	<u>NS</u>
Drinking Water Threat Score:		
13. Drinking Water Threat Score ([lines 5 × 8 × 12]/82,500, subject to a maximum of 100)	100	<u>NS</u>
Human Food Chain Threat		
Likelihood of Release:		
14. Likelihood of Release (same value as line 5)	550	<u>550</u>
Waste Characteristics:		
15. Toxicity/Persistence/Bioaccumulation	(a)	<u>5 × 10⁷</u>
16. Hazardous Waste Quantity	(a)	<u>10,000</u>
17. Waste Characteristics	1,000	<u>560</u>

TABLE 4-1. SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET (continued)

Factor categories and factors	Maximum value	Value assigned
Targets:		
18. Food Chain Individual	50	<u>20</u>
19. Population		
19a. Level I Concentrations	(b)	<u>0</u>
19b. Level II Concentrations	(b)	<u>0</u>
19c. Potential Human Food Chain Contamination	(b)	<u>0</u>
19d. Population (lines 19a + 19b + 19c)	(b)	<u>0</u>
20. Targets (lines 18 + 19d)	(b)	<u>20</u>
Human Food Chain Threat Score:		
21. Human Food Chain Threat Score ([lines 14 × 17 × 20]/82,500, subject to a maximum of 100)	100	<u>74.67</u>
Environmental Threat		
Likelihood of Release:		
22. Likelihood of Release (same value as line 5)	550	<u>550</u>
Waste Characteristics:		
23. Ecosystem Toxicity/Persistence/Bioaccumulation	(a)	<u>5 × 10⁸</u>
24. Hazardous Waste Quantity	(a)	<u>10,000</u>
25. Waste Characteristics	1,000	<u>1000</u>
Targets:		
26. Sensitive Environments		
26a. Level I Concentrations	(b)	<u>0</u>
26b. Level II Concentrations	(b)	<u>25</u>
26c. Potential Contamination	(b)	<u>0</u>
26d. Sensitive Environments (lines 26a + 26b + 26c)	(b)	<u>25</u>
27. Targets (value from 26d)	(b)	<u>25</u>
Environmental Threat Score:		
28. Environmental Threat Score ([lines 22 × 25 × 27]/82,500, subject to a maximum of 60)	60	<u>60</u>
Surface Water Overland/Flood Migration Component Score for a Watershed		
29. Watershed Score ^c (lines 13 + 21 + 28, subject to a maximum of 100)	100	<u>100</u>
Surface Water Overland/flood Migration Component Score		
30. Component Score (S _{of}) ^c (highest score from line 29 for all watersheds evaluated, subject to a maximum of 100)	100	<u>100</u>

^a Maximum value applies to waste characteristics category.

^b Maximum value not applicable.

^c Do not round to nearest integer.

NS =Not scored

TABLE 5-1. SOIL EXPOSURE PATHWAY SCORESHEET

Factor categories and factors	Maximum value	Value assigned
Resident Population Threat		
Likelihood of Exposure:		
1. Likelihood of Exposure	550	<u>550</u>
Waste Characteristics:		
2. Toxicity	(a)	<u>10,000</u>
3. Hazardous Waste Quantity	(a)	<u>10,000</u>
4. Waste Characteristics	100	<u>100</u>
Targets:		
5. Resident Individual	50	<u>50</u>
6. Resident Population:		
6a. Level I Concentrations	(b)	<u>30</u>
6b. Level II Concentrations	(b)	<u>0</u>
6c. Resident Population (lines 6a + 6b)	(b)	<u>30</u>
7. Workers	15	<u>0</u>
8. Resources	5	<u>0</u>
9. Terrestrial Sensitive Environments	(c)	<u>0</u>
10. Targets (lines 5 + 6c + 7 + 8 + 9)	(b)	<u>80</u>
Resident Population Threat Score:		
11. Resident Population Threat (lines 1 × 4 × 10)	(b)	<u>4.4 × 10⁶</u>
Nearby Population Threat		
Likelihood of Exposure:		
12. Attractiveness/Accessibility	100	<u>NS</u>
13. Area of Contamination	100	<u>NS</u>
14. Likelihood of Exposure	500	<u>NS</u>
Waste Characteristics:		
15. Toxicity	(a)	<u>NS</u>
16. Hazardous Waste Quantity	(a)	<u>NS</u>
17. Waste Characteristics	100	<u>NS</u>
Targets:		
18. Nearby Individual	1	<u>NS</u>
19. Population Within 1 Mile	(b)	<u>NS</u>
20. Targets (lines 18 + 19)	(b)	<u>NS</u>
Nearby Population Threat Score:		
21. Nearby Population Threat (lines 14 × 17 × 20)	(b)	<u>NS</u>
Soil Exposure Pathway Score		
22. Soil Exposure Pathway Score ^d (S _s), (lines [11 + 21]/82,500, subject to a maximum of 100)	100	<u>53.33</u>

^a Maximum value applies to waste characteristics category.

^b Maximum value not applicable.

^c No specific maximum value applies to factor. However, pathway score based solely on terrestrial sensitive environments is limited to maximum of 60.

^d Do not round to nearest integer.

NS= Not Scored

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- | Ref. No. | <u>Description of the Reference</u> |
|-----------------|--|
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| 3. | U.S. Geological Survey (USGS), 1980, 7.5-Minute Topographic Quadrangle Map of Des Arc, Missouri, 1980. |
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| 6. | Sverdrup Corporation, 1996, Screening Site Inspection Report for Site Assessment Activity at Annapolis Lead Mine, June 19, 1996, 238 pages (hand stamped, top right). |
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| 13. | Conner, Jon J., and Hansford T., Shacklette, 1984, Background Geochemistry of Some Rocks, Soils, Plants, and Vegetables in the Conterminous United States Geological Survey Professional Paper 574-F, U.S. Government Printing Office, Washington. D.C. 1984, 6 pages. |
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| 17. | Boone, Mark, 1998, Fisheries Management Biologist, Missouri Department of Conservation, Listing of Fish Species in Big Creek, Cape Girardeau, Missouri, July 8, 1998, 2 pages. |

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No. **Description of the Reference**

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APPENDICES

- A. Figures
- B. Photographic Record from 1997 ESI/RA
- C. EPA Data Results from 1996 SSI conducted by Sverdrup Corporation
- D. EPA Data Results from 1997 ESI/RA conducted by E & E/START

LIST OF ACRONYMS

AA	Atomic Absorption
ALM	Annapolis Lead Mine
bgs	Below Ground Surface
cfs	Cubic Feet per Second
CLP	Contract Laboratory Program
E & E	Ecology and Environment, Inc.
EPA	U.S. Environmental Protection Agency
ESI	Expanded Site Inspection
HRS	Hazard Ranking System
ICAP	Inductively Coupled Argon Plasma
MDNR	Missouri Department of Natural Resources
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
µg/L	micrograms per liter
PPE	Probable Point of Entry
ppm	parts per million
RA	Removal Assessment
SSI	Screening Site Inspection
START	Superfund Technical Assistance and Response Team
USGS	U.S. Geological Survey
W/A, Inc.	Walker Associates, Inc.
XRF	X-Ray Fluorescence

NOTES TO THE READER

1. The following rules were used when citing references in the Hazard Ranking System (HRS) package.
 - A. If the reference cited had an original page number, that original number is cited.
 - B. If the reference cited had no original page number, then a designated page number is assigned and cited.
 - C. If pagination of a reference is not complete, the original page number will be cited for those pages with page numbers and additional page numbers will be assigned and used for the remaining pages.
 - D. Analytical data will be referenced by the assigned page numbers.
 - E. The HRS will be referenced by Section and page numbers.
2. Hazardous substances are listed as they appear in the Superfund Chemical Data Matrix (SCDM).
- 3 Abbreviations/Conventions used to identify references and citations:

C	pg.	Single Page
C	pp.	Multiple pages
C	“;”	Next Reference
C	()	Selected acronyms

2.2 SOURCE CHARACTERIZATION

2.2.1 SOURCE IDENTIFICATION

Name of source: Chat/Tailing Pile

Number of source: 1

Source Type: Pile

Description and **Location** of Source (with reference to a map of the site):

Description: Galena ore (lead-bearing ore) (Ref. 7, pg. 47) was mined at the ALM facility beginning in the 1920s, continuing sporadically until 1940 (Appendix A, Figure A-1; Reference 7, pg. 54). There is evidence indicating that the mine had one shaft to 450 feet bgs with several hundred feet of lateral tunnels to work the ore bodies. Extracted ore was brought to the surface and milled at the former mining facility to obtain a purer extract. In the early 1920s the Annapolis Lead Company erected a power plant, hoisting plant, and ore-dressing plant. The mill operations began in 1923 and the plant operated under various managements until 1925 (Reference 8, pg. 2). During operations, mining/milling waste was generated and stockpiled at the former mining facility in a large tailings pile, which still exists today (Appendix A, Figure A-2). The chat/tailings pile is mostly unvegetated and occupies approximately 10 acres of the 50-acre former mining facility. The majority of the pile is composed of grey-to-tan colored material that resembles fine-grained sand, which is highly erodible, resulting in steep-sided features (Appendix B, Photo Nos. 4 to 7). The tailings pile is owned by multiple individuals (Ref. 9, pp. 5, 6; Ref. 6, pp. 7, 11, 12).

Location: The source is located in the southern section of Iron County, situated in southeast Missouri (Appendix A, Figure A-3). This area of southeast Missouri was known as the “old lead belt” and was formerly a major producer of lead (Ref. 7, pg. 41). Source 1 is located about 1 mile east of Annapolis, Missouri and is situated in the southeastern portion of the 50-acre former mining facility (Appendix A, Figures A-3 to A-4).

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

An EPA SSI was conducted by Sverdrup Corporation in June 1996 subsequent to a 1992 MDNR investigation, which identified lead and zinc contamination in the nearby Sutton Branch Creek (Ref. 6, pg. 8). During the SSI 34 locations were field screened with a Spectrace 9000 portable XRF unit (Ref. 6, pp. 16, 17, 18, 27). Soil/tailings were collected for confirmation of XRF screening locations from the tailings area, near the former residence, the former mine activity area, and in an area representative of native soil conditions (Ref. 6, Table 2b, pp. 16, 19, 20, 22). The samples were collected from a 0- to 3-inch interval (Ref. 6, pg. 16). Of the 34 XRF samples collected, 13 locations (locations 10 through 22) were reportedly collected from the tailings pile located at the former mining facility (Ref. 6, Table 2a, pp. 17, 18), the locations of the samples is shown on Figure 4b of the SSI report (Ref. 6, pg. 22) and XRF screening results are reported in Appendix C of the report (Ref. 6, pp. 79 to 91). The table below summarizes the XRF screening results for these 13 samples.

Analyte	Frequency of Detects	Concentration Range (mg/kg)	Average Concentration (mg/kg)
Cadmium	12/13	169 - 460	268
Lead	13/13	517 - 1,953	979
Nickel	5/13	94 - 280	141
Zinc	13/13	82 - 288	183

KEY: mg/kg = milligrams per kilogram

In addition to the XRF screening, nine soil samples were submitted to the EPA Region 7 laboratory for CLP metals analysis under activity number CC104 (Ref. 6, pg. 16). Tailings samples CC104-101, CC104-102 and CC104-103 were collected from the tailings area (Ref. 6, pp. 16, 19, 20, 22 [Figure 4b]). Soil sample CC104-111 was collected upgradient from the former mine area (Appendix A, Figure A-5; Ref. 6, pp. 16, 20, 22). This sample was collected to provide an indication of metals concentration in native soils (Ref. 6, pg. 20).

Results for samples CC104-102 and CC104-103, collected from Source 1 indicated concentrations of arsenic, copper, and lead significantly above native soils concentrations (Reference 6, Table 5, pg. 28; Appendix C, pp. 13, 14, 28).

In addition, extensive soil/tailings samples were collected during the 1997 EPA ESI/RA in other areas (outwash and former mining/milling areas) across the ALM facility (Appendix A, Figure A-4). These other source areas will be discussed in the source area 2 discussion beginning on page 16 of this HRS documentation record. During the ESI/RA chat/tailings samples were not collected at the pile (Source 1) because previous SSI analytical data was available. In addition, the levels of lead in the tailings pile were well above the normal range for lead in soils in Missouri which is 10 to 70 ppm (Reference 13, pg. 5).

- Background Samples and Concentrations:

Soil sample CC104-111 was collected upgradient from the former mine area (Appendix A, Figure A-5; Ref. 6, pp. 16, 20, 22). This sample was collected to provide an indication of metals concentration in native soils (Ref. 6, pg. 20).

Sample ID (CC104)	Sample Type	Date	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
-111	Soil	4/96	Arsenic Copper Lead	0.95 (U) 16.8 300	0.95 0.0832 0.702	Appendix C, pp. 20, 22, 30; Ref. 6, (Table 5), pp. 28, 121; Ref. 29, pp. 2, E-1

NOTE: See Attachment A, Figure A-5 for SSI soil sample locations.

KEY: U = Actual Value of Sample is < the Measurement Detection Limit (Reported Value)
mg/kg = Milligrams per Kilogram

- Source Samples and Concentrations:

Sample ID (CC104)	Sample Type	Date	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
-102	Tailings	4/96	Arsenic Copper Lead	44.6 92.3 971	0.95 0.0823 0.702	Appendix C, pp. 13, 22, 28; Ref. 6, (Table 5), pp. 28, 120; Ref. 29, pp. 2, E-1
-103	Tailings	4/96	Arsenic Lead	59 2,570	0.95 0.702	Appendix C, pp. 14, 22, 28; Ref. 6, (Table 5), pp. 28, 120; Ref. 29, pp. 2, E-1

NOTE: See Attachment A, Figure A-5 for SSI soil sample locations.

KEY: mg/kg = Milligrams per Kilogram

The ALM facility was once a mining community referred to by the locals as “Leadanna” (Reference 6, pg. 7). Lead ore was mined from the strata at the facility, beginning in the early 1920s and continuing sporadically until the 1940s (Ref. 7, pp. 54, 55; Appendix A, Figure A-1). Chat/tailings waste from the mining and milling operations were stockpiled in a large pile on site. According to production figures from 1923 to 1931 approximately 1,173,000 tons of mine waste were generated at the ALM facility (Reference 8, pp. 4, 5). EPA laboratory samples collected at Source 1 during the EPA SSI indicated concentrations of arsenic, copper, and lead. These metals concentrations in the tailings are significantly higher than native surface soil concentrations as documented by sample CC104-111.

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

Containment Description	Containment Factor Value	Reference
Gas release to air: Not Scored	NS	NS
Particulate release to air: Not Scored	NS	NS
Release to ground water: Not Scored	NS	NS
Release via overland migration and/or flood: Source 1 has no maintained engineered cover or run on and/or run off control system. Mine/milling tailings were stockpiled directly in a ravine tributary of Sutton Branch Creek located on site. During the EPA SSI and ESI/RA elevated concentrations of hazardous metals associated with Source 1 have been detected in the surface water pathway. During the 1997 ESI/RA sampling activities, there was evidence that source material from the pile had been washed and is continuing to be washed into Sutton Branch Creek, which eventually empties into Big Creek (Appendix B, photos 14, 15, 16; Ref. 5, pg. 6-1).	10	Appendix A, Figures A-1, A-2; Appendix B, Photos Nos. 5, 6, 7, 14, 15, 16.

KEY: NS = Not Scored

2.2.4 HAZARDOUS WASTE QUANTITY

2.2.4.1 Volume

Description: Approximately 10 acres of the former mining facility is stockpiled with chat/tailings rich in metals, particularly cadmium, lead, and zinc. Several techniques were employed during the ESI/RA (for removal assessment purposes) to estimate volume of metal-contaminated chat/tailings that may require excavation and/or stabilization. An aerial survey was performed by Walker Associates, Inc. (W/A, Inc.) from St. Louis, Missouri (Reference 5, pg. 3-3). Field control points (i.e., XRF screening points, sample locations, and cultural features) were established by EPA/START during the ESI/RA survey/sampling activities. W/A, Inc. obtained an aerial photograph from which all features were digitized using a stereo plotter. Vertical elevation data were digitized in the form of a digital terrain model, and topographic contours were developed at 2-foot interval. The resulting map is provided in Reference 28. The stereoscopic mapping techniques used by W/A, Inc. assisted with the volumetric estimate of the chat/tailings pile. In addition, EPA/START collected ten Geoprobe™ continuous soil profiles at the pile to aid in determining the depth of the parent material. The depth to parent material at these 10 locations varied between surface outcrops to over 21 feet (Reference 12, pg. 8). Further, outcroppings of parent material were land-surveyed at locations in the chat/tailings pile to assist with the volumetric calculations (Reference 11). The volume of material in the pile was estimated by subtracting the topography of the underlying parent material (which was estimated from on-site surveying [of surface parent material and Geoprobe™ waste/soil profiles] from the existing topography of the chat/tailings pile (which was derived from on-site surveying and aerial mapping). The resulting volume of material was 38,989 cubic yards. This volume estimation was derived by W/A., Inc. and is presented in Reference 11.

Source Type	Description (# drums or dimensions)	Units (yd ³ /gal)	References
Pile	Chat/Tailings Waste	38,989 yd ³	11

Sum (yd³/gal): 38,989 yd³

Equation for Assigning Value: 38,989/V 2.5 (Reference 1, Section 2.4.2.1.3, Table 2-5, pg. 51591)

2.2.4.2 Source Hazardous Waste Quantity Value

According to Section 2.4.2.1.5 of the HRS Final Rule, the highest of the values assigned to the source for hazardous constituent quantity (Tier A), hazardous wastestream quantity (Tier B), volume (Tier C), and area (Tier D) should be assigned as the source hazardous waste quantity value (Reference 1, Section 2.4.2.1.5, pg. 51591). Tiers A and B were not evaluated for Source 1 because the available information was not sufficient to evaluate these waste quantity tiers. Tier D (area) was also not evaluated because a greater HWQ value for volume can be assigned. According to the HRS Final Rule the highest HWQ value for volume or area should be assigned for source HWQ.

Highest assigned value assigned from Table 2-5: 15,595.6

2.2.2 SOURCE IDENTIFICATION

Name of source: Outwash and Former Mining Areas

Number of source: 2

Source Type: Contaminated Soil

Description and Location of Source (with reference to a map of the site):

Description: During the 1997 ESI/RA four metal-contaminated source areas, including the chat/tailings pile, mill-slime pond, former mining area, and the outwash area were evaluated for removal assessment purposes (Reference 5, pp. 4-1 to 4-7). These four areas are illustrated in Appendix A, Figure A-4 and were based on XRF *in situ* screening for lead contamination (Reference 28), metals confirmation sampling, previous investigations, and historical background information. The outwash area is a flat area with sparse vegetation and is composed of soil and residual material from the chat/tailings pile (Appendix B, Photo No. 14). This area was estimated to be about 5 acres for removal assessment purposes and is located adjacent (downgradient) of the chat/tailings pile and fans westwardly to Sutton Branch Creek (Appendix A, Figure A-4; Reference 11). The former mining area was estimated to be about 7 acres and is composed of mining refuse, including small boulder-sized chunks of ore, which are interspersed among the former buildings. Most of the buildings have deteriorated in the mining area to where only foundations are present (Appendix B, Photo Nos. 8 to 11). An exception is a single story of a once multi-storied structure near the center of the former mining facility, which was a former residence (Appendix B, Photo No. 3). Sections of the former mining area are vegetated and wooded. The former mining area is located north-northwest of the chat/tailings pile (Appendix A, Figures A-1, A-4).

Source 2 consists of contaminated surface soils within the designated outwash and former mining areas and is defined for HRS scoring purposes by confirmation EPA laboratory data. Sample locations -302, -305, -306, -310, -312 and -317 are used to delineate the boundaries of Source 2. These outermost soil sample locations meet the criteria for an observed release and were connected by lines on a scaled map (Appendix A, Figure A-6). This defined area of contamination is a conservative measurement for Source 2 because in-situ XRF readings indicated a much larger extent of surface soil contamination (Reference 28).

Location: Source 2 is located west-northwest of the chat/tailings pile. More specifically its boundaries extend west of County Road 138 adjacent to Sutton Branch Creek and to the east of the former residence. The furthest northern sample location (-305) and southern sample location (-317) extends about 250 feet and 400 feet from the former residence, respectively. Source 2 is illustrated in Appendix A, Figure A-6.

2.2.3 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

The XRF screening, which was conducted during the ESI/RA in the outwash and former mining areas indicated that lead contamination above 500 mg/kg exists throughout these two designated areas (Reference 5, pp. 4-2 to 4-5; Reference 28). Six confirmation surface soil samples (0-6 inches and 6-12 inches) were collected within the outwash area and eight surface soil samples (0-6 inches and 6-12 inches) were collected within the mining area, including adjacent to the former residence (Reference 5, [Table 4-2], pg. 4-5; Appendix D, pp. 44 to 52, 54 to 62, 87 to 90). The six contaminated source samples collected at 6-inch intervals are listed in the following table and were used to delineate the boundaries of the contaminated soil for Source 2. EPA analytical results of background samples (-313, -314, and -315) collected at a 6-inch interval north and northwest of the mining area were used for comparison purposes (Reference 5, [Table 4-2], pg.4-5). The highest concentrations detected in the three background samples were used for comparison. The highest metal concentrations identified within Source 2 was at sample location -300 collected within the former mining area and adjacent to the former residence. Metal concentrations identified at sample -300 included arsenic at 85 mg/kg, cadmium at 7.7 mg/kg, lead at 20,000 mg/kg, and zinc at 740 mg/kg (Reference 5, [Table 4-2], pg. 4-5; Appendix D, pg. 87). These concentrations for these metals are three or more times the designated background concentration. In addition, the levels of lead in the contaminated soils were well above the normal range for lead in soils in Missouri which is 10 to 70 ppm (Reference 13, pg. 5).

- Background Samples and Concentrations:

Sample ID (AGXXL)	Sample Type (inches)	Date	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
-314	Soil (0-6)	11/97	Arsenic Cadmium Zinc	9.6 0.56 46.1	1.47 0.25 0.49	App. D, pp. 58, 89; Ref. 5, (Table 4-2), pg. 4-5; Ref. 29, (Table 3), pg. 8 of 12
-315	Soil (0-6)	11/97	Lead	103	0.68	App. D, pp. 59, 90; Ref. 5, (Table 4-2), pg. 4-5; Ref. 29, (Table 3), pg. 9 of 12
-316	Soil (6-12)	11/97	Cadmium Lead	0.23 24.2	0.23 0.68	App. D, pp. 60, 90; Ref. 5, (Table 4-2), pg. 4-5; Ref. 29, (Table 3), pg. 10 of 12

NOTE: See Appendix A, Figure A-6 for ESI/RA surface soil sample locations. For 0-6 inch samples the highest concentration of the three background surface soil (0-6") samples was used for comparison of each analyte.

- Source Samples and Concentrations:

Sample ID (AGXXL)	Sample Type (inches)	Date	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
-302	Soil (0-6)	11/97	Lead Zinc	3,290 180	0.66 0.44	App. D, pp. 46, 87; Ref. 5, (Table 4-2), pg. 4-5; Ref. 29, (Table 2), pg. 16 of 20
-305	Soil (0-6)	11/97	Cadmium Lead Zinc	1.9 411 266	0.25 0.75 0.50	App. D, pp. 49, 88; Ref. 5, (Table 4-2), pg. 4-5; Ref. 29, (Table 2), pg. 19 of 20
-306	Soil (0-6)	11/97	Cadmium Lead Zinc	2.0 466 186	0.23 0.69 0.46	App. D, pp. 50, 88; Ref. 5, (Table 4-2), pg. 4-5; Ref. 29, (Table 2), pg. 20 of 20
-310	Soil (0-6)	11/97	Arsenic Cadmium Lead Zinc	53.4 4.9 1,690 319	1.25 0.21 0.62 0.42	App. D, pp. 54, 89; Ref. 5, (Table 4-2), pg. 4-5; Ref. 29, (Table 3), pg. 4 of 12
-312	Soil (6-12)	11/97	Cadmium Lead	2.3 130	0.23 0.68	App. D, pp. 56, 89; Ref. 5, (Table 4-2), pg. 4-5; Ref. 29, (Table 3), pg. 6 of 12
-317	Soil (0-6)	11/97	Arsenic Cadmium Lead Zinc	32 3.4 1,340 204	1.24 0.21 0.62 0.41	App. D, pp. 61, 90; Ref. 5, (Table 4-2), pg. 4-5; Ref. 29, (Table 3), pg. 11 of 12

NOTE: See Appendix A, Figure A-6 for ESI/RA surface soil sample locations.

ALM was once a mining community referred to by the locals as “Leadanna” (Reference 6, pg. 7). Lead ore was mined from the strata at the former mining facility, beginning in the early 1920s and continuing sporadically until the 1940s (Reference 7, pg. 54). Chat/tailings waste from the mining and milling operations were stockpiled in a large pile at the ALM facility. This pile still exist today (Appendix A, Figure A-2). According to production figures from 1923 to 1931 approximately 1,173,000 tons of mine waste were generated at the ALM facility (Reference 8, pp. 4, 5). Currently, there is nearly 40,000 cubic yards of tailings waste remaining on the ALM facility. Surface soil samples collected within the mining and outwash areas and within the designated source area (Source 2) indicate elevated metal concentrations, particularly arsenic, cadmium, lead, and zinc above the designated background concentration. Contaminated soils within the outwash area (Appendix A, Figure A-4) are the result of deposition from the large chat/tailings pile during rainfall and/or strong wind events spreading the contaminants because there is minimal vegetative cover over the pile. The ALM facility is situated on relatively rugged terrain that slopes westward towards Sutton Branch Creek (Appendix A, Figure A-3).

EPA laboratory samples collected at Source 2 during the EPA SSI indicated concentrations of arsenic, cadmium, lead, and zinc. These metals concentrations in the outwash and former mining areas are significantly higher than native surface soil concentrations as documented by samples AGXXL-314, AGXXL-315, and AGXXL-316.

2.2.4 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

Containment Description	Containment Factor Value	References
Gas release to air: Not Scored	NS	NS
Particulate release to air: Not Scored	NS	NS
Release to ground water: Not Scored	NS	NS
Release via overland migration and/or flood: Source 2 has no maintained engineered cover or run on and/or run off control system. Mine/milling tailings were stockpiled directly in a ravine tributary of Sutton Branch Creek located on site (Source 1). During the EPA ESI/RA sampling activities, there was evidence that source material from Source 1 and Source 2 had been washed into Sutton Branch Creek, which eventually empties into Big Creek (Appendix B, photos 14, 15, and 16; Ref. 5, pg. 6-1).	10	Appendix A, Figures A-1, A-2; Appendix B, Photos Nos. 5,6,7.

KEY: NS = Not Scored

2.2.5 HAZARDOUS WASTE QUANTITY

2.2.5.1 Area

Description

Metal-contaminated surface soils have been identified within the outwash and mining areas on the ALM facility. An area of contaminated soil (Source 2) has been delineated based on EPA laboratory sample results for the 1997 ESI/RA (see Section 2.2.2 for source 2 of the HRS documentation record). This area is a conservative measurement because XRF readings have indicated a much larger contaminated soil area. The waste quantity for Source 2 was not determined; however, is considered significant. Therefore, the area of soil contamination was assigned an area hazardous waste quantity value of greater than (>) 0, but the exact amount is unknown. The value of > 0 reflects that the area value is known to be greater than 0, but the exact amount is unknown.

Source Type	Units (ft ²)	References
Contaminated Soil	> 0; but unknown	Ref. 1, Section 2.4.2.1.4, (Table 2-6), pg. 51592; Appendix A, Figure A-6

Sum (ft²): > 0 square feet

Equation for Assigning Value : A/34,000 (Ref. 1, Section 2.4.2.1.4, (Table 2-5), pg. 51591

Area Assigned Value: **> 0; but unknown**

2.2.5.2 Source Hazardous Waste Quantity Value

According to Section 2.4.2.1.5 of the HRS Final Rule, the highest of the values assigned to the source for hazardous constituent quantity (Tier A), hazardous wastestream quantity (Tier B), volume (Tier C), and area (Tier D) should be assigned as the source hazardous waste quantity value (Ref. 1, pg. 51591, Section 2.4.2.1.5). Tiers A to C were not evaluated for Source 2 because the available information was not sufficient to evaluate these waste quantity tiers.

Highest assigned value from Table 2-5: **> 0; but unknown**

SUMMARY OF SOURCE DESCRIPTIONS

Source No.	Source Hazardous Waste Quantity Value	Source Hazardous Constituent Quantity Complete? (Y/N)	Containment Factor Value by Pathway				
			Ground Water (GW) (Table 3-2)	Surface Water (SW)		Air	
				Overland/flood (Table 4-2)	GW to SW (Table 3-2)	Gas (Table 6-3)	Particulate (Table 6-9)
1	15,595.6	N	NS	10	NS	NS	NS
2	> 0	N	NS	10	NS	NS	NS

KEY: NS = Not Scored

Description of Other Potential Sources

The mill slime pond (Appendix A, Figures A-1, A-2) located about 500 feet north of the chat/tailings pile contained the second highest lead concentration from the samples collected for laboratory analysis (-309; 7,000 mg/kg) and the area consistently produced the highest XRF lead screening values ranging from 5,700 mg/kg to 9,290 mg/kg (Reference 28). This highest concentration was collected at a 6-to 12-inch interval and is about 80 times the designated background concentration of 72 mg/kg (Reference 5, [Table 4-2], pg. 4-5; Appendix D, pp. 53, 88). A single core sample collected from the mill-slime pond indicated that the basin area had a solid/concrete floor and the area of the former structure was about 10,000 square feet (Reference 5, pp. 4-6, 4-7). This source area was not evaluated because it would not significantly change the overall HRS score. In addition, the threat of a release from this area is considered minimal due to the containment structure underlying the basin area.

4.0 SURFACE WATER MIGRATION PATHWAY

4.1 OVERLAND/FLOOD MIGRATION COMPONENT

4.1.1 Definition of Hazardous Substance Migration Path for Overland/Flood Component

Sutton Branch Creek borders the western boundary of the ALM facility (Appendix A, Figures A-1, A-2). There is strong evidence that source material from the chat/tailings pile (Source 1) is being washed into Sutton Branch Creek (Appendix B, Photographs 7, 14, 15). The tailings are located in a ravine, which is a tributary to Sutton Branch and ultimately flows to Big Creek (Appendix A, Figures A-2, A-3). Deposition is most likely occurring during rainfall events where tailings from the pile enter a drainage channel and eventually washes into Sutton Branch. As seen by the 1939 aerial Photo (Appendix A, Figure A-1) tailings can be seen directly adjacent to Sutton Branch. In addition, tailings (tan-to-grayish fine sediments) were observed during previous inspections along Sutton Branch, particularly at Highway 49 (Ref. 14). Tailings were reported to be at least two feet deep (Reference 14, pp. 1 and 2; Appendix B, Photo No.18). During the 1997 EPA investigation tailings material were observed at every surface water/sediment sample location along Sutton Branch Creek starting at the mine tailings outfall to the confluence with Big Creek. Big Creek, a perennial stream, flows southeast from the site for about 20 miles until it joins the St. Francis River immediately upstream of Lake Wappello. A secondary tributary, Hampton Branch, enters Sutton Branch about 100 feet upstream of the confluence of Big Creek and Sutton Branch (Appendix A, Figure A-7). During the ESI/RA water was observed in Hampton Branch (Appendix B, Photo No. 20). According to the U.S. Geological Survey topographic map for the site area (Reference 3), Sutton Branch is depicted as an intermittent stream; however, during ESI/RA field work in 1997 Sutton Branch exhibited the characteristics of a losing and gaining stream (characteristics typical of karst topography). During the EPA field work the creek bottom about 0.30 miles downstream of the mine tailings outfall was dry, but flowing water was observed further downstream. Flowing water was also observed at the confluence of Sutton Branch and the Big Creek (Appendix A, Photo Nos. 17 to 20).

For HRS scoring purposes Sutton Branch will be evaluated as an intermittent creek and designated as part of the overland segment. The overland segment extends from the on-site sources to Sutton Branch and then along Sutton Branch for about 3,960 feet before merging with Big Creek. The PPE for HRS scoring has been designated at the point where Sutton Branch merges with Big Creek (Appendix A, Figures A-7, A-8). The entire 15-mile TDL is composed of Big Creek (Appendix A, Figure A-8). The nearest USGS gaging station to the site is on Big Creek at Des Arc, located approximately 6 miles downstream of the confluence with Sutton Branch Creek (Reference 3). Average flow from 1983 to 1996 for Big Creek at Des Arc was 151 cfs (Reference 15, pg. 3). Metal contamination may also be occurring along Sutton Branch upstream of the mine tailings outfall from the former mining area during heavy rainfall events. However, for HRS scoring the mine tailings outfall (sample -108/-208) located downgradient (west) of the ALM chat/tailings pile (Source 1) was used as the PPE to Sutton Branch (Appendix A, Figure A-7).

Five surface water and six sediment samples, including background were collected along Sutton Branch to characterize the overland flow segment (Reference 5, [Table 3-1], pg.3-4). A single surface water/sediment sample point was also collected on Hampton Branch (sample -106/-206) to determine if this tributary may be contributing metal contamination to Big Creek. In addition, sediment sample -209 was collected along the drainage channel located on-site and downgradient of the chat/tailings pile about 250 feet east of the mine tailings outfall (Appendix A, Figure A-7). The following table highlights the selected analytical metal results of the sediment samples collected along Sutton Branch. Lead was the only metal detected in the total and dissolved aqueous samples along Sutton Branch, which was above the background concentration and designated AWQC benchmark of 2.5 µg/L for lead. Total lead was found as high as 17.4 µg/L and dissolved lead was found as high as 13.0 µg/L downstream of the mine tailings outfall (Reference 5, [Table 6-1], pg. 6-5; Appendix D, pp. 25 to 30, pp. 80 to 82).

SEDIMENT SAMPLE RESULTS—Annapolis Mine November 1997—EPA ESI/RA Units: mg/kg					
Sample Number (AGXXL)	Sample Location	Analytes			
		Arsenic	Cadmium	Lead	Zinc
Sutton Branch					
-205	Sutton Branch Creek (downstream of Outfall)	54	1.7	1,700	140
-207	Sutton Branch Creek (2,000' downstream of Outfall)	88	2	2,900	170
-208	Mine Tailings Outfall	60	1.9	2,600	140
-209	Drainage Channel	69	2.2	2,600	150
Background -212	Sutton Branch Creek (0.75 miles upstream of Outfall)	7.6	0.24 U	11	27
Hampton Branch					
-206	Hampton Branch Creek	8.4	0.29 U	32	65

NOTE: See Attachment A, Figure A-7 for sample locations and Appendix D, pp. 36 - 40, 43, pp. 85 and 86 for sample results.

KEY: **Bold** = Concentration is equal to or above the background detection limit or is at least 3 times above background concentration.
 U = Actual value of sample is < the measurement detection limit (the reported value).

Cadmium concentrations in the sediments of Sutton Branch downstream of the ALM facility ranged from 1.7 mg/kg (sample -205) detected at the furthestmost downstream sample collected along Sutton Branch to 2.2 mg/kg (sample -209) detected at the drainage channel downgradient of the chat/tailings pile (Appendix A-1, Figure A-7). These concentrations were three times above background concentrations. Sediment samples from Sutton Branch Creek collected upstream of the outfall (-211 & -212) and in Hampton Branch (-206) indicated cadmium below the laboratory detection limits (Reference 5, [Table 6-2], pg. 6-7; Appendix D, pp. 32 to 35, pp. 84 and 85). Lead was the metal detected at the highest concentration in sediments along Sutton Branch at 2,900 mg/kg (sample -207; collected 2,000 feet downstream of the outfall). Additionally, lead was detected at a concentration of 2,600 mg/kg in sample -208 (outfall) and sample -209 (drainage channel), respectively. These concentrations were significantly above the upstream (background) concentration of 11 mg/kg (sample -212) at Sutton Branch (Appendix A, Figure A-7). Arsenic was found above background concentrations along the entire Sutton Branch Creek segment starting at the outfall (sample -208; 60 mg/kg) to the confluence with Big Creek (sample -205; 54 mg/kg) (see table above and Appendix A, Figure A-7). In addition, zinc concentrations were elevated three times above background concentrations along the drainage channel and the Sutton Branch segment, ranging from 140 mg/kg (sample -208) to 170 mg/kg (sample -207) (Appendix A, Figure A-7).

The analytical results for Big Creek (in-water segment) will be discussed in detail in Section 4.1.2.1 of this HRS documentation record. Big Creek is used for fishing, and recreational activities such as swimming and boating. MDNR classifies Big Creek as an Outstanding State Resource Water, which contains high quality waters with significant aesthetic, recreational, or scientific value (Reference 16, pg. 2). Some fish species commonly caught in Big Creek include small mouth and large mouth bass, green sunfish, and bluegill (Reference 17, pg. 2). U.S. Fish and Wildlife Service studies have been conducted that indicate that edible fish from Big Creek have elevated levels of metals concentrations in their blood system. The studies implicated the ALM facility as a contributor of metal contamination to Big Creek downstream of its confluence with Sutton Branch Creek. These fishery studies will be discussed in detail on page 30 of this HRS documentation record. In addition, HRS-eligible wetlands are known to exist at the confluence of Sutton Branch and Big Creek (about 0.75 miles) downstream of the site (Appendix A, Figure A-7; Appendix B, Photo No. 20). Other wetlands are also located along Big Creek and within the 15-mile target distance limit (Reference 18).

4.1.2 Likelihood of Release

4.1.2.1 Observed Release

Direct Observation

- **Basis for Direct Observation:** Not Scored

Chemical Analysis

As part of the 1999 ESI, 11 surface water and 13 sediment samples were collected (Ref. 5, pg. 3-1). Samples were submitted to the EPA Region 7 laboratory for metals analysis (Ref. 5, pg. 3-1). Surface water samples (AGXXL-100 through AGXXL-110) (Ref. 5, pg. 3-4) were analyzed for both total and dissolved metals, sediments (AGXXL-200 through AGXXL-212) were analyzed for total metals only (Ref. 5, pp. 3-1, 3-2, 3-4). All of the sediment metals analyses were performed by inductively coupled argon plasma (ICAP), except mercury which was conducted by cold vapor atomic adsorption (CVAA) (Appendix D, pp. 82 - 86). All of the surface water metals analyses (total and dissolved) were performed by inductively coupled argon plasma (ICAP), except mercury which was conducted by CVAA; in addition cadmium and lead were also analyzed by atomic adsorption (AA) (Appendix D, pp. 76 - 84).

In the discussion below, surface water sample results reflect total metals analysis. AA results for cadmium and lead are used, ICAP results for zinc are presented (zinc was not analyzed via AA methods).

- **Background Aqueous and Sediment Samples:**

Collocated surface water and sediment samples (-103/-203) were collected along Big Creek about 250 feet upstream of the confluence with Sutton Branch (Reference 5, [Tables 6-1 and 6-2], p 6-4 and 6-7; Appendix D, pp. 23 and 34, pp. 77, 85). The rationale for choosing this location was to document any metal contamination upstream of the site on Big Creek. No total or dissolved metal concentrations were identified in any aqueous sample collected; however, some metals were detected in the background sediment sample and are reported below. Surface water samples were analyzed for total and dissolved metals (Ref. 5, pp. 3-1, 3-2). Eleven surface water samples (numbered 100 through 110) were collected during the ESI/RA (Ref. 5, pg. 3-4).

Sediment samples consisted of grab samples collected using a stainless steel auger to a depth of 1 foot (Reference 5, pg. 6-3). Aqueous samples for total metals were collected directly into the appropriate container. Aqueous samples for dissolved metals were filtered prior to placement into the appropriate container.

Sample ID (AGXXL)	Sample Medium	Sample Location	Date	Reference
-103	Aqueous	Big Creek, 250' upstream of confluence with Sutton Branch	11/97	5, pg. 6-4; Appendix D, pg. 77
-203	Sediment	Big Creek, 250' upstream of confluence with Sutton Branch	11/97	5, pg. 6-7; Appendix D, pg. 85

- **Background Aqueous Concentrations**

Sample ID (AGXXL)	Hazardous Substance	Concentration (µg/L)	Sample Quantitation Limit (µg/L)	Reference
-103	Cadmium	0.9 U	0.901	5, (Table 6-1), pg. 6-4 Appendix D, pg. 76; 29, Table 5 and 6, Appendix G 1
	Lead	1 U	1.00	
	Zinc	4.07 U	4.07	

NOTE: See Appendix A, Figure A-7 for sample locations and Appendix D for sample results.

KEY: U = The material was analyzed for, but was not detected. The associated numerical value is the sample detection limit.

- Background Sediment Concentrations

Sample ID (AGXXL)	Hazardous Substance	Concentration (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
-203	Arsenic	4.4	1.43	Appendix D, pg. 85; 5, (Table 6-2), pg. 6-7; 29, Table 2, pg. 4 of 20
	Cadmium	0.92	0.24	
	Lead	9.6	0.71	
	Zinc	22	0.48	

NOTE: See Appendix A, Figure A-7 for sample locations and Appendix D for sample results.

- Contaminated Aqueous and Sediment Samples:

An observed release was established by sediment and aqueous samples collected along Big Creek as they were above background concentrations exhibited in sediment sample -203 and aqueous sample -103. All of the designated sediment and aqueous samples which were contaminated were collected downstream of the confluence of Sutton Branch and Big Creek (Appendix A, Figure A-7). The rationale for choosing these sample locations was to document metal contamination in Big Creek that may be associated with the sources at the ALM facility. In 1992, MDNR identified similar metal constituents at elevated concentrations at the confluence of Sutton Branch and Big Creek with arsenic at 150 mg/kg, cadmium at 3.6 mg/kg, lead at 4,400 mg/kg and zinc at 250 mg/kg (Reference 19, pg. 5).

Sediment samples consisted of grab samples collected using a stainless steel auger to a depth of 1 foot (Reference 5, pg. 6-3). Aqueous samples for total metals were collected directly into the appropriate container.

Sample ID (AGXXL)	Sample Medium	Sample Location	Distance from PPE [mile(s)]	Date	Reference
-204	Sediment	Big Creek and Sutton Branch Creek Confluence (PPE)	0 (PPE)	11/97	Appendix D, pg. 35
-104	Aqueous	Big Creek and Sutton Branch Creek Confluence (PPE)	0 (PPE)	11/97	Appendix D, pg. 24
-202	Sediment	Big Creek, 100 feet down-stream of PPE	0.02	11/97	Appendix D, pg. 33
-102	Aqueous	Big Creek, 100 feet down-stream of PPE	0.02	11/97	Appendix D, pg. 22
-201	Sediment	Big Creek, 800 feet down-stream of PPE	0.15	11/97	Appendix D, pg. 32
-101	Aqueous	Big Creek, 800 feet down-stream of PPE	0.15	11/97	Appendix D, pg. 21
-200	Sediment	Big Creek, 1,980 feet down-stream of PPE	0.38	11/97	Appendix D, pg. 31
-100	Aqueous	Big Creek, 1,980 feet down-stream of PPE	0.38	11/97	Appendix D, pg. 20

- Contaminated Aqueous Concentrations—Big Creek

Sample ID (AGXXL)	Hazardous Substance	Concentration (µg/L)	Sample Quantitation Limit (µg/L)	Reference
-102	Cadmium	2.48	0.901	Appendix D, pg. 76, 77; 29, Table 5 and 6, Appendix G 1
	Zinc	4.32	4.07	
-100	Lead	4.58	1.00	Appendix D, pg. 76, 77; 29, Table 5 and 6, Appendix G 1
	Zinc	6.01	4.07	
-101	Lead	2.16	1.00	Appendix D, pg. 76, 77; 29, Table 6, Appendix G 1
-104	Lead	3.94	1.00	Appendix D, pg. 79, 80; 29, Table 5 and 6, Appendix G 1
	Zinc	14.1	4.07	

NOTE: The value for each analyte is the total metal concentration. Total cadmium and lead were analyzed by atomic adsorption (AA) and inductively coupled argon plasma (ICAP). Zinc was done by ICAP alone. AA results are reported for lead and cadmium, ICAP results are reported for zinc.

- Contaminated Sediment Concentrations—Big Creek

Sample ID (AGXXL)	Hazardous Substance	Concentration (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
-200	Arsenic	16	1.46	Appendix D, pp. 31 and 82; Ref. 29, Table 2, pg. 1 of 20
	Lead	440	0.73	
-201	Arsenic	14	1.60	Appendix D, pp. 32 and 82; Ref. 29, Table 2, pg. 2 of 20
	Lead	340	0.80	
-202	Arsenic	76	1.87	Appendix D, pp. 33 and 82; Ref. 29, Table 2, pg. 3 of 20
	Lead	1,700	0.94	
	Zinc	130	0.62	
-204	Arsenic	18	1.57	Appendix D, pp. 35 and 85; Ref. 29, Table 2, pg. 5 of 20
	Lead	250	0.78	

Attribution

The November 1997 EPA analytical data from the samples collected during the ESI/RA show that elevated concentrations of heavy metals, particularly arsenic, cadmium, lead, and zinc were found in the sediments and/or surface water in Big Creek that were significantly above background concentrations (Ref. 1, Section 2.3, pg. 51589). Lead was elevated three times above the designated background concentration in Big Creek at the furthest downstream sample location (sample -200), which was collected about 1,980 feet downstream of the confluence with Sutton Branch (PPE) (Appendix A, Figure A-7). Other sediment samples (sample -201 and sample -202) collected downstream at 800 feet and 100 feet, respectively of the PPE also indicated that a release of heavy metals has occurred. Sample -202 was found to have arsenic as high as 76 mg/kg, lead as high as 1,700 mg/kg, and zinc as high as 130 mg/kg (Appendix A, Figure A-7; Appendix D, pg. 82) Although cadmium was not found above background concentrations in sediment samples, it was identified in one aqueous sample (sample -102; 2.48 µg/L) above the designated background concentration of 0.901U µg/L (Appendix A, Figure A-7; Appendix D, pg. 77). This concentration was reported in the total metal fraction only and the sample was collected 100 feet downstream of the PPE. Total and/or dissolved lead and/or zinc were also identified along Big Creek at the confluence (sample -204), 100 feet downstream of PPE (sample -202), 800 feet downstream of PPE (sample -201), and 1,980 feet downstream of the PPE (sample -200) (see the above tables and Appendix A, Figure A-7).

The analytical results of samples collected along Sutton Branch (overland segment) also supports the observed release documented at Big Creek. Elevated metal concentrations three times or more above the Sutton Branch background concentration was evident at the mine tailings outfall sediment sample (sample -208) and at the runoff drainage channel sediment sample (sample -209), which receives materials from the chat/tailings pile during rainfall events. In addition, lead concentrations were found as high as 2,900 mg/kg in sediment sample (sample -207) collected 2,000 feet downstream of the mine tailings outfall area. Cadmium and zinc were also elevated three times or more above the background concentration at the same sediment sample location. Sediment sample results for samples -206, collected along Hampton Branch, -210, collected upstream of outfall from an unnamed tributary to Sutton Branch, and -211, collected about 500 feet upstream of outfall along Sutton Branch indicated considerable lower metal concentrations than sediments samples collected downstream of the mine tailings outfall (Reference 5, [Tables 6-1 & 6-2], pp. 6-4 to 6-7). Total and dissolved lead concentrations were also identified above background concentrations downstream of the outfall. Lead was the only heavy metal detected in aqueous samples collected along Sutton Branch. In addition to the chemical analysis tailings were observed by EPA/START in every surface water sample collected downstream along Sutton Branch (Appendix B, Photos Nos. 17 to 20).

The above hazardous substances documenting the surface water release can be attributable to the on-site sources (Source 1 & 2) at the ALM facility by the following:

Historical aerial photographs from 1939 (Appendix A, Figure A-1) and information documenting that a hazardous waste (chat/tailings) pile (Source 1) exists at the former mining facility from as early as 1923 (Ref. 8, pp. 2, 4). Visual observation indicates the pile is highly erodible, which has resulted in steep-sided features (Appendix B, photographs 4, 5, 6, and 7). This pile consists of tan-to-gray fine-silty sediment material which has washed into Sutton Branch Creek (Appendix B, photographs 14, 15, 16, 17, and 18) which flows to Big Creek (Appendix A, Figure A-7).

Visual observation of mine/mill tailings in the drainage channel located in the area of the former mining facility and Sutton Branch (Appendix B, photographs 14, 15, 16, 17, and 18).

EPA analytical data documenting heavy metal concentrations in surface water pathway samples at concentrations above designated background concentrations and benchmarks (see section 4.1.2.1 of this documentation record).

Hazardous Substances Released

Chemical analysis has indicated that aqueous and sediment samples collected along Big Creek during the 1997 EPA ESI/RA investigation has documented an observed release for arsenic, cadmium, lead, and zinc. An observed release factor value of 550 is assigned for the surface water pathway.

Surface Water Observed Release Factor Value: 550

4.1.3 Human Food Chain Threat Waste Characteristics

4.1.3.1 Toxicity/Persistence/Bioaccumulation

Hazardous Substance	Source No.	Toxicity Factor Value	Persistence Factor Value	Bioaccumulation Value	Toxicity/Persistence/Bioaccumulation Factor Value (Table 4-16)	References
Arsenic	1, 2	10,000	1.0	5	50,000	2, pg. BI-1
Cadmium	2	10,000	1.0	5,000	50,000,000	2, pg. BI-2
Copper	1	---	1.0	500	---	2, pg. BI-3
Lead	1, 2	10,000	1.0	5	50,000	2, pg. BI-8
Zinc	2	10	1.0	5	50	2, pg. BI-12

Note: River (fresh water) waters was the water category used for determining factor values for persistence and bioaccumulation. Factor values for each hazardous substance were obtained from SCDM, January 2004 (Ref. 2) .

KEY: --- = Not listed in SCDM.

Toxicity/Persistence/Bioaccumulation Factor Value: 5×10^7

4.1.3.2 Hazardous Waste Quantity

Below are the HWQ values for Sources 1 and 2 as discussed in Sections 2.2.1 and 2.2.2 of this documentation record. The sum of the hazardous waste quantity for the site is 15,595.6 and is used to assign a HWQ factor value from the HRS Rule Table 2-6 of 10,000 for the surface water human food chain threat.

Source No.	Source Type	Source Hazardous Waste Quantity
1	Chat/tailings Pile	15,595.6
2	Contaminated Soil	> 0

Sum of Values: 15,595.6

Hazardous Waste Quantity Factor Value: 10,000
(Ref. 1, Section 2.4.2.2, Table 2-6, pg. 51591)

4.1.3.3 Waste Characteristics Factor Category Value

In accordance with Section 4.1.3.2.3 of Reference 1 (pg. 51620), a waste characteristics factor value is computed by multiplying the toxicity/persistence factor value by the hazardous waste quantity factor value (the product of which is subject to a maximum of 1×10^8) and then multiplying that number by the bioaccumulation potential factor value. This product (subject to a maximum of 1×10^{12}) is then entered into Table 2-7 (Ref. 1, Section 2.4.3.1, pg. 51592) to obtain a waste characteristics factor category value. Of the metal compounds above, cadmium produces the highest value. This value is entered below and on line 17 in Table 4-1 found on page 3 of this documentation record.

Toxicity/persistence factor value

× hazardous waste quantity factor value: (1×10^8 maximum product)

$$10,000 \times 10,000 = 1 \times 10^8$$

(Toxicity/persistence × hazardous waste quantity)

× bioaccumulation potential factor value: (1×10^{12} maximum product)

$$1 \times 10^8 \times 5,000 = 5 \times 10^{11}$$

Waste Characteristics Factor Category Value: 560
(Ref. 1, Section 2.4.3.1, Table 2-7, pg. 51592)

4.1.3.4 Human Food Chain Threat Targets

Actual Human Food Chain Contamination

Sample ID (AXGGL)	Sample Medium	Distance from PPE (miles)	Hazardous Substance	Bioaccumulation Factor Value	Reference
-104	aqueous	0 (PPE)	Total Zinc	5	2, pg. BI-12
-102	aqueous	0.02	Total Zinc Total Cadmium	5 5,000	2, pp. BI-2, BI-12
-100	aqueous	0.38	Total Zinc	5	2, pg. BI-12
-202	sediment	0.02	Total Zinc	5	2, pg. BI-12

Big Creek is used for fishing and recreational activities (Ref. 16, pg. 4). Fish species commonly caught in Big Creek include: bass, sunfish, shiners, darters, and hogsuckers (Ref. 17, pg. 2). The benthic macroinvertebrate community is composed of many species of crayfish (Reference 17, pg. 2). According to MDOC there about 8 to 10 fishing locations between the PPE and Sam A. Baker Park, which is located nearly 15 miles downstream of the site (Reference 20). Currently, a health advisory posted by MDOC is in affect for sunfish from Big Creek in Iron County near Glover, Missouri to the Sam A. Baker State Park (Reference 21; Reference 23, pg. 32).

Cadmium was detected at 2.48 µg/L in Big Creek in surface water sample -102 collected 100 feet downstream of the PPE (Appendix D, pp. 22, 76 to 78). Cadmium has a bioaccumulation potential factor value (BCFV) of 5,000 (see table above). In addition, copper, lead, and zinc were also detected in surface water samples along Big Creek and establish an observed release, however, these contaminants only have a BCFV of 500, 5, and 5, respectively (Reference 2, pp. BI-3, BI-8, and BI-12). The entire 15-mile target distance in-water segment consists of Big Creek (Appendix A, Figure A-8).

Total cadmium, with a BCF of 5,000, was detected in surface water sample -102 at 2.48 µg/L, which is above the designated AWQC of 0.25 µg/L. Because cadmium was not detected in the background sample (Ref. 5, pg. 6-4), an observed release by chemical analysis can be documented for total cadmium in surface water. Sample -102 was collected about 100 feet downstream of the PPE (Ref. 5, [Table 6-1], pp. 6-4, 6-5; 2, pg. BII-3). Metals, particularly arsenic, cadmium, lead, and zinc have been found in Source 1 and/or Source 2 at the ALM facility. Cadmium, lead, and zinc have been detected in the two on-site sources ranging from 0.4 mg/kg to 7.7 mg/kg for cadmium; 12 mg/kg to 20,000 mg/kg for lead and 40 mg/kg to 740 mg/kg for zinc. In addition, elevated metal concentrations for cadmium, lead, and zinc have also been documented in Sutton Branch which flows south for about 3,960 feet before entering Big Creek (see Section 4.4.1 of this HRS documentation record). Cadmium was found as high as 2 mg/kg, lead as high as 2,900 mg/kg and zinc as high as 170 mg/kg in Sutton Branch. Sediment and aqueous samples collected during the ESI/RA have verified that metal contamination associated with the ALM facility has entered Big Creek and an observed release can be documented in Big Creek, a known fishery.

- Fishery Study

In 1999 MDOC and MDNR jointly issued a health advisory against consumption of sunfish in Big Creek from Glover to Sam A. Baker State Park due to metal contamination (Ref. 23, pg. 32).

Two U.S. Fish and Wildlife Service studies conducted on aquatic life in Big Creek have shown evidence of heavy metal contamination impact on fish species. Both studies involved the enzyme δ -aminolevulinic acid dehydratase (ALA-D), which catalyzes the formation of a hemoglobin precursor, porphobilinogen (PBG), from aminolevulinic acid. ALA-D activity is highly sensitive to lead and is relatively easy to measure. The inhibition of ALA-D activity is used as a biomarker for lead exposure in humans, waterfowl, and fish (Ref. 24, pg. 2).

The objective of the earlier study conducted in 1989 and 1990 and published in 1993, was to verify and calibrate the biomarker of lead exposure for use in a statewide assessment of metals pollution from lead and zinc mining and to determine whether metals other than lead and zinc affect ALA-D activity. Big Creek was chosen as a sampling site because it is near the Annapolis Lead Mine facility (Ref. 24, pg. 1 to 4).

Blood samples were collected from fish at each sampling location and tested for ALA-D activity, concentrations of hemoglobin, total protein, and total metals. Water and sediment samples were collected for trace metal analysis concurrently with fish sampling at each location (Ref. 24, pp. 4 to 8). Lead, zinc, and cadmium concentrations were elevated in all media above reference sites in Big Creek. Additionally, cadmium was present in greater concentrations in fish carcasses from Big Creek than in fish from other sites affected by historic mining, and at 10 times the concentrations found in reference streams (Ref. 24, pg. 9 to 16). The study stated that evidence suggested that cadmium in Big Creek was more bioavailable than cadmium in other streams. Also, the study concluded that ALA-D activity was a conservative estimate of lead exposure of Missouri stream fishes, in part because the presence of zinc had an ameliorative effect on enzyme deactivation by lead. Previous studies had shown that metals other than zinc had no effect on ALA-D activity). It was concluded at the end of the study that fish studies should measure ALA-D activity over directly measuring lead concentrations in fish blood since it is more rapid, less-costly, and a simpler alternative.

A study published in 1997, focused on Big Creek, which was noted as having anomalously high concentrations of cadmium, lead, and zinc in fish. This study was designed and conducted to better characterize the nature and extent of the elevated metals detected in fish from Big Creek by the earlier study; and to define the source(s) of metals on Big Creek. Twenty-two northern hogsuckers were collected from 4 locations on Big Creek on August 30 and 31, 1993. Fish were tested for metals concentrations in blood, ALA-D activity and hemoglobin concentration. Concentrations of metals and other inorganic materials were also determined in grab samples of water collected during the sampling period by EPA (Ref. 25, pp. 1 and 3).

The site location downstream of the confluence of Big Creek and Sutton Branch Creek was found to have elevated lead concentrations in fish blood significantly greater than an upstream site location along Big Creek. There was a cadmium gradient of increasing concentrations going from upstream to downstream among the 4 locations sampled, with the greatest concentrations found downstream of Annapolis and Sutton Branch Creek; the lowest ALA-D activity of all study locations was found at the same location (Ref. 25, pg. 3). Values found during the second study also exceeded metal concentrations determined during the earlier study. According to the 1997 report, this indicates that lead and cadmium are being accumulated by fish in Big Creek, and that concentrations are increasing. The Annapolis Lead Mine facility was noted as a probable source by study authors (Ref. 25, pg. 4).

These fishery studies are critical to mention because they verify that fish contamination has occurred in Big Creek and that this contamination is at least partially attributable to the past mining activities at the ALM facility. The ALM facility is a contributing source to future fish contamination. A surface water release has been documented by chemical analysis of sediment and aqueous samples collected during the 1997 EPA ESI/RA investigation. Currently, a fish advisory is in affected for consumption of sunfish species along Big Creek. In addition, MDOC have conducted other studies in 2000 concerning other edible fish species (i.e., bass) in Big Creek (Ref. 22). Information concerning these current studies was not made available to E & E/START for inclusion into this HRS documentation record.

Level I Fisheries

Not Scored

Most Distant Level I Sample

Sample ID: /-102 (surface water sample) (Appendix A, Figure A-7)

Distance from the PPE: 100 feet downstream of the PPE (Appendix, Figure A-7). Total cadmium was detected in sample -102 at a concentration of 2.48 : g/L. This concentration is above the background concentration of 1.0 U : g/L (Ref. 5, pg. 6-5) for total cadmium and the designated AWQC of 0.25 : g/L for cadmium (Ref. 2, pg. BII-3).

Level II Fisheries

Not Scored

Potential Fisheries

An observed release of cadmium in surface water has been documented in Big Creek downstream of the PPE. According to MDOC, there are about 8 to 10 fishing locations between the PPE and Sam A. Baker Park (Ref. 20); however, it could not be documented that the observed contamination is within the boundaries of a known fishing location.

Identity of Fishery	Extent of Potential Fishery (Relative to PPE) (miles)	References
Big Creek	Eight to 10 fisheries within Big Creek between the PPE and Sam A. Baker Park, which is located nearly 15 miles downstream of the PPE.	Ref. 20, pg. 1

4.1.3.5 Food Chain Individual

Sample ID: -202/-102 (Appendix A, Figure A-7)

Level I/Level II/or Potential: Potential

Hazardous Substance: Cadmium

Bioaccumulation Potential: 5,000 (Reference 2, pg. BI-2)

Identity of Fishery	Type of Surface Water Body	Dilution Weight (Table 4-13)	Reference
Big Creek	Moderate Stream (151 cfs)	0.01	1, Table 4-13, pg. 51613; 15; pg. 3

An observed release to a potential fishery has been established by chemical analysis. The annual fish production is unknown, but is > 0 , for the defined potential fishery. Using the human food chain population value of 0.03 (Ref. 1, Section 4.1.3.3.2.1, pg. 51612) and the dilution weight value of 0.01 (see above table), the potential human food chain contamination value for this fishery is 3.0×10^{-5} . The food chain individual receives a factor value of 20.

Food Chain Individual Factor Value: 20

4.1.4 Environmental Threat Waste Characteristics

4.1.4.1 Ecosystem Toxicity/Persistence/Bioaccumulation

Hazardous Substance	Source No.	Ecotoxicity Factor Value	Persistence Factor Value	Bioaccumulation Value	Ecosystem Toxicity/Persistence/Bioaccumulation Factor Value (Table 4-21)	References
Arsenic	1, 2	10	1.0	5,000	50,000	2, pg. BI-1
Cadmium	2	10,000	1.0	50,000	500,000,000	2, pg. BI-2
Copper	1	1,000	1.0	5,000	5,000,000	2, pg. BI-3
Lead	1, 2	1,000	1.0	50,000	50,000,000	2, pg. BI-8
Zinc	2	10	1.0	50,000	500,000	2, pg. BI-12

Note: River (fresh water) waters was the water category used for determining factor values for persistence and bioaccumulation determination. Factor values for each hazardous substance were obtained from SCDM, January 2004 version.

Ecosystem Toxicity/Persistence/Bioaccumulation Factor Value: 5×10^8

4.1.4.2 Hazardous Waste Quantity

Below are the HWQ values for Sources 1 and 2 as discussed in Sections 2.2.1 and 2.2.2. The sum of the hazardous waste quantity for the site is 15,595.6 and is used to assign a HWQ factor value from Table 2-6 of the HRS Rule of 10,000 for the surface water environmental threat.

Source No.	Source Type	Source Hazardous Waste Quantity
1	Chat/Tailings Pile	15,595.6
2	Contaminated Soil	> 0

Sum of Values: 15,595.6

Hazardous Waste Quantity Factor Value: 10,000
(Ref. 1, Section 2.4.2.2, Table 2-6, pg. 51591)

4.1.4.3 Waste Characteristics Factor Category Value

In accordance with Section 4.1.4.2.3 of reference 1 (pg. 51624), a waste characteristics factor value is computed by multiplying the ecotoxicity/persistence factor value by the hazardous waste quantity factor value (the product of which is subject to a maximum of 1×10^8) and then multiplying that number by the bioaccumulation potential factor value. This product (subject to a maximum of 1×10^{12}) is then entered into Table 2-7 (Ref. 1, Section 2.4.3.1, pg. 51592) to obtain a waste characteristics factor category value. Of the metal compounds above, cadmium produces the highest value. This value is entered below and on line 25 in Table 4-1 found on page 4 of this documentation record.

Ecosystem toxicity/persistence factor value
 \times hazardous waste quantity factor value: (1×10^8 maximum product)
 $10,000 \times 10,000 = 1 \times 10^8$

(Ecosystem toxicity/persistence \times hazardous waste quantity)
 \times bioaccumulation potential factor value: (1×10^{12} maximum product)
 $1 \times 10^8 \times 50,000 = 5 \times 10^{12}$

Waste Characteristics Factor Category Value: 1000
(Ref. 1, pg. 51592, Table 2-7)

4.1.4.4 Environmental Threat Targets

Level I Concentrations - NOT SCORED

Level II Concentrations

Sample ID (AGXXL)	Sample Medium	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Benchmark Concentration (mg/kg)	Benchmark	References
-200	sediment	Arsenic Lead	16 440	NA	NA	Appendix D, pg. 82
-201	sediment	Arsenic Lead	14 340	NA	NA	Appendix D, pg. 82

KEY: NA = Not Available

Most Distant Level II Sample

Sample ID: -200/-100 (collocated aqueous/sediment sample)

Distance from the probable point of entry: 0.38

Reference: Appendix A, Figure A-7

4.1.4.5 Sensitive Environments

4.1.4.5.1 Level I Concentrations - NOT SCORED

4.1.4.5.2 Level II Concentrations

Sensitive Environments

Wetlands are the only known sensitive environments that occur along the 15-mile TDL which meet Level II concentrations. The nearest known wetland is located at the confluence of Sutton Branch Creek and Big Creek (Reference 18). Sediment samples -201 and -200 contained arsenic and lead concentrations that meet the observed release criteria. Sediment sample -201 is located about 800 feet downstream of the PPE and within the boundaries of the wetland. Sediment sample -200 was collected about 0.38 miles downstream of the PPE and is located beyond the designated wetland boundary. The length considered subject to Level II concentrations is measured from the PPE (samples -204/-104) to the endpoint of the designated wetland. Therefore, the shoreline length of the wetland subject to Level II concentrations is about 1,880 feet (Appendix A, Figure A-7).

Wetlands

Wetland	Wetland Frontage (miles)	References
Palustrine Forested Broad-Leafed Deciduous Wetland	Approximately 0.35	Reference 18

Sum of Level II Wetland Frontages: 0.35

Wetlands Value (Table 4-24): 25

Sum of Level II Sensitive Environments Value + Wetlands Value: 25

Level II Concentrations Factor Value: 25

5.0 SOIL EXPOSURE PATHWAY

5.0.1 GENERAL CONSIDERATIONS

Letter by which this area is to be identified: **Area A**

Name of area: As designated in the Source Characterization Section (Section 2.2.1), Area A includes Source 1 (chat/tailings pile).

Location and description of area (with reference to a map of the site):

Area A consists of the chat/tailings pile which is mostly unvegetated and occupies about 10 acres of the 50-acre facility (Reference 26, pg. 1). The majority of the pile is composed of grey-to tan colored material that resembles fine-grained sand, which is highly erodible, resulting in steep-sided features (Appendix B, Photo Nos. 4 to 7). See Appendix A, Figure A-9 for the location of this area of observed contamination.

- Background Samples:

Sample ID	Sample Medium	Depth	Date	Reference
CC104-111	Soil	0-6 inches	4/96	Appendix C, pg. 20

NOTE: Sampling during the EPA SSI was conducted by Sverdrup Corporation in June 1996. See Attachment A, Figure A-5 for SSI soil sample locations.

-Background Concentrations:

Sample ID	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
CC104-111	Arsenic	0.95 U	0.95	Appendix C, pg. 30
CC104-111	Lead	300	0.702	

KEY: U = Actual Value of Sample is < the Measurement Detection Limit (Reported Value).
mg/kg = Milligrams per Kilogram

-Contaminated Samples

Area Letter: A

Sample ID	Sample Medium	Depth	Date	Reference
CC104-103	Tailings	0-6 inches	4/96	Appendix C, pp. 14, 28

NOTE: Sampling during the EPA SSI was conducted by Sverdrup Corporation in June 1996. See Attachment A, Figure A-5 for SSI soil sample locations.

5.0.2 GENERAL CONSIDERATIONS

Letter by which this area is to be identified: **Area B**

Name of area: As designated in the Source Characterization Section (Section 2.2.2), **Area B** includes Source 2 (Contaminated Surface Soil).

Location and description of area (with reference to a map of the site):

Area B consists of contaminated surface soils within the designated outwash and former mining areas and is defined for HRS scoring purposes by confirmation EPA laboratory data. For removal assessment purposes the outwash area was estimated to be about 5 acres and the former mining area was estimated to be about 7 acres. (Reference 5, pp. 4-1 to 4-7). The former mining area is composed of mining refuse, including boulder-sized chunks of ore which are interspersed among the former foundations. The outwash area is composed of soil and fine to granular-sized materials from the chat/tailings pile (Area A). EPA sample locations -302, -305, -306, -310, -312 and -317 are used to delineate the boundaries of Area B. Area B is located about directly northwest of Area A (Appendix A, Figure A-9).

- Background Samples:

Sample ID (AGXXL)	Sample Medium	Depth (inches)	Date	Reference
-314	Soil	0-6	11/97	Appendix D, pg. 58
-315	Soil	0-6	11/97	Appendix D, pg. 59
-316	Soil	6-12	11/97	Appendix D, pg. 60

Sample ID (AGXXL)	Hazardous Substances	Concentrations (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
-314	Arsenic Cadmium Zinc	9.6 0.56 46	1.47 0.25 0.49	Appendix D, pg. 89; Ref. 29, Table 3, pg. 8
-315	Lead	100	0.68	Appendix D, pg. 90; Ref. 29, Table 3, pg. 8
-316	Cadmium Lead	0.23 24	0.23 0.68	Appendix D, pg. 90; Ref. 29, Table 3, pg. 8

KEY: mg/kg = Milligrams per kilogram

-Contaminated Samples:

Area Letter: B

Sample ID (AGXXL)	Sample Medium	Depth (inches)	Date	Reference
-300	Soil	0-6	11/97	Appendix D, pg. 44
-301	Soil	0-6	11/97	Appendix D, pg. 45
-302	Soil	0-6	11/97	Appendix D, pg. 46
-305	Soil	0-6	11/97	Appendix D, pg. 49
-306	Soil	0-6	11/97	Appendix D, pg. 50
-310	Soil	0-6	11/97	Appendix D, pg. 54
-312	Soil	6-12	11/97	Appendix D, pg. 56
-317	Soil	0-6	11/97	Appendix D, pg. 61

-Contaminated Sample Concentrations:

-Area Letter: B

Sample ID	Sample Depth (inches)	Analytes (mg/kg)			
		Arsenic	Cadmium	Lead	Zinc
-300	0-6	85	7.7	20,000	740
-301	0-6	71	2.0	3,200	180
-302	0-6	22	1.0	3,300	180
-305	6-12	25	1.9	410	270
-306	0-6	12	2.0	470	190
-312	0-6	12	2.3	130	270
-317	0-6	32	3.4	1,300	200
Background					
-313	0-6	7.5	0.23 U	29	26
-314	0-6	9.6	0.56	74	46
-315	0-6	5.7	0.47	100	39
-316	6-12	11	0.23	24	58
Benchmarks (Screening Conc.)					
Reference Dose		23.0	39.0	---	23,000
Cancer Risk		0.43	---	---	---
References		2, pg. B-65	2, pg. B-67	2, pg. B-76	2, pg. B-83
Level of Contamination		Level I	Level II	Not Applicable	Level II

NOTE: See Appendix D, pp. 87 - 90 for sample results.

KEY: --- = Not Established

mg/kg = Milligrams per kilogram

U = The material was analyzed for, but was not detected. The associated numerical value is the sample detection limits.

Lead ore was mined from the strata at the former mining facility, beginning in the early 1920s and continuing sporadically until the 1940s (Reference 7, pg. 54). Chat/tailings waste from the mining and milling operations were stockpiled in a large pile located on the former mining facility and currently exist today (Appendix A, Figure A-2). Surface soil samples collected within the mining and outwash areas during the 1997 ESI/RA indicated elevated metal concentrations, particularly arsenic, cadmium, lead, and zinc above the designated background concentrations (see table above). Contamination within these two areas are the results of deposition from the pile from erosional episodes. Area B consists of contaminated surface soils within the designated outwash and former mining areas and is defined by confirmation EPA laboratory data. Six surface soils samples locations -302, -305, -306, -310, -312, and -317 are used to delineate the boundaries of Area B. Elevated metal concentrations also exist within these boundaries especially in close proximity to the former on-site residence. These outermost soil samples locations meet the criteria for an observed release and were connected by lines on a scaled map (Appendix, Figure A-9).

Area Hazardous Waste Quantity

- Area: B

Description: See Section 2.2.2 (Source 2) for the area hazardous waste quantity for **Area B**.

Source Type	Units (ft ²)	References
Contaminated Soil	> 0	Appendix A, Figure A-9; Ref. 1, Section 2.4.2.2, (Table 2-5), pg. 51591

Sum (ft²): > 0 square feet

Equation for Assigning Value (Table 5-2): A/34,000 = > 0 square feet

Area Assigned Value: => 0; but unknown

5.1 RESIDENT POPULATION THREAT

5.1.1 LIKELIHOOD OF EXPOSURE

Sample ID	Distance of Population/Resource from Area of Observed Contamination	Reference
-300	The residence (3 people) is situated within the boundaries of Area B.	Appendix A, Figure A-9
-301		
-302		

Resident Population Threat Likelihood of Exposure Factor Category Value: **550**

5.1.2 WASTE CHARACTERISTICS

5.1.2.1 Toxicity

Hazardous Substance	Toxicity Factor Value	Reference
Arsenic	10,000	2, pg. BI-1
Cadmium	10,000	2, pg. BI-2
Lead	10,000	2, pg. BI-8
Zinc	10	2, pg. BI-12

Toxicity Factor Value: **10,000**

5.1.2.2 Hazardous Waste Quantity

Area Letter	Source Type	Area Hazardous Waste Quantity
A	Chat/Tailings Pile	12,811.8
B	Contaminated Soil	> 0

Sum of Values: 12, 812

Hazardous Waste Quantity Factor Value: **10,000**
(Table 2-6)

5.1.2.3 Calculation of Waste Characteristics Factor Category Value

Toxicity Factor Value: **10,000**

Hazardous Waste Quantity Factor Value: **10,000**

Toxicity Factor Value x Hazardous Waste Quantity Factor Value: **1 x 10⁸**

Waste Characteristics Factor Category Value: **100**
(Table 2-7)

5.1.3 TARGETS

5.1.3.1 Resident Individual

Area Letter: A

Level of Contamination (Level I/Level II): Level I

Reference: Ref. 1, pg. 51647; Appendix D, pp. 87

During the ESI/RA three persons (2 adults and 1 child [about 15 years old]) were documented to be living at the residence located on site. The smaller children evaluated as having high lead blood levels during the previous EPA emergency response no longer live at the residence (Ref. 30, pg. 1; Ref. 31, pg. 1; Ref. 32, pp. 1 to 3). Because the residence is situated within an area of observed contamination and the dwelling is within 200 feet of an area of observed contamination, the residents are subject to Level I contamination based on EPA sample -300, -301, and -302 results. A value of 50 was assigned to Area A (Reference 1, Section 5.1.3.1, pg. 51647).

Resident Individual Factor Value: **50**

5.1.3.2 Resident Population

5.1.3.2.1 Level I Concentrations

Area Letter	Sample ID (AGXXL)	Number of Residences	County Multiplier	Total No. of Residents	References
B	-300 -301 -302	1	NA	3	Ref. 27, pg. 2

NA = Not Applicable

Sum of individuals subject to Level I concentrations: **3**

Sum of individuals subject to Level I concentrations: 3 x 10: **30**

Level I Concentrations Factor Value: **30**

5.1.3.2.2 Level II Concentrations - NOT SCORED

5.1.3.3 Workers - NOT SCORED

5.1.3.4 Resources

Description of Resource(s): NOT SCORED

5.1.3.5 Terrestrial Sensitive Environments

NOT SCORED

Likelihood of exposure factor category value (LE): 550

Waste characteristics factor category value (WC): 100

Terrestrial sensitive environments value (ES): 0

Product (LE x WC x ES): 0

(LE x WC x ES)/82,500 (EC): **0**

If EC is >60, Value of EC:

Terrestrial Sensitive Environments Factor Value: **0**

APPENDIX A

Figures

APPENDIX B

Photographic Record from 1997 ESI/RA

APPENDIX C

EPA Data Results from 1996 SSI Conducted by Sverdrup Corporation

APPENDIX D

EPA Data Results from 1997 ESI/RA Conducted by E & E/START