

HRS DOCUMENTATION RECORD--REVIEW COVER SHEET

Name of Site: Bautsch-Gray Mine

Contact Persons

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Pathways, Components, or Threats Not Scored

The air migration pathway and the soil exposure pathway were not scored as part of this Hazard Ranking System (HRS) evaluation. The air migration pathway and soil exposure pathway were not included because a release to these media does not significantly affect the overall site score and because the ground water migration and surface water migration pathways produce an overall site score above the minimum required for the site to qualify for inclusion on the National Priorities List (NPL). The air migration and soil exposure pathways may be of concern to EPA and may be evaluated during future investigations.

HRS DOCUMENTATION RECORD

Name of Site: Bautsch-Gray Mine

CERCLIS ID: ILN 000 510 407

EPA Region: 5

Date Prepared: March 2012

Street Address of Site:

1000 S. Blackjack Road

City, County, State, Zip code: Galena, Jo Daviess County, Illinois 61036

General Location in the State: Northwestern Illinois (Figure 1)

Topographic Map: Bellevue, IA-IL (Ref. 7)

Latitude: N 42.357422

Longitude: W 90.398569 (Ref. 7; Figure 1)

Site Reference Point: Approximate middle of Tailings pile (Ref. 4, p. 6; Figure 1)

Congressional District: 16

* The street address, coordinates, and contaminant locations presented in this HRS documentation record identify the general area in which the site is located. They represent one or more locations EPA considers to be part of the site based on the screening information EPA used to evaluate the site for NPL listing. EPA lists national priorities among the known "releases or threatened releases" of hazardous substances; thus, the focus is on the release, not precisely delineated boundaries. A site is defined as where a hazardous substance has been "deposited, stored, placed or otherwise come to be located." Generally, HRS scoring and the subsequent listing of a release merely represent the initial determination that a certain area may need to be addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Accordingly, EPA contemplates that the preliminary description of facility boundaries at the time of scoring will be refined as more information is developed as to where the contamination has come to be located.

Scores

<i>Ground Water Pathway</i>	<i>63.20</i>
<i>Surface Water Pathway</i>	<i>74.84</i>
<i>Soil Exposure Pathway</i>	<i>Not Scored (NS)</i>
<i>Air Pathway</i>	<i>Not Scored (NS)</i>
<i>HRS SITE SCORE</i>	<i>48.97</i>

WORKSHEET FOR COMPUTING HRS SITE SCORE

	<u>S</u>	<u>S²</u>
1. Ground Water Migration Pathway Score (S_{gw}) (from Table 3-1, line 13)	63.20	3994.2400
2a. Surface Water Overland/Flood Migration Component (from Table 4-1, line 30)	74.84	5601.0256
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.	74.84	5601.0256
3. Soil Exposure Pathway Score (S_s) (from Table 5-1, line 22)	NS	
4. Air Migration Pathway Score (S_a) (from Table 6-1, line 12)	NS	
5. Total of $S_{gw}^2 + S_{sw}^2 + S_s^2 + S_a^2$		9595.2656
6. HRS Site Score Divide the value on line 5 by 4 and take the square root	48.97	

**SCORESHEET TABLE 3 – 1
GROUND WATER MIGRATION PATHWAY SCORESHEET**

Factor Categories and Factors	Maximum Value	Value Assigned
Likelihood of Release		
1. Observed Release	550	550
2. Potential to Release		
2a. Containment	10	NS
2b. Net Precipitation	10	NS
2c. Depth to Aquifer	5	NS
2d. Travel Time	35	NS
2e. Potential to Release [(lines 2a(2b+2c+2d)]	500	NS
3. Likelihood of Release (higher of lines 1 and 2e)	550	550
Waste Characteristics		
4. Toxicity/Mobility	(a)	10,000
5. Hazardous Waste Quantity	(a)	10,000
6. Waste Characteristics	100	100
Targets		
7. Nearest Well	50	50
8. Population		
8a. Level I Concentrations	(b)	30
8b. Level II Concentrations	(b)	0
8c. Potential Concentrations	(b)	14.8
8d. Population (lines 8a+8b+8c)	(b)	44.8
9. Resources	5	0
10. Wellhead Protection Area	20	0
11. Targets (lines 7+8d+9+10)	(b)	94.8
Ground water Migration Score for an Aquifer		
12. Aquifer Score [(lines 3x6x11)/82,500 ^c	100	63.20
Ground Water Migration Pathway Score		
13. Pathway Score (S _{gw}) (highest value from line 12 for all aquifers evaluated) ^c	100	63.20

^c Do not round to the nearest integer.

**SCORESHEET TABLE 4-1
SURFACE WATER PATHWAY (OVERLAND/FLOOD MIGRATION
COMPONENT) SCORESHEET**

<u>Factor Categories and Factors</u>	<u>Maximum Value</u>	<u>Value Assigned</u>
DRINKING WATER THREAT		
<u>Likelihood of Release</u>		
1. Observed Release	550	550
2. Potential to Release by Overland Flow		
2a. Containment	10	NS
2b. Runoff	25	NS
2c. Distance to Surface Water	25	NS
2d. Potential to Release by Overland Flow [lines 2a x (2b + 2c)]	500	NS
3. Potential to Release by Flood		
3a. Containment (Flood)	10	NS
3b. Flood Frequency	50	NS
3c. Potential to Release by Flood (lines 3a x 3b)	500	NS
4. Potential to Release (lines 2d + 3c, subject to a maximum of 500)	500	NS
5. Likelihood of Release (higher of lines 1 and 4)	550	550
<u>Waste Characteristics</u>		
6. Toxicity/Persistence	(a)	NS
7. Hazardous Waste Quantity	(a)	NS
8. Waste Characteristics	100	NS
<u>Targets</u>		
9. Nearest Intake	50	NS
10. Population		
10a. Level I Concentrations	b	NS
10b. Level II Concentrations	b	NS
10c. Potential Contamination	b	NS
10d. Population (lines 10a + 10b + 10c)	b	NS
11. Resources	5	NS
12. Targets (lines 9 + 10d + 11)	(b)	NS
<u>Drinking Water Threat Score</u>		
13. Drinking Water Threat Score ([lines 5 x 8 x 12] / 82,500, subject to a maximum of 100)	100	NS

Factor Categories and Factors	Maximum Value	Value Assigned
HUMAN FOOD CHAIN THREAT		
<u>Likelihood of Release</u>		
14. Likelihood of Release (same value as line 5)	550	550
<u>Waste Characteristics</u>		
15. Toxicity/Persistence/ Bioaccumulation	(a)	50,000,000
16. Hazardous Waste Quantity	(a)	10,000
17. Waste Characteristics	1,000	560
<u>Targets</u>		
18. Food Chain Individual	50	20
19. Population		
19a. Level I Concentrations	(b)	0
19b. Level II Concentrations	(b)	0
19c. Potential Human Food Chain Contamination	(b)	0
19d. Population (lines 19a + 19b + 19c)	(b)	0
20. Targets (lines 18 + 19d)	(b)	20
<u>Human Food Chain Threat Score</u>		
21. Human Food Chain Threat Score ([lines 14 x 17 x 20] / 82,500, subject to a maximum of 100)	100	74.66

Factor Categories and Factors	Maximum Value	Value Assigned
ENVIRONMENTAL THREAT		
<u>Likelihood of Release</u>		
22. Likelihood of Release (same value as line 5)	550	550
<u>Waste Characteristics</u>		
23. Ecosystem Toxicity/Persistence/ Bioaccumulation	(a)	5×10^8
24. Hazardous Waste Quantity	(a)	10,000
25. Waste Characteristics	1,000	1,000
<u>Targets</u>		
26. Sensitive Environments		
26a. Level I Concentrations	(b)	0
26b. Level II Concentrations	(b)	0
26c. Potential Contamination	(b)	0.0275
26d. Sensitive Environments (lines 26a + 26b + 26c)	(b)	0.0275
27. Targets (value from line 26d)	(b)	0.0275
<u>Environmental Threat Score</u>		
28. Environmental Threat Score ([lines 22 x 25 x 27] / 82,500, subject to a maximum of	60	0.18

60)		
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORE FOR A WATERSHED		
29. Watershed Score ^c (lines 13 + 21 + 28, subject to a maximum of 100)	100.00	74.84
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORE		
30. Component Score (S _{sw}) ^c (highest score from line 29 for all watersheds evaluated, subject to a maximum of 100)	100.00	74.84

- ^a Maximum value applies to waste characteristics category
- ^b Maximum value not applicable
- ^c Do not round to nearest integer
- NS Not Scored

LIST OF ACRONYMS AND ABBREVIATIONS

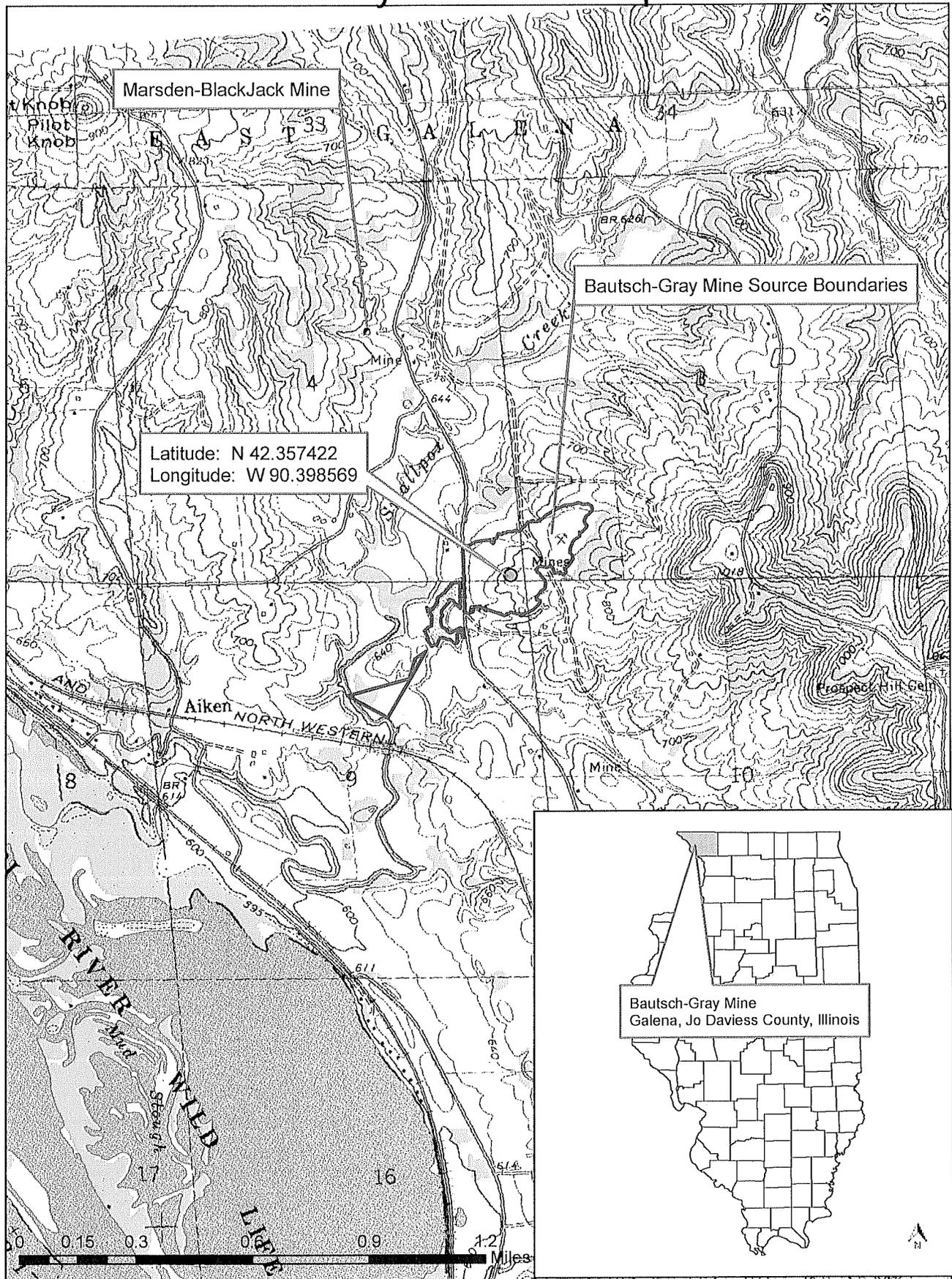
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cfs	cubic feet per second
Conc.	Concentration
CLP	Contract Laboratory Program
CRQL	Contract Required Quantitation Limit
EcoCAT	Ecological Compliance Assessment Tool
EPA	U.S. Environmental Protection Agency
ESI	Expanded Site Inspection
GIS	Geographic Information System
GPS	Global Positioning System
HRS	Hazard Ranking System
IDNR	Illinois Department of Natural Resources
INAI	Illinois Natural Area Inventory
Iowa DNR	Iowa Department of Natural Resources
MCL	Maximum Contaminant Level
MDL	method detection limit
mg/kg	milligrams per kilogram, equivalent to parts per million
NPDES	National Pollutant Discharge Elimination System
PPE	Probable Point of Entry
NS	not scored
RSL	U.S. EPA Regional Screening Levels
SCDM	Superfund Chemical Data Matrix
SOW	Statement of Work
SVOC	Semivolatile organic compound
SQL	Sample Quantitation Limit
START	Superfund Technical Assessment and Response Team
TDL	Target Distance Limit
ug/kg	micrograms per kilogram, equivalent to parts per billion
USGS	U.S. Geological Survey
VOC	volatile organic compound

FIGURES ATTACHED

- Figure 1 Facility Location Map
- Figure 2 Bautsch-Gray Mine Map
- Figure 3 Source Sample Location Map
- Figure 4 Sediment Sample Location Map
- Figure 5 Overland Flow and PPE Map
- Figure 6 15 Mile Surface Water Map
- Figure 7 Sediments and Wetlands Map

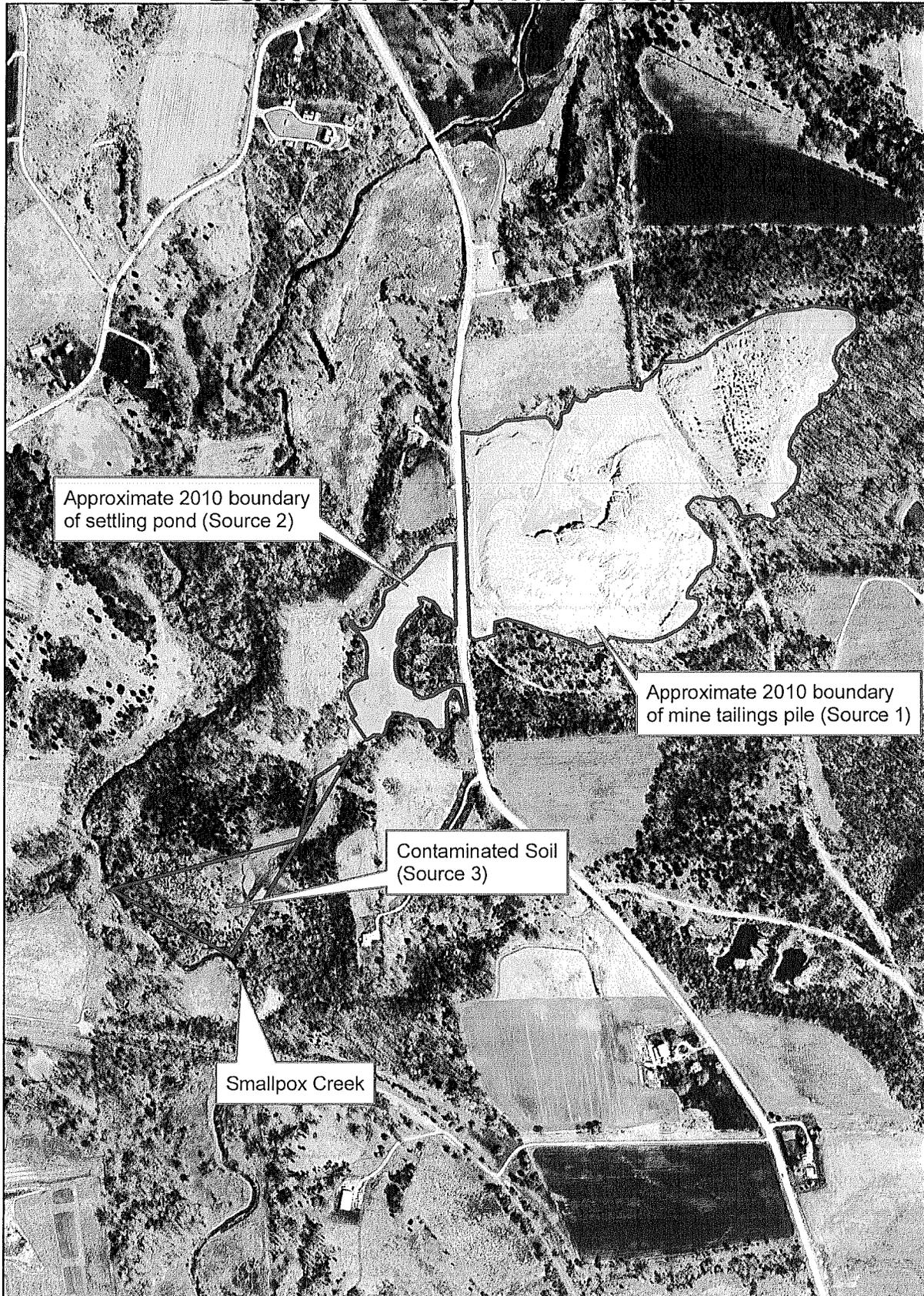
- Figure 8 Residential Well Sample Locations

Figure 1 Facility Location Map



The Topographic map Bellevue Quadrangle was downloaded from <http://www.isgs.uiuc.edu/nsdihome/webdocs/drgs/drgorder24bymap.html> on 4/27/2011. The red outline represents the source area boundary identified in Ref. 17, p. 1.

Figure 2 Bautsch-Gray Mine Map

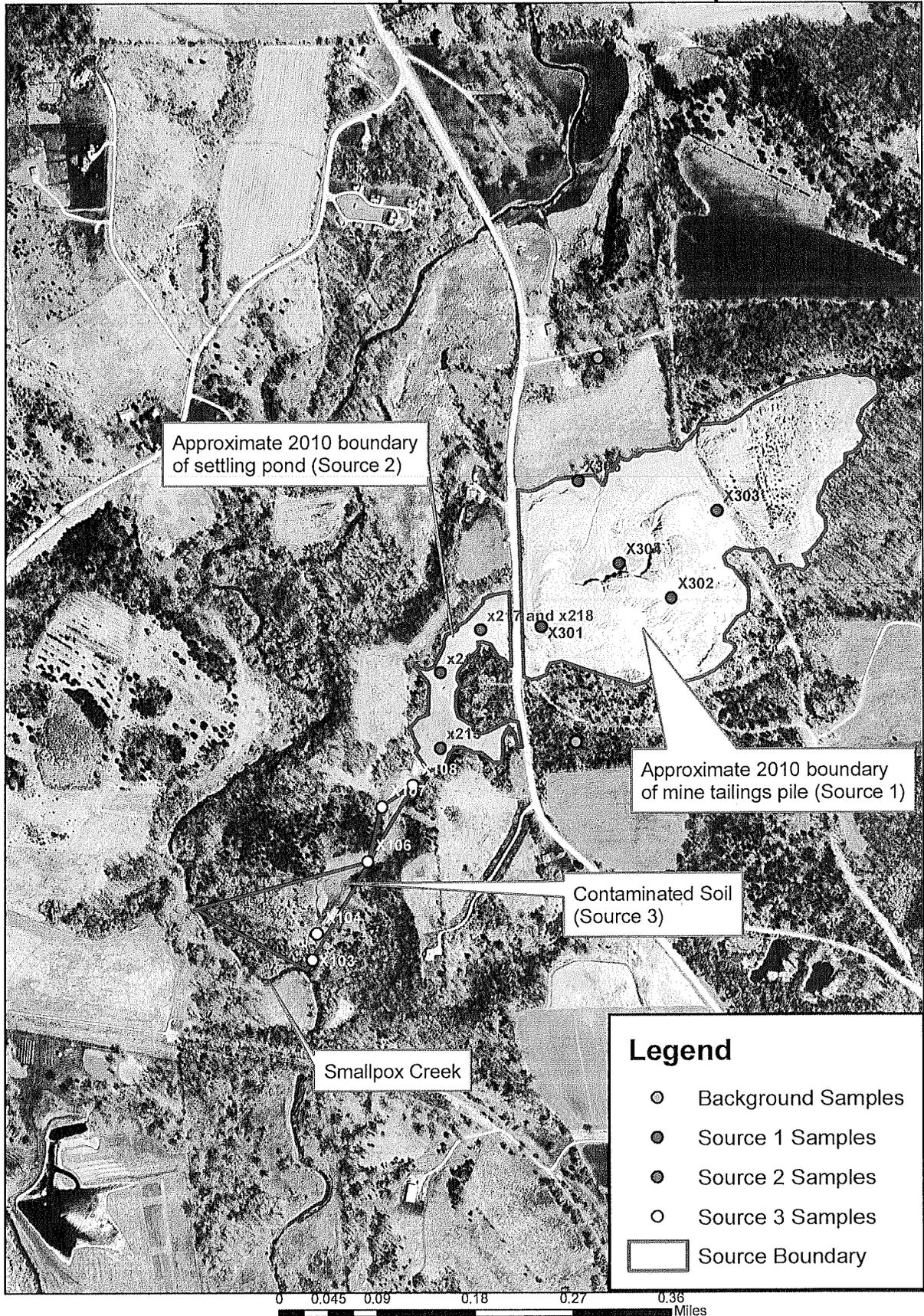


00.0375075 0.15 0.225 0.3
Miles

Source: Illinois Natural Resources Geospatial Clearinghouse, Illinois State Geological Survey, <http://isgs.edu/nsdihome/>, Illinois Historical Aerial Photography, Flight BWT-2D-87, May 17, 2011

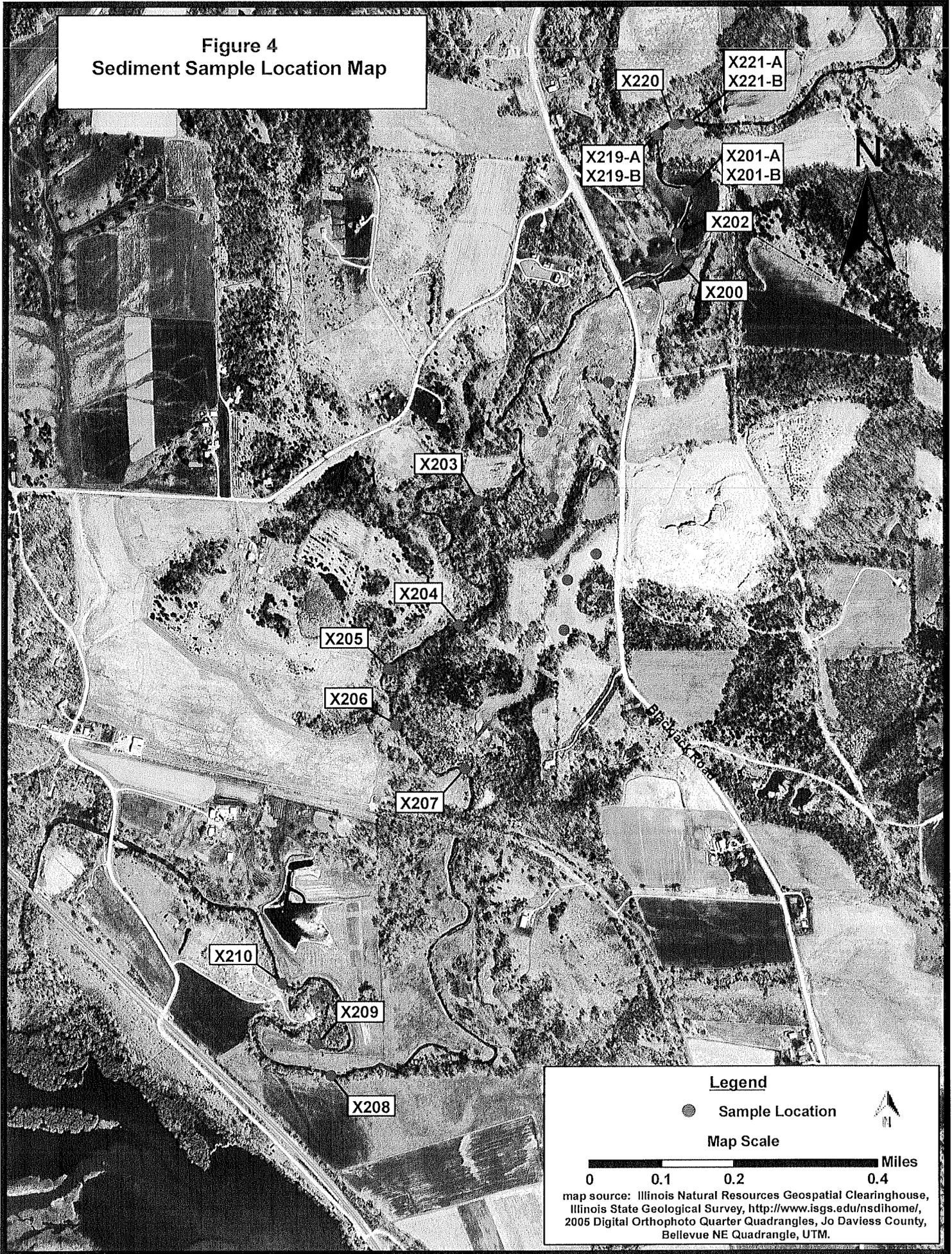
Figure 3

Source Sample Location Map



Source: Illinois Natural Resources Geospatial Clearinghouse, Illinois State Geological Survey, <http://isgs.edu/nsdihome/>, Illinois Historical Aerial Photography, Flight BWT-2D-87, May 17, 2011. Sample Locations were obtained from GPS data collected during the 2009 ESI (Ref. 4).

Figure 4
Sediment Sample Location Map

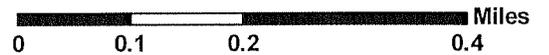


Legend

● Sample Location

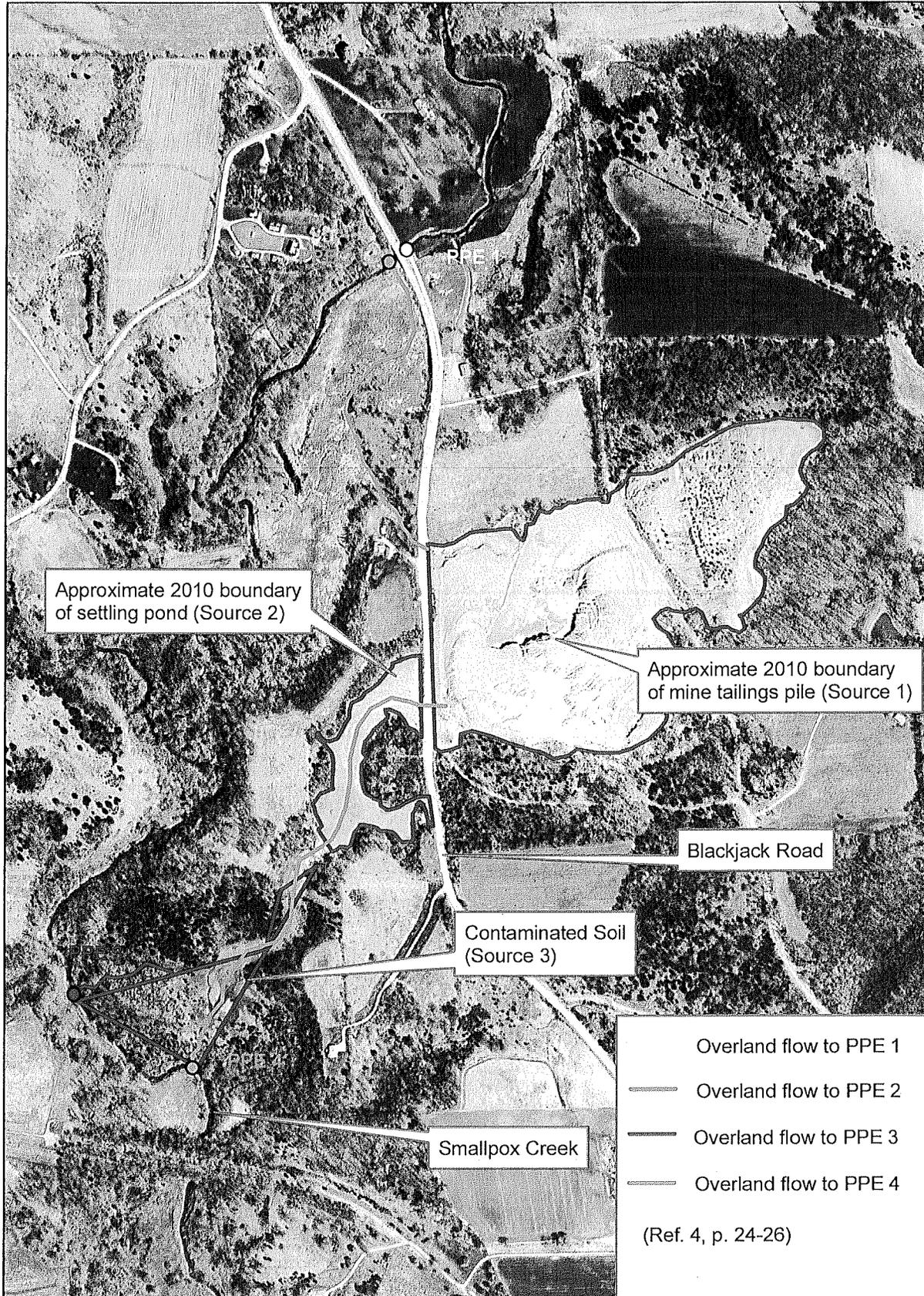


Map Scale



map source: Illinois Natural Resources Geospatial Clearinghouse,
Illinois State Geological Survey, <http://www.isgs.edu/nsd/home/>,
2005 Digital Orthophoto Quarter Quadrangles, Jo Daviess County,
Bellevue NE Quadrangle, UTM.

Figure 5 Overland Flow and PPE Map



0 0.0375 0.075 0.15 0.225 0.3 Miles

Source: Illinois Natural Resources Geospatial Clearinghouse, Illinois State Geological Survey, <http://isgs.edu/nsd/home/>, Illinois Historical Aerial Photography, Flight BWT-2D-87, May 17, 2011

Probable Point
of Entry
(PPE)

Figure 6
15-Mile Target Distance Limit Map
Bautsch-Gray Mine Site

Bautsch-Gray
Mine Site



LEGEND



Site Location

Map Scale: 1 in = 1 miles

15-Mile Surface Water
Target Distance Limit
(TDL)

source: Illinois Natural Resources Geospatial Data Clearinghouse, Illinois State Geological Survey, <http://www.igs.uiuc.edu/nsd/home/>, Bellevue - Iowa Quadrangle (1968); Hanover Quadrangle (1968 - photoinspected 1975), Springbrook - Iowa Quadrangle (1980), Green Island - Iowa-Illinois Quadrangle (1953 - photorevised 1975), UTM, accessed January 7, 2010.

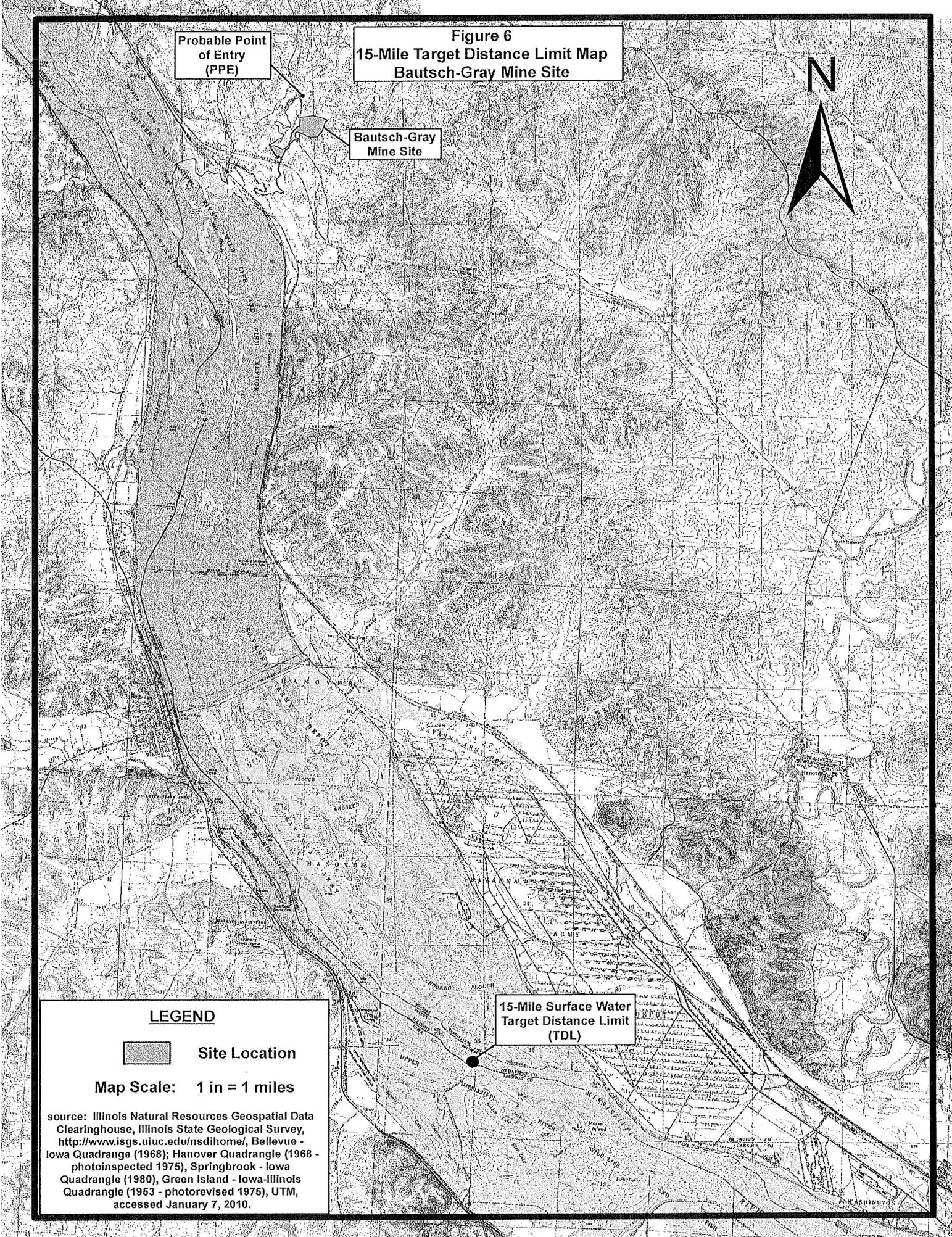
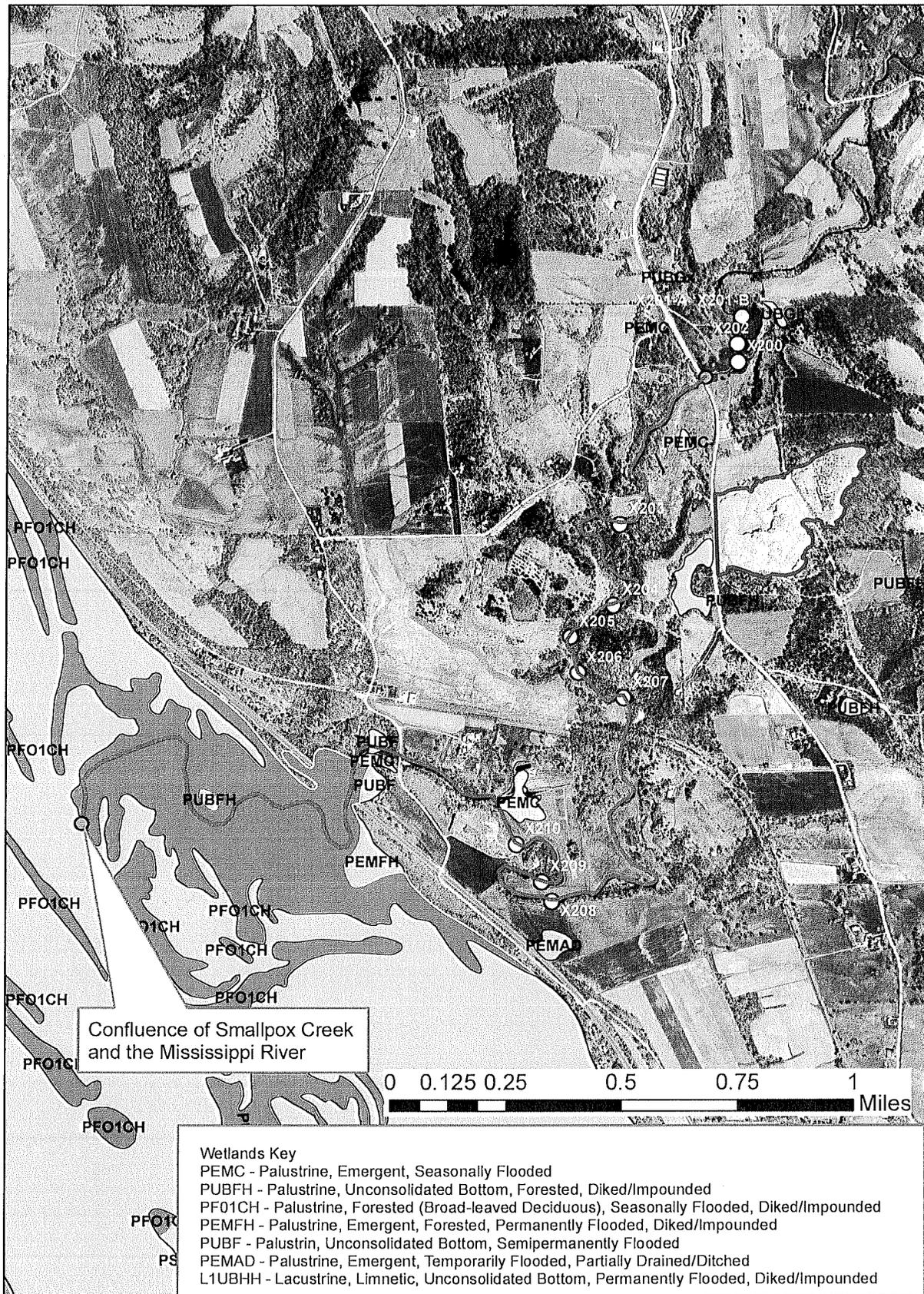
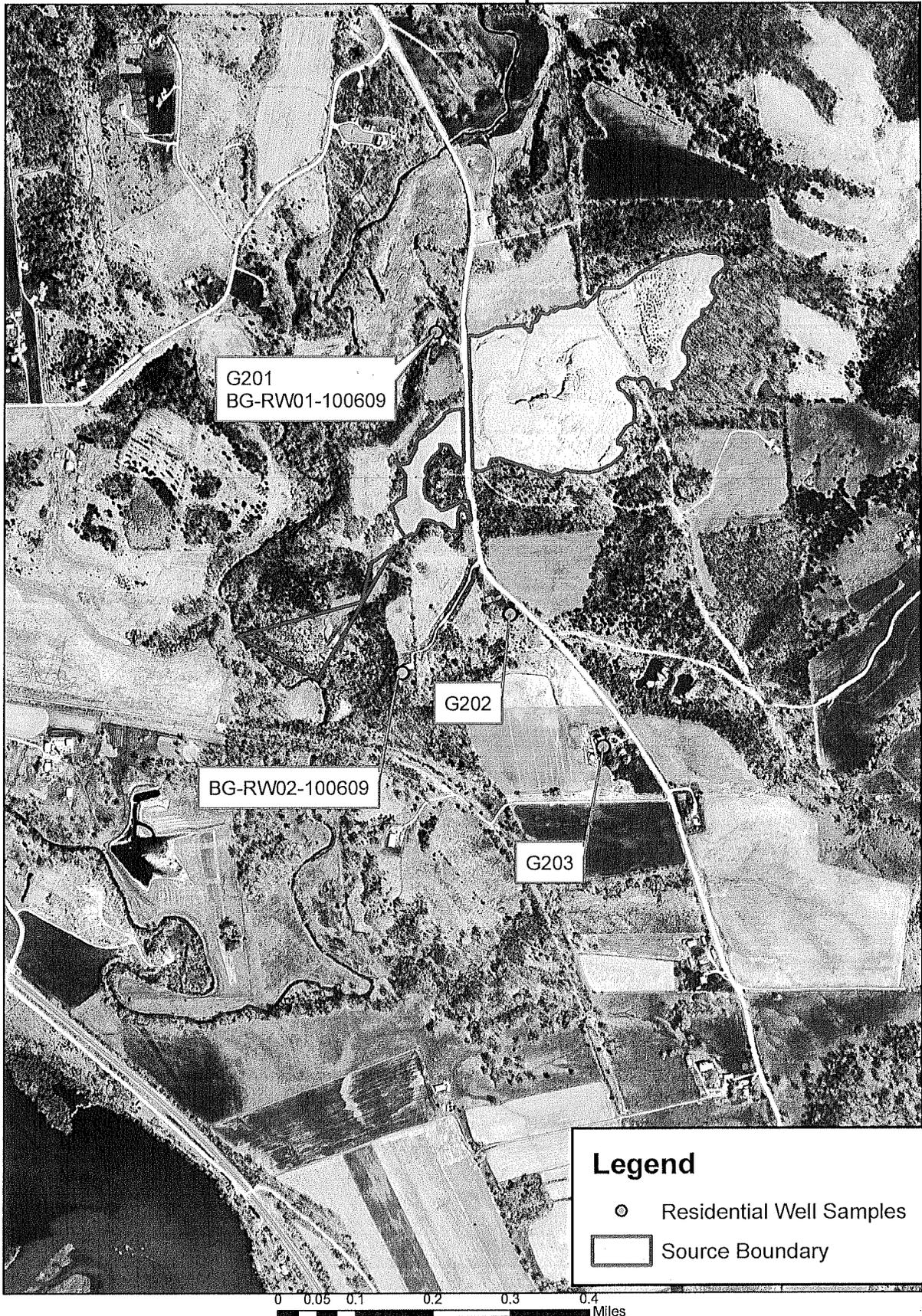


Figure 7 Sediments and Wetlands



Illinois Natural Resources Geospatial Clearinghouse, Illinois State Geological Survey, <http://www.isgs.edu/nsdihome/>, 2005 Digital Orthophoto Quadrangles, Jo Daviess County, Bellevue NE Quadrangle, UTM. Accessed on June 28, 2011. National Wetlands Inventory, <http://www.fws.gov/wetlands/Data/Mapper.html>. Ref. 52. Accessed on November 28, 2011. Sediment Sample Locations (Ref. 4)

Figure 8
Residential Well Sample Locations



Source: Illinois Natural Resources Geospatial Clearinghouse, Illinois State Geological Survey, <http://isgs.edu/nsdihome/>, Illinois Historical Aerial Photography, Flight BWT-2D-87, May 17, 2011. Sample Locations were obtained from GPS data collected during the 2009 ESI (Ref. 4) and 2000 SI (Ref. 12) and Ref. 48.

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2.0 SITE SUMMARY

2.0.1 Site Description

The Bautsch-Gray Mine is comprised of three principal sources; an estimated 40 acres of mine tailings, located approximately four miles south of Galena, Illinois on Blackjack Road (Ref. 4, p. 6), a settling pond, located to the west of the mine tailings pile and contaminated soil along the overland flow route from the settling pond to Smallpox Creek (Ref. 4, pp. 18-22) (Figures 1 and 2). All three sources contained elevated levels of arsenic, cadmium, copper, lead and zinc (Ref. 4, pp. 16, 17, 19 - 21).

As part of this HRS evaluation, the pathways evaluated for the Bautsch-Gray Mine were the ground water migration and surface water migration pathways.

The tailings pile can be found at the intersection of Sections 3, 4, 9 and 10 in Rice Township, Jo Daviess County (Ref. 4, p. 6; Ref. 7). At its highest, the mine tailings pile ascends approximately 40 feet above the surrounding terrain (Ref. 4, p. 6). The tailings pile is mostly void of vegetation with large erosion channels and gullies scattered throughout (Ref. 4, pp. 6, 20). Large pieces of metal that appear to be remnants of old mining equipment can be found throughout the tailings pile (Ref. 4, p. 6). The general slope of the tailings pile is toward Blackjack Road to the west (Ref. 4, p. 6).

There is no indication that a liner is present beneath the mine tailings pile (Ref. 4, p. 20). The surface of the mine tailings pile is mostly void of vegetation (Ref. 4, p. 20). A berm, composed of mine tailings, exists along the western boundary of the pile but does not appear to completely contain the material (Ref. 4, p. 20). An overflow tube is present along the west-central portion of the tailings pile that allows excess surface water and mine tailings to flow west beneath Blackjack Road and into a settling pond (Ref. 4, p. 20). There is visual evidence that material from the waste pile has migrated from this source to the north, west, and south. Regardless of the three routes, runoff flows into Smallpox Creek (Ref. 4, p. 24).

Access to the mine tailings pile is somewhat restrictive with no trespassing signs posted (Ref. 4, p. 6). A large berm, composed of mine tailings, provides a natural barrier along most of the western boundary that parallels Blackjack Road (Ref. 4, p. 6). A locked gate along the northwestern boundary prohibits vehicles from entering the property (Ref. 4, p. 6). A barbed-wire fence prevents vehicle access along the southwestern boundary (Ref. 4, p. 6). There are signs of human intrusion on the mine tailings pile such as shotgun shells, beverage cans and remnants of small fires (Ref. 4, p. 6).

The ore body of the Bautsch mine was found in 1944 (Ref. 5, p. 4) and put into operation in 1946 (Ref. 5, p. 4). In 1949, the mine comprised an area of over 2.56 acres and consisted of two shafts and a truck incline (Ref. 5, p. 4). Water was being pumped from the mine at a rate of about 1,500 gallons per minute (Ref. 5, p. 4). From 1963 to 1968, operations at the

mine were terminated, and the mine was allowed to flood (Ref. 5, p. 5). After dewatering in 1968, it was discovered that one of the pillars had failed (Ref. 5, p. 6). There was a massive failure in 1972, which caused the closure of the Bautsch mine (Ref. 5, p. 6).

The Bautsch and Gray mines were lead-zinc mines. A room-and-pillar mining method was used at the Bautsch mine (Ref. 5, p. 6). Ore was broken by conventional drilling and blasting and loaded into trucks by means of electric shovels and front-end loaders (Ref. 5, p. 6). A truck incline and two shafts were utilized for haulage, access, and ventilation (Ref. 5, p. 6).

The Bautsch-Gray Mine tailings pile consisted of the Gray Mill which began processing ore from the Gray (Heer) ore body in 1944 and shortly thereafter on the Bautsch (Ref. 19, p. 4). The Gray mill was designed originally to handle 600 tons of ore per day; by revisions in both primary and secondary crushing and by adding a ball mill the capacity was subsequently raised to 850 tons per day, but was treating approximately 1,050 tons per day (Ref. 19, p. 18).

The ore is crushed to minus-7/16-inch in 3 stages and dewatered in an Esperanza-type drag-belt classifier. The classifier underflow is split at the center cells of an 8-cell, cooley type jig, each half of the feed being sent to 4 cells. The tailing, which comes off the fourth cell on each half of the jig, amounts to about 50 percent of the initial feed. The hutch product from the first 2 cells is cleaned further in a single-cell Cooley type jig to yield a 70-percent lead concentrate (Ref. 19, p. 18). The tailing from the cleaner jig and the hutch products of cells 2 and 3 are ground to minus-48-mesh in 2 parallel ball mills in closed circuits with spiral classifiers. The classifier overflow is conditioned and passes to a 2-cell lead circuit, where a lead flotation concentrate is made. The tailing from the lead cells passes to a zinc conditioner and on to a 6-cell flotation circuit. Zinc concentrate from the cleaner cell of this circuit is filtered and stored for shipment. The flotation tailing is sampled and flows to the tailing pond. Zinc concentrate produced averages of 62.6 percent zinc (Ref. 19, p. 18).

There are three principal sources (mine tailings pile, settling pond and contaminated soil) identified at the property (Ref. 4, pp. 18-22) (Figure 2). As evidenced within this HRS documentation record, zinc and lead material were identified in Smallpox Creek, which contained elevated concentrations of arsenic, copper and lead (Ref. 4, pp. 19, 20).

Smallpox Creek is shown as a lower perennial water body according to U.S. Geological Survey Maps (Ref. 7). At the request of Illinois Environmental Protection Agency (EPA), IDNR completed an Endangered Species Consultation on October 28, 2009 (Ref. 20). The consultation concluded that Smallpox Creek empties into a Mississippi River Backwaters area which is designated as a Jo Daviess County Illinois Natural Area (Ref. 20, p. 1). Also,

the weed shiner and western sand darter were two protected aquatic resources located in the backwaters of the Mississippi River at this location (Ref. 20, p. 1).

Over the years, mine tailings have migrated west across Blackjack Road and into the neighboring residential yard and wetland area (Ref. 4, p. 25). An aerial photograph from 1946 indicates that the settling pond was not present during that time (Ref. 4, p. 86). It appears that waste material generated from the milling process may have flowed directly into Smallpox Creek as illustrated by a defined channel in the 1946 aerial photograph (Ref. 4, p. 86).

Illinois EPA conducted an Integrated Assessment in October 2000 (Ref. 12). Analytical results from the Integrated Assessment documented the presence of mine related waste in nearby residential properties and Smallpox Creek (Ref. 12, p. 26-27). The Integrated Assessment also documented that a nearby residential private drinking water well had been impacted by the presence of the mine tailings at the Bautsch-Gray Mine (Ref. 12, p. 27).

In 2001, Illinois EPA conducted sediment sampling activities within Smallpox Creek for the purpose of determining the impact to this perennial waterway (Ref. 18, p. 5). The data was compiled in an Expanded Site Inspection (ESI) report (Ref. 18). The inspection documented the presence of heavy metals along two separate drainage routes that enter Smallpox Creek (Ref. 18, p. 6). The sediments within Smallpox Creek were also found to have inorganic contaminants attributable to mining activities that occurred at the Bautsch-Gray Mine milling area (Ref. 18, p. 20).

During the summer of 2009, excess rain resulted in mine tailings washing off the mine tailings pile and migrating over Blackjack Road into a nearby residential property (Ref. 4, p. 11). This incident prompted an investigation on August 18 and 24, 2009 by Illinois EPA (Ref. 4, p. 11). During the investigation, Illinois EPA collected X-ray Fluorescence samples from the mine tailings pile, roadside ditch, and a residential property near the Bautsch-Gray Mine (Ref. 24, p. 1-2). The results indicated that elevated levels of lead, zinc, cadmium, and arsenic were present in material that washed off the mine tailings pile (Ref. 24, p. 5, Table 2). The results also prompted a request by Illinois EPA for a time-critical removal action to be conducted by U.S. EPA Region 5 (Ref. 24).

From October 6 - 8, 2009, U.S. EPA's Emergency Response Program, their contractors, and Illinois EPA collected additional data for establishing an imminent and substantial threat posed by the Bautsch-Gray Mine (Ref. 14, p. 3). The main constituent of concern, lead, yielded results exceeding the U.S. EPA removal action level and cleanup objective in samples collected from in and around the adjacent residential area, in and around the southwest runoff ravine area, and around the mine property (Ref. 14, p. 14). During the removal action, contaminated soil from the residential property was removed and placed back on the main tailings pile (Ref. 60, p. 2). The mine tailings pile was contoured and settling basins were installed on the pile to impede the migration of mine tailings (Ref. 60, p. 2).

Targets affected by the Bautsch-Gray Mine include individuals living near the mine tailings pile which has migrated to residential yards and into residential drinking water well (Ref. 14, p. 11; Ref/ 39). The potential for contamination also exists for people served by drinking water from points of withdrawal subject to potential contamination within the 4-mile target limit distance. These targets will be discussed in greater detail in Section 3.3 of this report.

According to the Illinois Department of Natural Resources (INDR) Ecological Compliance Assessment Tool (EcoCAT) has determined that protected resources in the area include Casper Bluff Illinois Natural Areas Inventory (INAI) Site, Mississippi River Backwaters – Jo Daviess County INAI site, Casper Bluff Land and Water Reserve, weed shiner (*Notropis texanus*) and western sand darter (*Ammocrypta clarum*) (Ref. 20, p. 1). According to the topographic map (Ref. 7), there is the Mississippi River Fish and Wildlife Refuge located along the east side of the Mississippi River in the area of confluence of Smallpox Creek. The Mississippi River Backwaters-Jo Daviess County INAI site; the Mississippi River Fish and Wildlife Refuge; the weed shiner (*Notropis texanus*) and the western sand darter (*Ammocrypta clarum*) were used in the HRS documentation record for scoring purposes for potential contamination.

Potential contamination exists for the Mississippi River Backwaters – Jo Daviess County INAI site (Ref. 25, p. 12), the Mississippi River Fish and Wildlife Refuge, and the habitat for the weed shiner and the western sand darter (Ref. 20, p. 1). These targets will be discussed in greater detail in Section 4.1.4.3.1.2.

2.0.2 Facility History

The Gray farm south of Galena was acquired under lease by Tri-State Zinc, Inc., in 1944 (Ref. 40, p. 4). Subsequently Tri-State Zinc Inc., sank a shaft on the Gray drilling, built a 600-ton flotation mill, and began mining and milling the Gray ore body (Ref. 40, p. 4). Mining and milling began in November. Exploratory drilling on the property was undertaken by the Bureau of Mines early in 1943, and, as a result of favorable showings and to encourage development of the property, drilling was continued to July 1944 (Ref. 40, p. 4). The ore body was found to extend into the adjoining Bautsch property, which was also drilled during 1944 (Ref. 26, p. 283-284). From the 1946 Minerals yearbook, The Tri-State Zinc, Inc., continued to operate the Gray (Heer) mine and 600 ton flotation mill south of Galena and in June began operating also the newly developed Bautsch mine (Ref. 27, p. 1372). Besides ore from the two mines, the mill treated old tailings from nearby properties (Ref. 27, p. 1372). In 1948, there is not a mention of the Gray mine being in production, but Tri-State Zinc, Inc. operated the Bautsch, Heer, and Blackjack mines (Ref. 28, p. 1476). The Bautsch and Heer were operated throughout the year, whereas the Blackjack, last worked in 1927, was dewatered during the year and produced only in November and December (1948) (Ref. 28, p. 1476). Ore from all three mines was treated in the company's Gray mill (Ref. 28, p. 1476). In 1949, the Tri-State Zinc, Inc. operated its Bautsch, Heer

and Blackjack mines (Ref. 29, p. 1450). The Bautsch mine operated throughout the year, whereas the Heer mine operated from January through July and the Blackjack during January and February (Ref. 29, p. 1450). The ore is concentrated in the company Gray mill by jigs and flotation (Ref. 29, p. 1450). An inclined adit, 1,625 feet long to the Bautsch mine was finished July 1 (Ref. 29, p. 1450). The ore is now hauled by diesel trucks direct from the mine through the adit to the mill (Ref. 29, p. 1450). Daily capacity of the Gray mill was increased from 600 to 850 tons by the addition of a new crushing plant which began operation on July 1 (Ref. 29, p. 1450). An inclined adit to the Blackjack mine was begun in October 1949 (Ref. 29, p. 1450).

In 1950, Tri-State Zinc operated the Bautsch, Blackjack, and Heer mines, hauling ore from them to the company's adjacent beneficiation plant (Gray Mill) by truck (Ref. 30, p. 1472). The Bautsch and Blackjack mines both have inclined adit tunnels leading to the mine through which trucks are driven directly from the mill to stopes in the mine (Ref. 30, p. 1472). At the Heer mine ore is hoisted to the surface through a 278 foot shaft (Ref. 30, p. 1472). These mines are in R. 1 E., T. 27 N (Ref. 30, p. 1472). The Blackjack mine is in sec. 4 and the Bautsch and Heer in sec. 10 (Ref. 30, p. 1472). From the 1951 Minerals yearbook, the Heer mine is no longer included as an operated mine, although Bautsch was operated throughout the year and the Blackjack mine intermittently (Ref. 31, p. 1502).

From the Minerals yearbook 1956, Tri-State Zinc mined zinc-lead ore from the Amelia and Gray mines (Ref. 32, p. 407-408). The Gray mine, consisting of a group of properties, was operated throughout the entire year (Ref. 32, p. 408). Ore was hauled directly to the Gray mill by diesel trucks through an inclined adit approximately 1700 feet in length (Ref. 32, p. 408). At the mill about a half mile from the portal of the adit the ore was concentrated by jigging and flotation (Ref. 31, p. 408). The Amelia mine, near the Gray mine was newly operated beginning the middle of May 1956 (Ref. 32, p. 408). Ore was mined by open stoping and hauled by truck to the Gray mill for processing (Ref. 32, p. 408).

According to the Minerals yearbook of 1968, Eagle-Picher Industries, Inc. operated the Blackjack, Rehm-Bauer, and Bautsch mines (Ref. 34, p. 262). First production from the latter property (Bautsch), which was last operated by Tri-State Zinc, Inc., in 1963, was in July (1968) (Ref. 34, p. 262). It appears that Eagle-Picher processed the ore at the Graham mill and not at the Gray mill (Ref. 34, p. 265). In 1969, Eagle-Picher operated the Bautsch, Blackjack, and Rehm-Bauer mines. The company started an incline shaft into the Gray ore body, Jo Daviess County, late in the year (Ref. 35, p. 267). In 1971, Eagle Picher operated the Bautsch, Blackjack and Gray mines; the Rehm-Bauer mine was abandoned as of February 1970 (Ref. 36, p. 262). Eagle-Picher Industries, Inc. operated the Bautsch and Gray mines; the Blackjack mine was abandoned as of May 1971 (Ref. 37, p. 239). The Gray mine closed in September 1972, and the Bautsch mine is scheduled to close in May 1973 (Ref. 37, p. 239). The Bautsch mine, owned by Eagle-Picher Industries, Inc., located in northern Illinois near Galena (Jo Daviess County), closed in May (1973); this was the last all-lead-zinc mine operating in the state (Ref. 38, p. 223).

The actual location of the Bautsch Mine is located to the south of the mine tailings pile. The Gray Mine is located just south of the mine tailings pile. The location of these mines can be found in Ref. 8, p. 1-2. The location of the mines can also be located using the USGS Topographic map of the Bellevue Quadrangle (Ref. 7). The location of the Amelia mine is unknown, although the United States Geological Survey (USGS) topographic map of the Bellevue Quadrangle depicts mines in the area surrounding the milling area (Ref. 7).

Surface water drainage is mainly to the west (Ref. 4, p. 25). In 1971, Illinois EPA issued a National Pollutant Discharge Elimination System (NPDES) permit to Eagle-Picher Industries to discharge wastewater into Smallpox Creek (Ref. 9, p. 3). Over the years, mine tailings have migrated west across Blackjack Road and into the neighboring residential yard and wetland area (Ref. 4, p. 25). An aerial photograph from 1946 indicates that the settling pond was not present during that time (Ref. 4, p. 86). It appears that waste material generated from the milling process may have flowed directly into Smallpox Creek as illustrated by a defined channel in the 1946 aerial photograph (Ref. 4, p. 86).

On July 1, 1999, the Illinois EPA investigated a complaint received by the Rockford Regional Office on June 16, 1999 (Ref. 11, p. 1). During the inspection, vehicles and equipment were discovered. Illinois EPA personnel contacted the owner of the equipment on June 17, 1999 to advise that mine tailings are not acceptable material for use as "clean fill" (Ref. 11, p. 3). Illinois EPA conducted an Integrated Assessment in October 2000 (Ref. 12, p. 4). Analytical results from the Integrated Assessment documented the presence of mine related waste in nearby residential properties and Smallpox Creek (Ref. 12, p. 26-27). The Integrated Assessment also documented that a nearby residential private drinking water well had been impacted by the presence of the mine tailings at the Bautsch-Gray Mine (Ref. 12, p. 27). Following the inspection, Illinois Department of Public Health recommended that the residents stop using the well for drinking purposes (Ref. 6, p.1).

In 2001, Illinois EPA conducted sediment sampling activities within Smallpox Creek for the purpose of determining the impact to this perennial waterway (Ref. 18, p. 5). The data was compiled in an ESI report (Ref. 18) and was submitted to U.S. EPA Region 5 in March 2002. The inspection documented the presence of heavy metals along two separate drainage routes that enter Smallpox Creek (Ref. 18, p. 6). The sediments within Smallpox Creek were also found to have inorganic constituents attributable to mining activities that occurred at the Bautsch-Gray Mine milling area (Ref. 18, p. 20).

During the summer of 2009, excess rain resulted in mine tailings washing off the mine tailings pile and migrating over Blackjack Road into a nearby residential property (Ref. 4, p. 11). Illinois EPA was notified of the situation by the Jo Daviess County Highway Department in August 2009 (Ref. 4, p. 11). The incident prompted an investigation on August 18 and 24, 2009 by Illinois EPA (Ref. 4, p. 11). During the investigation, Illinois EPA collected X-ray Fluorescence samples from the waste pile, roadside ditch, and a residential property near the Bautsch-Gray Mine (Ref. 24, p. 1-2). The results indicated that elevated levels of lead, zinc, cadmium, and arsenic were present in material that washed off

the mine tailings pile (Ref. 24, p. 5, Table 2). The results also prompted a request by Illinois EPA for a time-critical removal action to be conducted by U.S. EPA Region 5 (Ref. 24). Soil cleanup work was completed at the residential property, by removing tailing and contaminated soil. The top layer of soil and vegetation in some areas was impacted by contaminated tailings. The material was loaded into dump trucks and transported back across Blackjack Road to the tailings pile on site (Ref. 60, p. 2).

From October 6 - 8, 2009, U.S. EPA's Emergency Response Program, their contractors, and Illinois EPA collected additional data for establishing an imminent and substantial threat posed by the Bautsch-Gray Mine (Ref. 14, p. 3). The main constituent of concern, lead, yielded results exceeding the U.S. EPA removal action level and cleanup objective in samples collected from in and around the adjacent residential area, in and around the southwest runoff ravine area, and around the mine property (Ref. 14, p. 14).

2.2 SOURCE CHARACTERIZATION

2.2.1 Source Identification

Number of the source: 1

Name: Mine Tailings pile

HRS Source Type: Pile

Description and Location of the source:

Source 1 is comprised of a mine tailings pile located on the property (Figure 2 of this HRS documentation record). Source 1 is categorized as source type “pile” (Ref. 1, Table 2-5). Source 1 consists of waste mine tailing material from the lead-zinc ore processing operations at the Bautsch-Gray Mine milling process area (Ref. 4, p. 19). Numerous inorganic contaminants have been documented in the waste mine tailings pile sampled on the surface within the property boundaries of the Bautsch-Gray Mine (Ref. 4, p. 16, 47, 48, Table 2).

The mine tailings pile has been stockpiled in a large visible pile on the east side of Blackjack road. The mine tailings material that is present has the general appearance of gray/brown beach sand with dark striations throughout (Ref. 4, p. 19). The material is very porous and contains large pieces of metal that once made up the mining operations (Ref. 4, p. 19). Throughout the tailings pile are eroded valleys and channels that generally slope toward the west (Ref. 4, p. 19). There are large, “canyon-like” ridges throughout the central portion of the tailings pile in which birds burrow into the side walls for nests (Ref. 4, p. 19). There are signs of human intrusion on the mine tailings pile such as shotgun shells, beverage cans, and remnants of small fires (Ref. 4, p. 6). Observations made during the ESI indicated that the tailings pile, at its highest point, is approximately 40 feet above the surrounding terrain (Ref. 4, p. 19). The size of the pile has been calculated as 1,528,956 square feet utilizing Figure 7 of the 2009 ESI (Ref.4, p. 44) and a GIS software (Ref. 17, p. 2).

Location

As shown on Figure 2, Source 1 is located along the eastern edge of Blackjack Road.

Containment

Gas release to air: The air migration was not scored; therefore, gas containment was not evaluated.

Particulate release to air: The air migration was not scored; therefore, particulate containment was not evaluated.

Release to ground water: There is no indication that a liner is present beneath the mine tailings pile (Ref. 4, p. 20). Due to the absence of a liner, the containment factor value for the ground water migration pathway is 10 (Ref. 1, Table 3-2, p. 51596).

Release via overland migration and/or flood: Source 1 is not covered (Ref. 12, p. 18). There is evidence of hazardous substance migration from Source 1 by chemical analysis for arsenic, lead and zinc in a residential yard (Ref. 14, p. 9-10). Due to the evidence of hazardous substances have migrated from the source area, the containment factor value for the surface water overland flow migration pathway is 10 (Ref. 1, Table 3-2, p. 51596).

The mine tailings are graded into a large berm that steeply slopes along S. Blackjack Road (Ref. 14, p. 4). A large drainage culvert running under Blackjack Road directs water and waste onto a marshland located on a residential property located across Blackjack Road (Ref. 14, p. 4). During a large August 2009 rain event, mine tailings were flushed from the main tailings pile at the mine property across Blackjack Road and onto a residential property (Ref. 14, p. 3). According to the Jo Daviess Highway Department, apparently this has been a frequent problem during the rainy seasons over the last several years (Ref. 14, p. 3).

Excess surface water from the Bautsch-Gray Mine milling area could flow in three separate directions. Regardless of the three routes, each empties into Smallpox Creek and eventually the Mississippi River (Ref. 4, p. 24).

Excess surface water could travel north from the northwestern corner of the mine tailings pile within the ditches that parallel Blackjack Road (Ref. 4, p. 25). This is evident by the mine tailings that are visible in the ditches to the east of Blackjack Road (Ref. 49, p. 54). Sample descriptions of X-ray Fluorescence samples also indicate that mine tailings are present along the east side of Blackjack Road (Ref. 14, p. 19, 25). Elevated levels of lead are present within ditches along Blackjack Road (Ref. 14, p. 19). Surface water travels approximately ¼ mile to the north before emptying into Smallpox Creek just east of the Blackjack Road Bridge (Ref. 4, p. 25).

A second route became prominent during heavy rain activities during the summer of 2009 (Ref. 4, p. 25). Excess surface water migrated west across Blackjack Road and into a residential property (Ref. 4, p. 25; Ref. 14, p. 3). The surface water has carried excess mine tailings and deposited them on Blackjack Road and within the residential property. From the residential property, excess surface water continues to travel in a northwest direction following the natural contours of the land before reaching a wetland approximately 0.1 mile from the mine tailings pile. Once reaching the wetland there is no discernible flow, but there are several ditches that channel the water toward Smallpox Creek to the north, northwest, and west (Ref. 4, p. 25). According to the topographic map (Ref. 7), there is an

intermittent flow to the north through this wetland area. This intermittent flow intersects Smallpox Creek just to the west of the Blackjack Road Bridge (Ref. 7).

A third route begins at the mine tailings pile as excess surface water and mine tailings are channeled to the west from the mine tailings pile to the settling pond by a storm water drainage pipe (Ref. 14, p. 54). From the settling pond, excess surface water and mine tailings migrate west/southwest and follow the natural contours of the settling pond (Ref. 14, p. 55). At the southern end of the settling pond is a dike that has broken (Ref. 14, p. 56). This broken dike allows surface water and mine tailings from the settling pond to migrate to an area south of the settling pond (Ref. 4, p. 26), this area is designated as contaminated soil (Source 3) (Ref. 14, p. 56). From the settling pond, excess surface water follows the natural contour of the terrain forming a “fan-shaped” area of contaminated soil. Runoff from this area of contaminated soil empties into Smallpox Creek at Samples X206 and X207 (Ref. 4, p. 26; Figure 4). These samples are designated on the Figure 5 as PPE 3 and PPE 4 (Figure 4).

2.2.2 Hazardous Substances Associated with the Source

The hazardous substances arsenic, cadmium, copper, lead and zinc (Ref. 4, p. 19) were detected in five waste samples from Source 1, collected during the November 2009 CERCLA ESI (Ref 4, p. 19). Samples X301 – X305 were all obtained from the mine tailings pile (Ref. 4, p. 42, Figure 5). Source sample locations are presented on Figure 3 of this HRS Documentation Record. Waste samples were collected according to the Bureau of Land Sampling Procedures Guidance Manual for waste piles (Ref. 16, p. 5.6 – 5.7).

Cadmium, lead, magnesium and zinc were detected in five waste samples, arsenic in four samples, and copper in one waste sample collected during the 2009 ESI (Ref. 4, p. 19, 48, Table 2) from the mine tailing pile (Ref. 4, p. 42, 47). Sample locations are depicted in Reference 4, Figure 5, p. 42.

Analysis of the samples from Source 1 were conducted using EPA Contract Laboratory Program (CLP) Scope of Work (SOW) ILM05.4 analysis procedures (Ref. 15, p. 4) and results indicate the presence of arsenic, cadmium, copper, lead, magnesium, and zinc (Refs. 24, p. 14; 33, Table 1).

Table 1a

Sample Description Table (Ref. 4, pp. 42, 47, 75-77; Ref. 49, pp. 49-52)

Sample ID	Sample Collection Date	Sample Collection Depth	Sample Location	Sample Description
X301 (ME0006)	11/17/09	0-2 inches	Taken from an eroded drainage way leading to the settling pond west of road, collected near the southwest portion of the mine tailings pile	Gray, clay type material (mine tailings)
X302 (ME0002)	11/17/09	0-6 inches	Taken from top of the southeast large mine tailings pile	Brown fine sand/silty (mine tailings)
X303 (ME0003)	11/17/09	0-2 inches	Collected from a side wall of mine tailings, towards the middle east portion of the mine tailings pile	Fine gray/dark gray sand (mine tailings)
X304 (ME0004)	11/17/09	0-2 inches	Low lying area on the pile that appeared to have collected fine mine tailings, near middle of mine tailings pile	Brown /gray fine sandy silt (mine tailings)
X305 (ME0005)	11/17/09	0-2 inches	Northern edge of the mine tailings pile	Dark gray, fine mine tailings

Table 1
Hazardous Substances Associated with Source 1

Sample ID	Sample Type	Sample Collection Date	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Adjusted Value (Ref. 3, p. 8, 18)	Sample Quantitation Limit (mg/kg)	References
X301 (ME0006)	Waste	11/17/09	Arsenic	26.1		1.35	15, p. 11, 15, 24, 62, 67, 71, 72
			Cadmium	33		0.67	
			Copper	265 J	217	3.37	
			Lead	1460 J	1,013	1.35	
			Magnesium	36500 J	29,675	674.76	
			Zinc	16100 J+	10,733	40.49	
X302 (ME0002)	Waste	11/17/09	Arsenic	15.3		1.06	15, p. 11, 15, 20, 62, 67, 71, 72
			Cadmium	39		0.53	
			Copper	66.2 J	54	2.66	
			Lead	3610 J	2,507	1.06	
			Magnesium	90200 J	73,333	1,597.44	
			Zinc	15400 J+	10,267	25.56	
X303 (ME0003)	Waste	11/17/09	Arsenic	30.2		1.09	15, p. 11, 15, 21, 62, 67, 71, 72
			Cadmium	19		0.54	
			Copper	5.8 J-	5.8	2.72	
			Lead	3120 J	2,167	1.09	
			Magnesium	77400 J	62,926	544.66	
			Zinc	7880 J+	5,253	26.14	
X304 (ME0004)	Waste	11/17/09	Arsenic	41.4		1.22	15, p. 11, 15, 22, 62, 67, 71, 72
			Cadmium	19.8		0.61	
			Copper	36.2 J	30	3.06	
			Lead	8970 J	6,229	1.22	
			Magnesium	60600 J	49,628	611.25	
			Zinc	8800 J+	5,867	29.34	
X305 (ME0005)	Waste	11/17/09	Arsenic	68		1.25	15, p. 11, 15, 23, 62, 67, 71, 72
			Cadmium	37.8		0.63	
			Copper	44.1 J	36	3.13	
			Lead	15500 J	10,764	5.01	
			Magnesium	37700 J	30,650	626.57	
			Zinc	19000 J+	12,667	30.08	

Notes:

J – The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample. The ICP serial dilution percent difference was not in control. Hits were qualified “J” (Ref. 15, pp. 7, 10).

J+ - The result is an estimated quantity, but the result may be biased high. The matrix spike recovery was high (>125%), indicating that the sample results may be biased high. The required post spike was performed and results were greater than 125%. Hits were qualified "J+" (Ref. 15, pp. 6, 10).

J- - The result is an estimated quantity, but the result may be biased low. Sample result affected by an interference check "A" sample (ICSA) for which false negative concentration values greater than absolute value of the MDL were obtained. Hits less than 10 times the absolute value of the ICSA are qualified "J-" (Ref. 15, pp. 8, 9, 10).

The J value indicates the analyte was present in the sample but the quantity is estimated (Ref. 15, p. 10).

Calculating Adjusted (Sample-Specific) Quantitation Limits (SQL) from Contract Required Quantitation Limits (CRQLs) (Ref. 13, pp. 37-38).

Adjusted Limit (mg/kg) = $C \times W_m / W_r \times V_r / V_m \times 1/S \times DF$

Where:

C = Contract Required Quantitation Limit

W_m = Minimum method-required wet sample weight (g)

W_r = Reported wet sample weight (g)

V_m = Method-required final sample volume (mL)

V_r = Reported final sample volume (mL)

S = % solids/100

DF = Sample Dilution Factor

2.4.2 HAZARDOUS WASTE QUANTITY

2.4.2.1.1. Hazardous Constituent Quantity (Tier A)

The information available is not sufficient to adequately support evaluation of the hazardous constituent quantity for Source 1 (Ref. 1, p. 51590). As a result, the evaluation of hazardous waste quantity proceeds to the evaluation of Tier B, hazardous waste stream quantity (Ref. 1, pp. 51590, 51591).

Hazardous Constituent Quantity Assigned Value: NS

2.4.2.1.2. Hazardous Wastestream Quantity (Tier B)

The hazardous wastestream quantity is not available; therefore it is not possible to adequately determine a hazardous wastestream quantity (Tier B) for Source 1 (Ref. 1, p. 51591). As a result, the evaluation of hazardous waste quantity proceeds to the evaluation of Tier C, volume (Ref. 1, p. 51591).

Hazardous Wastestream Quantity Assigned Value: NS

2.4.2.1.3. Volume (Tier C)

The volume cannot adequately be determined; therefore it is not possible to determine a volume (Tier C) for Source 1 (Ref. 1, p. 51591).

Volume Assigned Value: 0

2.4.2.1.4 Area (Tier D)

Based on aerial photographs of the Bautsch-Gray Mine milling area, the area of the mine tailings pile was outlined and determined to be 35.1 acres or 1,528,956 square feet (Ref. 17, p. 2).

The Area Assigned Value was calculated by dividing the area (1,528,956) by 13 (Ref. 1, p. 51591, Table 2-5) for a pile.

Source Type	Units (square feet)	Reference
Mine Tailings Pile	1,528,956	Ref. 17, p. 2

Equation for Assigning Value (Ref. 1, p. 51591, Table 2-5):

Hazardous Waste Quantity = 1,528,956 square feet/13

Area Assigned Value = 117,612

2.4.2.1.5. Source Hazardous Waste Quantity Value

According to the HRS, the highest of the values assigned to each source for hazardous constituent quantity (Tier A), hazardous waste stream quantity (Tier B), volume (Tier C), and area (Tier D) should be assigned as the source hazardous waste quantity. Because area (Tier D) was the only tier evaluated for Source 1, the area will be assigned as the source hazardous waste quantity value for Source 1 (Ref. 1, p. 51591).

Source Hazardous Waste Quantity Value: 117,612

2.2.1 Source Identification

Number of the Source: Source 2

Name of Source: Settling Pond

Source Type: Surface impoundment

Description and Location of Source:

Description

The second source scored at the Bautsch-Gray Mine is a settling pond which contains mine tailings (Refs. 14, p. 2). The application for permit to discharge or work in navigable waters and their tributaries indicates that discharge began on November 6, 1967 (Ref. 41, p. 4). An Eagle Picher diagram of the Bautsch-Gray Mine indicated that the settling lagoon was located on the east side of Blackjack Road (Ref. 41, p. 11). There is no information that suggests that a liner was placed beneath the settling pond when it was constructed (Ref. 4, p. 21).

The settling pond is approximately 191,331 square feet in size (Ref. 17, p. 2). An aerial photograph indicates that the settling pond was in place in 1970. The settling pond utilized the natural contours of the land along with a dam along the western boundary to retain tailings materials (Ref. 4, p. 20). The tailings materials enter into the settling pond by way of an overflow pipe originating from the tailings pile (Ref. 4, p. 20). Source 2 was diked and helps to retain a portion of the excess runoff (Ref. 4, p. 20). There was an overflow pipe located along the western portion of the settling pond (Ref. 18, p. 15). On Figure 2 of this HRS documentation record, this is at the intersection of the Settling pond (Source 2) and the Defined Channel of mine tailings (Source 3). During the 2009 ESI, the dike that has suppressed the tailings within the settling pond had broken (Ref. 4, p. 22). Due to this break, the overland flow continues to be impacted from mine tailings flowing from the settling pond (Ref. 4, p. 22). At this time, the dike is still breached and allowing mine tailing material to continue along the overland flow route to Smallpox Creek (Ref 62, p. 1).

Samples from Source 2 were collected during the CERCLA ESI of 2009 (Ref. 4, pp. 20). Samples X215 – X218 were all collected within the area designated as the settling pond (Source 2) (Ref. 4, p. 20). Samples X215-X218 document the presence of the following hazardous substances: arsenic, cadmium, copper, lead and zinc (Refs. 4, p. 49, Table 3). Waste samples were collected according to the Bureau of Land Sampling Procedures Guidance Manual for sediments (Ref. 16, p. 10.6).

Location

As shown on Figure 2 of this HRS documentation record, Source 2 is located west of Blackjack Road.

Containment

Gas release to air: The air migration was not scored; therefore, gas containment was not evaluated.

Particulate release to air: The air migration was not scored; therefore, particulate containment was not evaluated.

Release to ground water: There is no indication that a liner is present beneath the settling pond (Ref. 4, p. 20). Due to the absence of a liner, the containment factor value for the ground water migration pathway is 10 (Ref. 1, Table 3-2, p. 51596).

Release via overland migration and/or flood: Source 2 was separated from vegetated marshland by a makeshift dike of woodland debris and trash that separated the tailings from vegetated marshland further south (Ref. 14, p. 5, Appendix A, p. A-7). Documentary photographs show that the dike has been breached and has allowed mine tailings to flow toward Smallpox Creek (Ref. 14, Appendix A, p. A-7). Source 2 utilized the natural contours of the land along with a dike along the western boundary to retain tailings material (Ref. 4, p. 20). There is no information that suggests that a liner was placed beneath the settling pond during construction (Ref. 4, p. 21). The tailings material enters the settling pond by way of an overflow pipe originating from the tailings pile (Ref. 4, p. 20). This overflow pipe travels beneath Blackjack Road and emerges along the eastern boundary of the settling pond (Ref. 4, p. 20).

The southwest end of the horseshoe-shaped area of the settling pond is approximately 16 feet deep; the eastern end is approximately 4 feet deep (Ref. 14, p. 5). Very little vegetative growth was observed on the tailings in this area (Ref. 14, p. 5). Source 2 was diked and helped to retain a portion of the excess runoff (Ref. 4, p. 20). There was an overflow pipe located along the western portion of the settling pond (Ref. 18, p. 15). During the 2009 ESI, the dike that has suppressed the tailings within the settling pond had broken (Ref. 4, p. 22). Due to this break, the overland flow continues to be impacted from mine tailings flowing from the settling pond (Ref. 4, p. 22). Area of the settling pond is 4.4 acres or 191,331 square feet (Ref. 17, p. 1).

There is evidence of hazardous substance migration from Source 2 by chemical analysis and by visual confirmation (Ref. 14, Appendix A, p. A-7, Ref. 4, p. 21). There is indication that hazardous substances have migrated from Source 2 (Ref. 4, p. 21; Ref. 14, Appendix A, p. A-7). Due to the unsound diking, lack of a liner and the evidence of hazardous substance migration, the containment factor value for the surface water migration pathway is 10 (Ref. 1, Table 4-2, p. 51610).

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH SOURCE 2

The hazardous substances arsenic, cadmium, copper, lead and zinc were detected in three samples obtained from Source 2 during the 2009 CERCLA ESI (Ref. 4, p. 49, Table 3). Samples X215-X218 were all obtained from Source 2 (Ref. 4, p. 20). The analytical results included in Table 2 are evidence of the contamination associated with Source 2, the settling pond. Source sample locations are presented in Figure 3 of this HRS documentation record.

Analysis of the samples from Source 2 was conducted using EPA CLP SOW ILM05.4 and results indicate the presence of arsenic, cadmium, copper, lead and zinc (Ref. 4, p. 49, Table 3; Ref. 15, p. 81).

Table 2-1 Source Soil Sample Descriptions (Ref. 4, pp. 42, 46, 74-75; Ref. 49, pp. 45-47)

Sample ID	Sample Collection Date	Sample Collection Depth	Sample Location	Sample Description
X215 (ME0023)	11/17/09	0-1 inches	Collected from the south portion of the settling pond	Gray/brown mine tailings
X216 (ME0024)	11/17/09	0-1 inches	Collected near the middle of the settling pond	Fine, pasty gray/brown mine tailings
X217 (ME0025)	11/17/09	0-1 inches	Collected near the middle of the north end of the settling pond	Gray/brown very fine mine tailings
X218 (ME0026) Duplicate of X217	11/17/09	0-1 inches	Collected near the middle of the north end of the settling pond	Gray/brown very fine mine tailings

**Table 2-2
Hazardous Substances Associated with Source 2**

Sample ID	Sample Type	Sample Collection Date	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Adjusted Value (Ref. 3, p. 8, 18)	SQL (mg/kg) (Ref. 13, p. 37-38).	References
X215 (ME0023)	Sediments-mine tailings	11/17/09	Arsenic	47.5		1.2	4, p. 20, 46; 15, pp. 87, 90, 96, 125, 130
			Cadmium	19.6 J	13.9	.60	
			Copper	157		2.98	
			Lead	1890 J	1,313	1.19	
			Zinc	9790		28.61	
X216 (ME0024)	Sediments-mine tailings	11/17/09	Arsenic	38.6		1.3	4, p. 20, 46; 15, pp. 87, 90, 97, 125, 130
			Cadmium	18.8 J	13.3	.65	
			Copper	147		3.27	
			Lead	2010 J	1,396	1.31	
			Zinc	9160		31.37	
X217 (ME0025)	Sediments-mine tailings	11/17/09	Arsenic	43.5		1.3	4, p. 20, 46; 15, pp. 87, 90, 98, 125, 130
			Cadmium	15.7 J	11.1	.63	
			Copper	79.9		3.15	
			Lead	2020 J	1,402	1.26	
			Zinc	7610		30.26	
X218 (ME0026) Duplicate of X217	Sediments-mine tailings	11/17/09	Arsenic	49.7		1.3	4, p. 20, 46; 15, pp. 87, 90, 99, 125, 130, 131
			Cadmium	16.9 J	12	.63	
			Copper	101		3.13	
			Lead	2970 J	2,063	1.25	
			Zinc	9190		30.04	

J - Cadmium and lead results are associated with an ICP serial dilution percent difference which is not in control. Hits are qualified "J" and non-detects are qualified "UJ" (Ref. 15, pp. 83, 84). The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample (Ref. 15, p. 86).

J - Cadmium is associated with a matrix spike recovery which is low (30-74%) indicating that sample results may be biased low. The required post spike was performed and results were greater than or equal to 75%. Hits are qualified "J" and non-detects are qualified "UJ" (Ref. 15, p. 83). The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample (Ref. 15, p. 86).

The J value indicates the analyte was detected but the quantity is estimated (Ref. 15, p. 10).

Calculating Adjusted (Sample-Specific) Quantitation Limits (SQL) from CRQLs
Adjusted Limit (mg/kg)= C x Wm/Wr x Vr/Vm x 1/S x DF (Ref. 13, pp. 37-38)

Where:

C = Contract Required Quantitation Limit

Wm = Minimum method-required wet sample weight (g)

Wr = Reported wet sample weight (g)

Vm = Method-required final sample volume (mL)

Vr = Reported final sample volume (mL)

S = % solids/100

DF = Sample Dilution Factor

2.4.2 Hazardous Waste Quantity

2.4.2.1.1. Hazardous Constituent Quantity (Tier A)

The information available is not sufficient to adequately support evaluation of the hazardous constituent quantity for Source 2 (Ref. 1, p. 51590). As a result the evaluation of hazardous waste quantity proceeds to the evaluation of Tier B, hazardous waste stream quantity (Ref. 1, pp. 51590, 51591).

Hazardous Constituent Quantity Assigned Value: NS

2.4.2.1.2. Hazardous Wastestream Quantity (Tier B)

The hazardous wastestream quantity is not available; therefore it is not possible to adequately determine a hazardous wastestream quantity (Tier B) for Source 2 (Ref. 1, p. 51591). As a result, the evaluation of hazardous waste quantity proceeds to the evaluation of Tier C, volume (Ref. 1, p. 51591).

Hazardous Wastestream Quantity Assigned Value: NS

2.4.2.1.3. Volume (Tier C)

The volume cannot adequately be determined, assign the source a value of 0 for volume (Ref. 1, p. 51591).

Volume Assigned Value: 0

2.4.2.1.4 Area (Tier D)

Based on aerial photographs of the Bautsch-Gray Mine, the area of the settling pond was outlined and determined to be 4.39 acres or 191,331 square feet (Ref. 17, p. 2).

The Area Assigned Value was calculated by dividing the area (191,331) by 13 (Ref. 1, p. 51591, Table 2-5) for an impoundment.

Source Type	Units	Reference
Surface Impoundment	191,331 sq. feet	17, p. 2

Equation for Assigning Value (Ref. 1, p. 51591, Table 2-5):
Hazardous Waste Quantity = 191,331 square feet/13

Area Assigned Value = 14,717.769

2.4.2.1.5. Source Hazardous Waste Quantity Value

According to the HRS, the highest of the values assigned to each source for hazardous constituent quantity (Tier A), hazardous waste stream quantity (Tier B), volume (Tier C), and area (Tier D) should be assigned as the source hazardous waste quantity. Because area (Tier D) was the only tier evaluated for Source 2, the area will be assigned as the source hazardous waste quantity value for Source 2 (Ref. 1, p. 51591).

Source Hazardous Waste Quantity Value: 14,717.769

2.2.1 Source Identification

Number of the Source: Source 3

Name of Source: Contaminated soil

Source Type: Contaminated Soil

Description and Location of Source:

Description

Tailings material that was once present in the settling pond has resulted in an area of contaminated soil (Ref. 4, p. 21). The mine tailings migrate from the settling pond area, through the overflow pipe located along the southwestern portion of the settling pond to the overland flow route (Ref. 18, p. 15). During the 2009 ESI, the dike that has suppressed the tailings within the settling pond had broken (Ref. 4, p. 22). Due to this break, the overland flow was impacted from mine tailings flowing from the settling pond (Ref. 4, p. 22). Contaminated sediments, from up gradient sources, have been deposited along this overland flow route to Smallpox Creek, resulting in an area of contaminated soil (Ref. 18, p. 16). This area of contaminated soil follows the natural contour of the terrain (Ref. 4, p. 21). The terrain of the contaminated soil area has a slight slope that appears to be toward the west and southwest. Due to the topography, the mine tailings are spread throughout the area in a fan shaped pattern (Ref. 4, p. 21). This fan-shaped pattern contains mine tailings on the surface and stressed vegetation throughout (Ref. 4, p. 21).

The contaminated soil can be identified by using samples X103 through X108 (Ref. 4, p. 21). These samples were taken in the area believed to have been impacted by the overflow of mine tailings (Ref. 4, p. 21). All five locations (one is a duplicate) contained levels of arsenic, cadmium, lead, copper and zinc that met or exceeded observed release criteria (Ref. 4, p. 21). These inorganic contaminants are the same as those found in up-gradient sources (Ref. 4, p. 21-22). Using a scaled aerial photograph and visual observations made during the ESI, an area of 4.9 acres of contaminated soil was determined (Ref. 4, p. 22). The area of the contaminated soil was determined to be 213,444 sq feet (Ref. 17, p. 2).

When compared to soil background Samples X101 and X102, all five locations contained levels of arsenic, lead, copper and zinc that exceed background (Ref. 4, p. 21, 50). These inorganic contaminants can be attributed to those found in up-gradient sources (Ref. 4, p. 21-22).

Samples from Source 3 were collected during the 2009 CERCLA ESI (Ref. 4, pp. 21, 47). Samples X103 through X108 all obtained from Source 3 (Ref. 4, p. 21, 47). Soil samples

were collected according to the Bureau of Land Sampling Procedures Guidance Manual for soil less than three feet (Ref. 16, pp. 6.7– 6.8).

Location

As shown on Figure 2 of this HRS documentation record, Source 3 is located just to the southwest of the mine tailings pile.

Containment

Gas release to air: The air migration was not scored; therefore, gas containment was not evaluated.

Particulate release to air: The air migration was not scored; therefore, particulate containment was not evaluated.

Release to ground water: There is no indication that a liner is present beneath the contaminated soil (Ref. 4, p. 20). Due to the absence of a liner, the containment factor value for the ground water migration pathway is 10 (Ref. 1, Table 3-2, p. 51596).

Release via overland migration and/or flood: Source 3 does not have a complete, maintained, engineered cover or functioning maintained run-on or run-off control system. Source 2 is dammed and helps to retain a portion of the excess runoff (Ref. 4, p. 20). There was an overflow pipe located along the western portion of the settling pond (Ref. 18, p. 15). During the 2009 ESI, the dam that has suppressed the tailings within the settling pond had broken (Ref. 4, p. 22). Due to this break, the overland flow continues to be impacted from mine tailings flowing from the settling pond (Ref. 4, p. 22). According to the Federal Emergency Management Agency (FEMA) Flood Insurance Map, portions of the overland flow are located within the 100-year flood zone (Ref. 4, p. 22).

Sediment samples X206 and X207 were two locations in Smallpox Creek that indicated that the overland flow was entering Smallpox Creek (Ref. 4, p. 22). This leads to an assigned value of 10 [Ref. 1, p. 51609, Table 4-2].

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

The hazardous substances arsenic, cadmium, copper, lead and zinc were detected in five samples (one is a duplicate) obtained from Source 3 during the 2009 CERCLA ESI (Ref. 4, pp. 21, 47, Table 1 p. 50, Table 4). The analytical results included in Table 3 are evidence of the contamination associated with Source 3, the contaminated soil. Source sample locations are presented in Figure 3 of this HRS documentation record.

Analysis of the samples from Source 3 was conducted using EPA CLP SOW ILM05.4 for total metals (Ref. 15, p. 81) and results indicate the presence of arsenic, cadmium, copper, lead and zinc (Ref. 15, p. 88-89; Ref. 4, p. 50, Table 4).

Table 2-3 Background Soil Sample Descriptions (Ref. 4, pp. 42, 47, 48, 80-81; Ref. 46, pp. 35, 40)

Sample ID	Sample Medium	Sample Location	Depth	Date	References
X101 (ME0027)	Soil	South of wastepile	0-2 inches	11/18/09	4, p. 47, Table 1; 15, p. 88
X102 (ME0028)	Soil	North of wastepile	0-2 inches	11/18/09	4, p. 47, Table 1; 15, p. 88

Table 2-4 Background Soil Concentrations

Sample ID	Hazardous Substance	Sample Concentration (mg/kg)	Adjusted Conc. (mg/kg)	Background Concentration (mg/kg) (3 x background)	SQL (mg/kg) (Ref. 13, p. 37-38).	References
X101 (ME0027)	Arsenic	3.6	3.6	10.8	1.29	15, p.88, 100, 125, 126, 130; 3, pp. 8, 18
	Copper	5.8	5.8	17.4	3.22	
	Lead	35.2 J	50.688	152.06	1.29	
	Zinc	135	135	405	7.72	
X102 (ME00028)	Arsenic	5.6	5.6	16.8	2.08	15, p.88, 101, 125, 126, 130; 3, pp. 8, 18
	Copper	22.4	22.4	67.2	5.2	
	Lead	44.5 J	64.08	192.24	2.08	
	Zinc	255	255	765	12.47	

SQL Sample Quantitation Limit
mg/kg milligrams per kilogram

J The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample (Ref. 15, p. 86).

Adjusted Concentrations:

Lead results are associated with an ICP serial dilution percent difference which is not in control. Hits are qualified "J" and non-detects are qualified "UJ" (Ref. 15, p. 83-84).

Lead results are of an unknown bias. Due to being a background sample with an unknown bias, lead concentrations are multiplied by the adjustment factor (1.44) (Ref. 3, p. 8, 18).

Calculating Adjusted (Sample-Specific) Quantitation Limits (SQL) from CRQLs
Adjusted Limit (mg/kg)= C x Wm/Wr x Vr/Vm x 1/S x DF

Where:

C = Contract Required Quantitation Limit

Wm = Minimum method-required wet sample weight (g)

Wr = Reported wet sample weight (g)

Vm = Method-required final sample volume (mL)

Vr = Reported final sample volume (mL)

S = % solids/100

DF = Sample Dilution Factor

Table 2-5 Source Soil Sample Descriptions (Ref. 4, p. 42, 47, 71-73; Ref. 49, p. 41-45)

Sample ID	Sample Collection Date	Sample Collection Depth	Sample Location	Sample Description
X103 (ME0029)	11/17/09	0-1 inches	Approximately 40 to 50 feet north from Smallpox Creek in the overland flow route	light brown/gray silt (very fine)
X104 (ME0030)	11/17/09	0-2 inches	Collected from the overland flow route	Light brown, pasty silt with some organic material, appeared to be wet mine tailings (fines)
X105 (ME0031) duplicate of X104	11/17/09	0-2 inches	Collected from the overland flow route	Light brown, pasty silt with some organic material, appeared to be wet mine tailings (fines)
X106 (ME0032)	11/17/09	0-2 inches	Collected near the middle of the overland flow route from the settling pond to Smallpox Creek	Light brown/gray silt resembling mine tailing fines

Sample ID	Sample Collection Date	Sample Collection Depth	Sample Location	Sample Description
X107 (ME0033)	11/17/09	0-1 inches	Collected from the western edge of the overland flow route south of the settling pond dike	Fine gray/brown silt (appeared to be wet mine tailings)
X108 (ME0034)	11/17/09	0-0.5 inches	Collected near the eastern portion of the overland flow route, immediately south of the settling pond dike	Gray/brown fine silty material (mine tailings)

**Table 3
Hazardous Substances Associated with Source 3**

Sample ID	Sample Type	Sample Collection Date	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Adjusted Value (Ref. 3, p. 8, 18)	SQL (mg/kg) (Ref. 13, p. 37-38).	References
X103 (ME0029)	Soil	5/6/08	Arsenic	37.5		1.55	15, pp. 88, 90, 102, 125, 126, 130, 131
			Copper	199		3.87	
			Lead	2720 J	1,888	1.55	
			Zinc	12500		37.15	
X104 (ME0030)	Soil	5/6/08	Arsenic	41.8		1.44	15, pp. 88, 90, 103, 125, 126, 130, 131
			Copper	154		3.60	
			Lead	2560 J	1,778	1.44	
			Zinc	10700		34.58	
X105 (ME0031)	Soil	4/16/02	Arsenic	56.8		1.45	15, pp. 88, 90, 104, 125, 126, 131
			Copper	201		3.63	
			Lead	3300 J	2,292	1.45	
			Zinc	12700		26.12	
X106 (ME0032)	Soil	4/16/02	Arsenic	38.3		1.29	15, pp. 89, 91, 105, 125, 126, 131
			Copper	133		3.22	
			Lead	2100 J	1,458	1.29	
			Zinc	8720		23.16	
X107 (ME0033)	Soil	4/16/02	Arsenic	42		1.22	15, pp. 89, 91, 106, 125, 126, 131
			Copper	96.7		3.04	
			Lead	1690 J	1,174	1.22	
			Zinc	7650		29.20	

Sample ID	Sample Type	Sample Collection Date	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Adjusted Value (Ref. 3, p. 8, 18)	SQL (mg/kg) (Ref. 13, p. 37-38).	References
X108 (ME0034)	Soil		Arsenic	91.2		1.29	15, pp. 89, 91, 107, 125, 126, 131
			Copper	80.9		3.21	
			Lead	2440 J	1,694	1.29	
			Zinc	4430		30.85	

J - Cadmium and lead results are associated with an ICP serial dilution percent difference which is not in control. Hits are qualified “J” and non-detects are qualified “UJ” (Ref. 15, pp. 83, 84). The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample (Ref. 15, p. 86).

Calculating Adjusted (Sample-Specific) Quantitation Limits (SQL) from CRQLs
Adjusted Limit (mg/kg)= C x Wm/Wr x Vr/Vm x 1/S x DF (Ref. 13, pp. 37-38)

Where:

C = Contract Required Quantitation Limit

Wm = Minimum method-required wet sample weight (g)

Wr = Reported wet sample weight (g)

Vm = Method-required final sample volume (mL)

Vr = Reported final sample volume (mL)

S = % solids/100

DF = Sample Dilution Factor

2.4.2 Hazardous Waste Quantity

2.4.2.1.1. Hazardous Constituent Quantity (Tier A)

The information available is not sufficient to adequately support evaluation of the hazardous constituent quantity for Source 3 (Ref. 1, p. 51590). As a result the evaluation of hazardous waste quantity proceeds to the evaluation of Tier B, hazardous waste stream quantity (Ref. 1, pp. 51590, 51591).

Hazardous Constituent Quantity Assigned Value: NS

2.4.2.1.2. Hazardous Wastestream Quantity (Tier B)

The hazardous wastestream quantity is not available; therefore it is not possible to adequately determine a hazardous wastestream quantity (Tier B) for Source 3 (Ref. 1, p. 51591). As a result, the evaluation of hazardous waste quantity proceeds to the evaluation of Tier C, volume (Ref. 1, p. 51591).

Hazardous Wastestream Quantity Assigned Value: NS

2.4.2.1.3. Volume (Tier C)

The volume cannot be determined, assign the source a value of 0 for the volume measure and proceed to Ref. 1, Section 2.4.2.1.4.

Volume Assigned Value: 0

2.4.2.1.4 Area (Tier D)

Evaluate the area measure using the area of the source (or the area of the area of observed contamination). Based on this area, assign a value to the area measure as follows; For the migration pathways assign the source a value for area using the appropriate Tier D equation from Ref. 1, Table 2-5.

Based on aerial photographs of the Bautsch-Gray Mine migration pathways, the area of the contaminated soil was outlined and determined to be 4.9 acres or 213,444 square feet (Ref. 17, p. 2).

The Area Assigned Value was calculated by dividing the area (213,444) by 34,000 (Ref. 1, p. 51591, Table 2-5) for a contaminated soil.

Source Type	Units	Reference
Contaminated Soil	213,444 sq. feet	17, p. 2

Equation for Assigning Value (Ref. 1, p. 51591, Table 2-5):

Hazardous Waste Quantity = 213,444 square feet/34,000

Area Assigned Value = 6.2777647

2.4.2.1.5. Source Hazardous Waste Quantity Value

According to the HRS, the highest of the values assigned to each 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. Because area (Tier D) was the only tier evaluated for Source 3, the area will be assigned as the source hazardous waste quantity value for Source 3 (Ref. 1, p. 51591).

Source Hazardous Waste Quantity Value: 6.2777647

TABLE 4 - SITE 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	117,612	N	10	10	NS	NS	NS
2	14,717	N	10	10	NS	NS	NS
3	6.2777647	N	10	10	NS	NS	NS

Notes: NS – Not Scored

3.0 GROUND WATER MIGRATION PATHWAY

3.0.1 GENERAL CONSIDERATIONS

Ground Water Migration Pathway Description

The target distance limit defines the maximum distance from the sources at the site over which targets are evaluated. Use a target distance limit of 4 miles for the ground water migration pathway (Ref. 1, p. 51595).

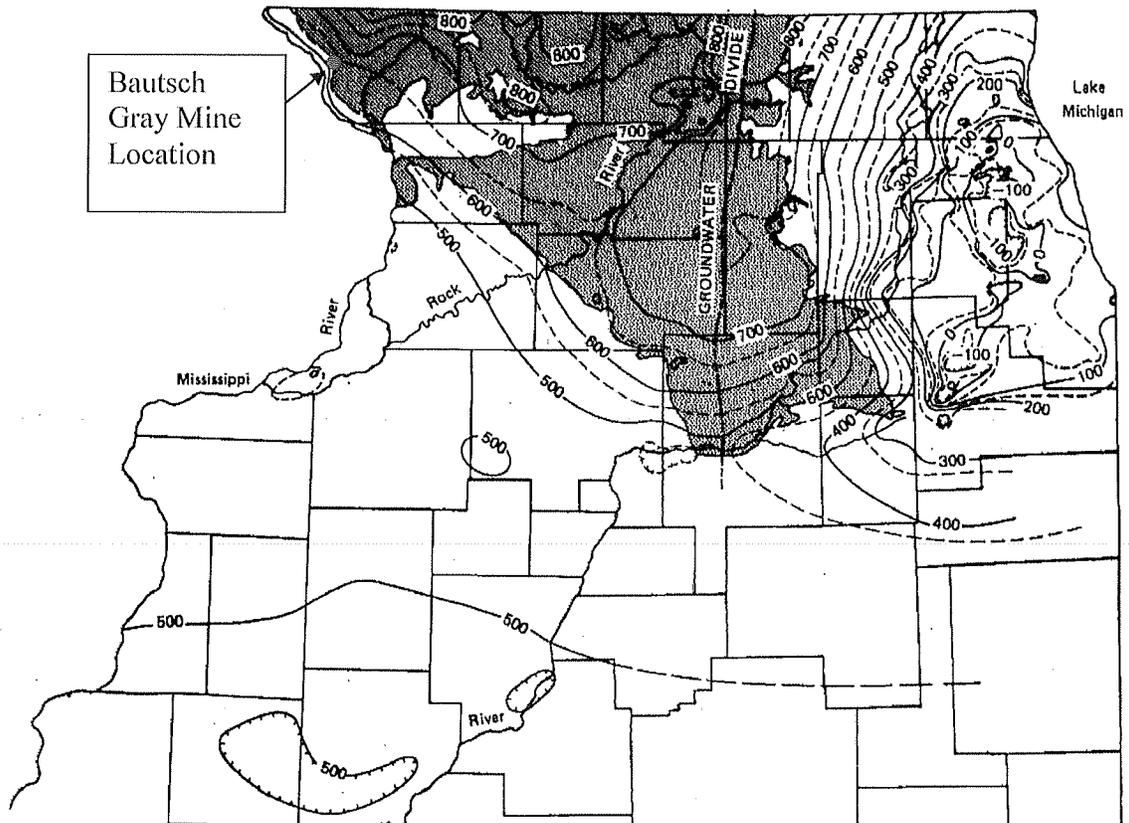
Regional Geology

The Regional geology of the area is composed of Cambrian and Ordovician strata which provide much of the ground water supply in the northern half of Illinois (Ref. 44, p. 1). The detailed stratigraphic column which follows identifies and gives a description of the major systems.

Detailed stratigraphic column (Ref. 44, p. 52, Figure 24).

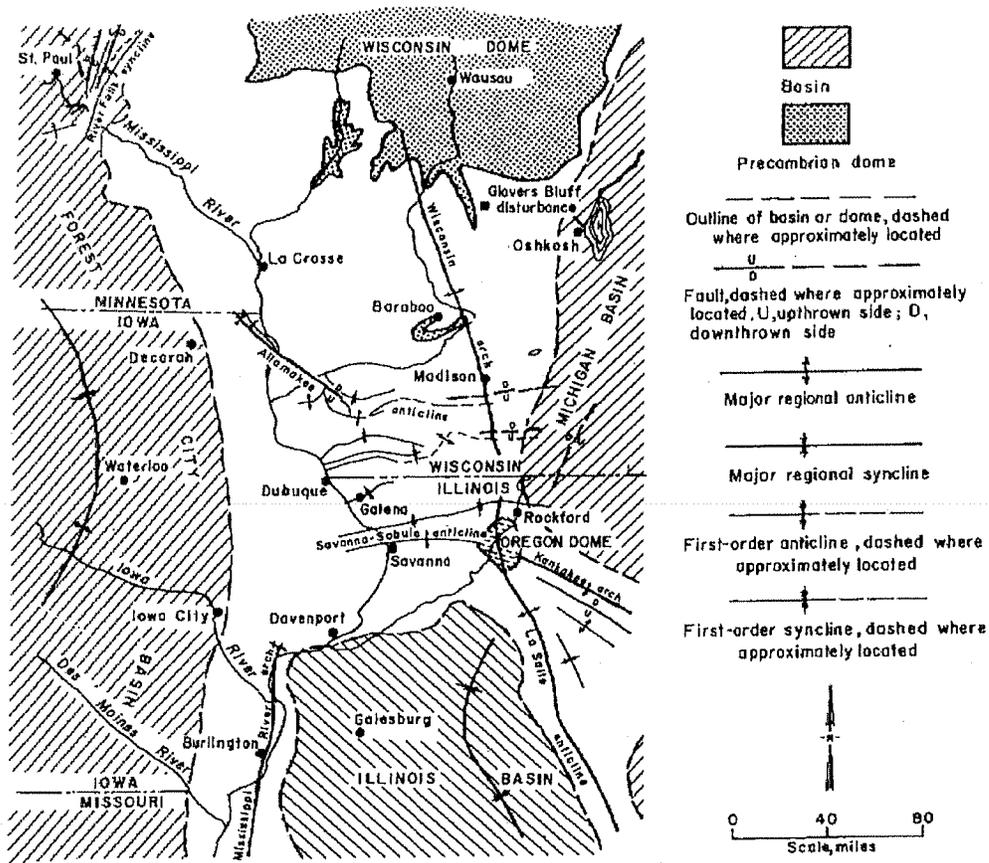
SYSTEM	SERIES AND MEGAGROUP	GROUP AND FORMATION	HYDROSTRATIGRAPHIC UNITS		LOG	THICKNESS (ft)	DESCRIPTION	
			Aquifer	aquifer/aquitard				
Quaternary	Pleistocene	Undifferentiated	Prairie	Pleistocene		0 - 600	Unconsolidated glacial deposits - pebbly clay (with silt, and gravel. Loess (windblown silt), and alluvial silts, sands and gravels.	
Tertiary & Cretaceous		Undifferentiated					0 - 100	Sand and silt.
Carboniferous	Mississippian	Pennsylvanian	Upper Bedrock	Mississippi Valley	Pennsylvanian		0 - 500	Mainly shale with thin sandstone, limestone and coal beds.
		Valmeyeran			St. Louis Ls Salem Ls Warsaw Ls Keokuk Ls Burlington Ls	St. Louis - Salem aquifer		0 - 600
Kinderhookian	Undifferentiated	Keokuk - Burlington aquifer						
Devonian	Undifferentiated	Devonian			0 - 400	Shale, calcareous; limestone beds, thin.		
Silurian	Niagaran	Port Byron Fm Racine Fm Waukesha Ls Joliet Ls	Upper Bedrock	Mississippi Valley	Silurian dolomite aquifer		0 - 465	Dolomite, silty at base, locally cherty.
	Alexandrian	Kankakee Ls Edgewood Ls						
Ordovician	Cincinnatian	Maquoketa Shale Group	Midwest Bedrock	Mississippi Valley	Maquoketa confining unit		0 - 250	Shale, gray or brown; locally dolomite and/or limestone, argillaceous.
		Mohawkian			Ottawa Ls Megagroup Galena Group Decorah Subgroup Platteville Group	Galena-Platteville unit		0 - 450
	Chazyan	Ancell Gr Glenwood Fm St. Peter Ss		Ancell aquifer		100 - 650	Sandstone, fine- and coarse-grained; little dolomite; shale at top. Sandstone, fine- to medium-grained; locally cherty red shale at base.	
	Canadian	Knox Megagroup Prairie du Chien Group Shakopee Dol New Richmond Ss Oneota Dol Gunter Ss		Prairie du Chien		100 - 1300	Dolomite, sandy, cherty (oolitic), sandstone. Sandstone, interbedded with dolomite. Dolomite, white to pink, coarse-grained, cherty (oolitic), sandy at base.	
Cambrian	St. Croixian	Jordan Ss Eminence Fm - Potosi Dolomite	Midwest Bedrock	Mississippi Valley	Erminence-Potosi			Dolomite, white, fine-grained, oolitic quartz, sandy at base.
		Franconia Fm			Franconia			Dolomite, sandstone, and shale, glauconitic, green to red, micaceous.
		Ironton Ss Galesville Ss		Ironton-Galesville aquifer		0 - 270	Sandstone, fine- to medium-grained, well sorted, upper part dolomitic.	
		Eau Claire Fm Mt. Simon Fm		Eau Claire Elmhurst-Mt. Simon aquifer		0 - 450	Shale and siltstone; dolomite, glauconitic; sandstone, dolomitic, glauconitic.	
Pre-Cambrian		Crystalline				0 - 2600	Sandstone, coarse-grained, white, red in lower half; lenses of shale and siltstone, red, micaceous.	
Pre-Cambrian			Crystalline				No aquifers in Illinois	

The Bautsch-Gray Mine is located in the Upper Mississippi Valley Zinc-Lead District (Ref. 5, p. 3). Structurally, the Upper Mississippi Valley Zinc-Lead District is an uplifted, gently southerly sloping area, bounded by the Wisconsin Dome, Wisconsin Arch, Savanna-Sabula anticline, and the Forest City Basin (Ref. 5, p. 9, Figure 8). The Bautsch-Gray Mine is located north of the Savanna-Sabula anticline (Ref. 5, p. 10).



Piezometric surface (MSL) of the Midwest Bedrock Aquigroup in October 1980 (Ref. 44, p. 70).

Generalized diagram showing the major structural features of the region and relationship within the district (Ref. 5, p. 10, Figure 8).



All of the Paleozoic sedimentary rocks of the district, except for the St. Peter Sandstone and Quimbys Mill Member of the Platteville Formation, have very low primary permeability. However, owing to the widespread faults and joints, an interconnected fracture system between permeable beds produces high secondary permeability. Combined with the enlargement of fractures by solutioning, water movement is essentially unimpeded, both vertically and laterally (Ref. 5, p. 13).

Site-specific Geology

The Maquoketa Shale (in the higher elevations) and part of the Galena Dolomite comprise the overburden at the Bautsch-Gray Mine. The mining zone encounters rocks from the McGregor Member of the Platteville Formation which underlies the Galena Dolomite, up into the Galena Dolomite (Ref. 5, p. 13).

The Galena and Platteville Groups consist of a nearly continuous sequence of carbonate rocks that are generally 250 to 450 feet thick in northern and western Illinois (Ref. 44, p. 35) and 250 to 275 feet thick in the northern outcrop area (Ref. 44, p. 36). The Galena Group comprising the Galena Formation, Decorah Formation, Guttenberg Limestone Member, and Spechts Ferry Shale Member is approximately 257 feet in thickness at the Bautsch-Gray Mine (Ref. 5, pp. 40, 41). The Galena Group consists of limestone and dolomite formations overlying the Platteville Group (Ref. 44, p. 36). The Galena formation of the Galena Group is extremely honeycomb-like from weathering (Ref. 5, p. 39).

The Platteville Group includes the dominantly limestone formations that overlie the Glenwood Formation of the Ansell Group and underlie the Spechts Ferry or Guttenberg Formations of the Galena Group (Ref. 44, p. 36). The Platteville group is only about 30 to 45 feet thick in extreme western and northwestern Illinois (Ref. 44, p. 36). At the Bautsch-Gray Mine the Platteville Formation is approximately 31 feet in thickness and occurs at a depth of approximately 257 feet below ground surface (Ref. 5, pp. 40, 41, 42). In northern Illinois, the Platteville Group is largely blue-gray, lithographic, partly dolomite-mottled limestone, but in some areas it is gray, very fine-grained, cherty dolomite (Ref. 44, p. 36)

Underlying the Platteville Group is the Ansell Group. The Ansell Group is predominantly elastic unit consisting of sandstone and argillaceous and sandy limestone and dolomite formations. It overlies the Prairie du Chien Group and older rocks and underlies the Platteville Group in northern Illinois. Ansell strata underlie most of the study area in northern Illinois and range in thickness from 100 to about 600 feet (Ref. 44, p. 30). The Ansell Group includes the Glenwood Formation and St. Peter Sandstone in descending order (Ref. 5, p. 52).

The dolomitic part of the Knox Megagroup includes the strata between the base of the St. Peter Sandstone of the Ansell Group and the top of the Ironton Sandstone. The group is dominantly dolomitic in the northern part of the state of Illinois (Ref. 44, p. 24). The megagroup is 300 to 500 feet in thickness in the northern part of the state (Ref. 44, p. 27). The Knox Megagroup between the Ansell and Ironton aquifers is mainly a confining unit except for a few small aquifers (Ref. 44, pp. 27, 52).

Underlying the Knox Megagroup are the Ironton Sandstone and Galesville Sandstone in descending order. The sandstones are separated mainly on the basis of texture and dolomite content. The Galesville Sandstone is fine-grained, well-sorted sandstone, essentially free from shale and glauconite, whereas the Ironton is medium-grained, generally poorly-sorted, dolomitic sandstone. The Galesville is commonly 40 to 100 feet thick. The Ironton Sandstone is commonly 50 to 100 feet thick (Ref. 44, p. 23).

Ground water/hydrology

The Cambrian and Ordovician aquifers (Midwest Bedrock Aquigroup) underlying the Bautsch-Gray Mine average approximately 1,000 feet in thickness. Although numerous

alternating layers of sandstones, limestone, and dolomites impart a heterogeneous character to them, these units are hydraulically interconnected and behave as a single aquifer. Hydraulic properties within the aquifers are generally affected by local or regional changes in thickness of the Ancell and Ironton-Galesville aquifers. Recharge occurs principally by vertical percolation of precipitation in areas where the Galena-Platteville Unit is the uppermost bedrock, as is the case at the Bautsch-Gray Mine (Ref. 5, pp. 11, 40; Ref. 44, pp. 1, 2). The Galena-Platteville aquifer is the uppermost aquifer of the Midwest Bedrock Aquigroup at the mine (Ref. 5, pp. 40, 41).

The Midwest Bedrock Aquigroup comprises the aquifers in this area of study (Ref. 44, p. 70). Because most wells tapping the Midwest Bedrock Aquigroup are open to several aquifers as well as to the Middle Confining Unit, the aquigroup behaves more or less as a single hydraulic system (Ref. 44, p. 61). In the area of the Bautsch-Gray Mine, the Galena-Platteville unit is highly dissected by streams (Ref. 44, p. 72). Based on water level measurements at the Illinois State Water Survey, the assumption can be made that ground water movement from the Bautsch-Gray Mine is toward the Mississippi River (Ref. 44, p. 72).

The Midwest Bedrock Aquigroup is characterized by intermediate and regional ground water flow systems in indurated rock that are overlain in some areas by indurated rock confining units. The top of the aquigroup is defined as the top of the Maquoketa Shale Group or other confining units where the Maquoketa is absent (Ref. 44, p. 54). A map depicting the thickness of the Maquoketa Shale Group indicates that the group is absent or eroded at the surface (Ref. 44, p. 40, Figure 19). Part of the Galena Dolomite comprises the overburden of the Bautsch-Gray Mine indicating that the Maquoketa Shale is absent in areas of the mine (Ref. 5, p. 13). The Maquoketa Shale Group, where present, overlies the Galena Dolomite (Ref. 44, p. 52).

There are at least three bedrock aquifers comprising the Midwest Bedrock Aquigroup in the vicinity of the Bautsch-Gray Mine. The first is the Galena-Platteville formation, which immediately underlies the unconsolidated overburden (Ref. 44, pp. 52, 56), and is approximately 225 to 344 feet thick (Ref. 5, p. 14, Figure 10; Ref. 44, pp. 36-37). The McGregor Member (part of the Platteville Group) (Ref. 5, p. 14, Figure 10) is a recognized aquifer in the district and (Bautsch) mine, most of the other beds present are also adequate aquifers (Ref. 5, p. 16). This is primarily due to the fracture system and secondary openings (Ref. 5, p. 16). The majority of private wells in the area are completed in the Galena-Platteville aquifer (Ref. 43).

Prior to mining at the Bautsch-Gray Mine the water table was at the Maquoketa Shale-Galena Dolomite contact (Ref. 5, p. 16), which corresponds to a depth of 108 to 240 feet (Ref. 5, p. 14, Figure 10).

The second aquifer, the Ancell aquifer, includes the St. Peter Sandstone, along with the overlying Glenwood Sandstone when present (Ref. 44, p. 56). The Ancell aquifer occurs at

a depth of approximately 400 to 1,100 feet below ground surface (Ref. 44, p. 32, Figure 15). This aquifer is composed of sandstone and a little dolomite (Ref. 44, p. 52). The Galena-Platteville formation overlies the Ancell aquifer and sometimes forms part of the confining unit for that aquifer, although it is locally productive (Ref. 44, p. 56). At the Bautsch-Gray Mine, the primary source of recharge to the Ancell aquifer is precipitation percolating through the glacial deposits where the Galena-Platteville dolomite or older rocks are the uppermost bedrock formation (Ref. 5, p. 13; Ref. 45, p. 9).

According to the Aquifer Sensitivity Map (Ref. 22), the area to the west of the Mine Tailing Pile is considered an area of very high sensitivity (designated as A4). According to this designation the depth to the aquifer is 5 to 25 feet and the aquifer is composed of sand and gravel and/or bedrock. The thickness of this aquifer is greater than 50 feet. The footnote for A4 indicates that sand and gravel aquifers directly overlie bedrock aquifers in most areas (Ref. 22).

Natural discharge to rivers from the sandstone aquifer occurs where riverbeds are cut into the Galena-Platteville dolomite or older formations, and piezometric levels are higher than river levels. Rivers currently receiving water from the deep aquifer are the Mississippi north of Thompson (Ref. 45, p. 9). The majority of private wells in the area are completed in the Galena-Platteville aquifer (Ref. 43).

Underlying the Ancell aquifer is the third aquifer comprising the Midwest Bedrock Aquigroup, the Ironton-Galesville aquifer. The Ironton-Galesville aquifer is composed of sandstone (Ref. 44, Fig. 11), and is the most uniform and productive zone in the Cambrian and Ordovician Systems in Illinois north of the Illinois River (Ref. 44, p. 55).

According to the Aquifer Sensitivity Map of Jo Daviess County, Illinois (Ref. 22), the area surrounding the Bautsch-Gray Mine to the south and north is considered A3 which correlates to a depth to aquifer of 5-25 feet and to the west is considered A4 which correlates to a depth to aquifer of 5-25 feet (Ref. 22).

3.0.1.2 Aquifer Boundaries

Combine multiple aquifers into a single hydrologic unit for scoring purposes if aquifer interconnections can be established for these aquifers (Ref. 1, p. 51595). All the Paleozoic sedimentary rocks of the district, except for the St. Peter Sandstone and Quimbys Mill Member of the Platteville Formation, have very low primary permeability (Ref. 5, p. 13). However, owing to the widespread faults and joints, and interconnected fracture system between permeable beds produces high secondary permeability (Ref. 5, p. 13). Combined with the enlargement of fractures by solutioning, water movement is essentially unimpeded, both vertically and laterally (Ref. 5, p. 13).

3.1 LIKELIHOOD OF RELEASE

For an aquifer, evaluate the likelihood of release factor category in terms of an observed release factor or a potential to release factor (Ref. 1, p. 51595).

3.1.1 Observed Release

Establish an observed release to an aquifer by demonstrating that the site has released a hazardous substance to the aquifer. An observed release can be demonstrated by chemical analysis – an analysis of ground water samples from the aquifer indicates that the concentration of hazardous substances has increased significantly above the background concentration for the site. Some portion of the significant increase must be attributable to the site to establish the observed release.

Residential well sampling was conducted at nearby residential homes in 2000 (Ref. 12, p. 14). Sample G201 and G201D (duplicate) were collected from a residence located directly west of the mine tailings pile (Ref. 12, p. 14). Prior to sampling this well, Illinois EPA secured property owner approval and determined that the home was not on any water treatment systems present (Ref. 46, pp. 38, 39). The well was allowed to purge until pH, conductivity and temperature was stabilized (Ref. 46, p. 38). After well readings had stabilized (at ± 0.1 standard unit for pH, ± 3 percent for conductivity, and ± 0.1 degree Celsius for temperature) (Ref. 46, p. 38), Illinois EPA filled designated containers with the residential well water (Ref. 46, p. 38).

Residential well sample G202 was collected from a residence approximately 300 yards south of the mine tailings pile. The well was allowed to purge until pH, conductivity and temperature was stabilized (Ref. 12, p. 15). After well readings had stabilized (at ± 0.1 standard unit for pH, ± 3 percent for conductivity, and ± 0.1 degree Celsius for temperature) (Ref. 46, p. 39), Illinois EPA filled designated containers with the residential well water (Ref. 46, p. 39).

Residential well sample G203 was collected from a residence approximately 3 miles south of the mine tailings pile (Ref. 12, p. 15). The well was allowed to purge until pH, conductivity and temperature was stabilized (Ref. 46, p. 39). After well readings had stabilized (at ± 0.1 standard unit for pH, ± 3 percent for conductivity, and ± 0.1 degree Celsius for temperature) (Ref. 46, p. 39), Illinois EPA filled designated containers with the residential well water (Ref. 46, p. 49).

Residential well water samples were packaged, shipped and submitted for inorganic analysis to U.S.EPA Central Region Laboratory located at 536 South Clark Street, Chicago, Illinois (Ref. 12, p. 15; Ref. 47, p. 18).

Residential well sampling was conducted in 2009 at residential homes (sample locations, RW-01 and RW-02) located along S. Blackjack Road (Ref. 14, p. 6, Figure 4). Prior to

sampling each well, U.S.EPA secured property owner approval and the home water treatment systems were disengaged (Ref. 14, p. 6). WESTON Superfund Technical Assistance and Response Team (START) purged the wells for 15 minutes prior to sampling. During the purging period, WESTON START monitored water parameters using a water quality meter (Ref. 14, p. 6). After well readings had stabilized (at \pm 0.1 standard unit for pH, \pm 3 percent for conductivity, and \pm 0.1 degree Celsius for temperature), WESTON START filled designated containers with the residential well water (Ref. 14, pp. 6-7).

Residential well water samples were submitted for analyses for volatile organic compounds (VOC), semi-volatile organic compounds (SVOC), metals and pH. WESTON START packaged and shipped all samples to TestAmerica Laboratory of University Park, Illinois, under chain of custody (Ref. 14, p. 7, Appendix B).

Residential well samples RW-01 and G201 were collected from the same residence (Ref. 14, p. 20, Figure 4; 12, p. 14).

Observed Release by Chemical Analysis

Three residential well samples plus one field duplicate were collected and analyzed for VOCs, SVOCs, metals and pH in 2000 (Ref. 12, pp. 14, 15). The residential well sample results were compared to the U.S. EPA maximum contaminant levels (MCL) for drinking water (Ref. 2, p. 24). Lead exceeded its MCL of 0.015 mg/L in sample G201 and G201D. G201 contained lead at 0.026 mg/L and cadmium at 0.0008 mg/L (Ref. 2, p. 24; Ref. 47, p. 19). Residential well sample locations from the 2001 Bautsch Gray Mine Site Assessment Report are shown in Figure 8. Analytical data from the 2001 Site Assessment Report event supports an observed release by chemical analysis to the residential well (Ref. 47, p. 19)

Two residential well samples plus one field duplicate were collected and analyzed for VOCs, SVOCs, metals and pH in 2009 (Ref. 14, p. 11). The residential well water sample results were compared to the U.S. EPA Regional Screening Levels (RSLs) for tap water and the U.S. EPA maximum contaminant levels for drinking water (Ref. 14, p. 11). Lead exceeded the MCL of 0.015 mg/L in sample BG-RW01-100609, which contained 0.027 mg/L lead (Ref. 2, p. 24; Ref. 14, p. 11). Residential well sample locations from the 2010 Bautsch Gray Mine Site Assessment Report are shown in Figure 4, Reference 14, p. 20. Analytical data from the 2009 Site Assessment Report event supports an observed release by chemical analysis to the residential well (Ref. 14, p. 41).

Background Samples

Illinois EPA collected a residential well sample during the 2000 Integrated Assessment to document if contamination from the mine was affecting ground water in the area (Ref. 12, p. 15). It has been determined to utilize residential well sample G203 as the background sample due to being un-impacted by the Bautsch-Gray Mine. G203 was determined to be suitable for background based on the location of the sample being outside the influence of

the activities that have occurred at the Bautsch-Gray Mine (Ref. 12, p. 15).

Residential well sampling (sample locations G201, G202, and G203) was conducted at residential homes located nearby along Blackjack Road (Ref. 12, p. 14). The sample used to document background ground water conditions, G203, was collected from a residential home approximately three miles south of the mine tailings pile (Ref. 12, p. 15). The well was allowed to purge until pH, conductivity and temperature was stabilized (Ref. 46, p. 39). After well readings had stabilized (at±0.1 standard unit for pH, ±3 percent for conductivity, and ±0.1 degree Celsius for temperature) (Ref. 46, p. 39), Illinois EPA filled designated containers with the residential well water (Ref. 46, p. 39).

Residential well water samples were packaged, shipped and submitted for inorganic analysis to U.S.EPA Central Region Laboratory located at 536 South Clark Street, Chicago, Illinois (Ref. 12, p. 15; Ref. 47, p. 18).

The background ground water sample (G203) was collected from the same aquifer as the release samples; this is based on the depths associated with each well (Ref. 48) and the location of the Galena-Platteville aquifer at the depth of which the wells are drilled (Ref. 5, pp. 13, 40, 41; Ref. 44, p. 52)

Table 3-1 Background Residential Well Sample Description

Sample ID	Sample Medium	Sample Location	Depth	Date	References
Background for Year 2000					
G203	Residential well water	Residential home south of mine tailings pile	285 feet bgs	10/24/2000	Ref. 12, p. 15; Ref. 46, p. 39; Ref. 48, p. 2
Background for Year 2009					
BG-RW02-100609	Residential well water	Residential home southwest of the mine tailings pile	170 feet bgs	10/06/09	Refs. 14, p. 20, 41, 113; 43, p. 58

Background Concentration

The table below provides a summary of the concentrations of hazardous substances detected in the background sample collected from the residential well samples G203 and BG-RW02-100609. The analytical data package and data validation report from the sampling event in 2000 are provided in Reference 47; the analytical data and data validation report from the

2009 sampling event are provided in Reference 64. The HRS states that “if the Sample Quantitation Limit is less than or equal to the sample measurement. Then an observed release is established as follows: if the background concentration is not detected or is less than the detection limit, an observed release is established when the sample measurement equals or exceeds the sample quantitation limit. If the background concentration equals or exceeds the detection limit, an observed release is established when the sample measurement is 3 times or more above the background concentration (Ref. 1, p. 51589, Table 2-3).

Table 3-2 – Background Ground Water Sample Concentrations

Sample ID	Hazardous Substance	Sample Concentration (mg/L)	Adjusted Conc. (mg/L)	Background Concentration (mg/L) (3 x background)	MDL (mg/L)	References
Background for Year 2000						
203	Lead	.001 M	No adjustment needed	0.003	0.0007	Ref. 47, p. 19; Ref. 50, Table 2, p. 41.
Background for Year 2009						
BG-RW02-100609	Lead	0.00079 B	No adjustment needed	0.00237	0.00050	Ref. 14, pp. 41, 120, 149; Ref. 64, pp. 7, 8, 31, 646

M – This flag is used when the analyte is confirmed to be qualitatively present in the sample, extract or digestate, at or above the CRL Method Detection Limit (MDL) but below the CRL reporting limit (RL). This flag applies to all values in this concentration range and indicates the quantitated value is estimated due to its presence in this concentration range (Ref. 47, p. 20).

B – Compound was found in the blank and the sample (Ref. 14, p. 149)
 The lead concentration is qualified B because lead was detected in the blank (Ref. 14, p. 149; Ref. 64, p. 62), however, it is not otherwise qualified. Due to these findings the “B” value does not call into question the presence of the analyte or accuracy of the sample concentration as documented in the validation report (Ref. 14, pp. 120, 149).

MDL – Method detection limit

Observed Release Samples:

All samples were analyzed for total metals and mercury (Ref. 63, p. 1; 64, p. 646). Lead is present in the sources associated with the Bautsch-Gray Mine and was also documented in the release samples. One residential well (G201 and G201D, BR-RW01-100609) has been impacted by contamination from the Bautsch-Gray Mine (Ref. 12, p. 16, 34 Table 5; 14, p. 11, 20). Lead meets the criteria present in HRS Table 2-3 for establishing an observed release by chemical analysis (Ref. 1, Table 2-3). The inorganic concentrations in the ground water sample are greater than three times the established background concentration. The established background concentration level is 0.001 mg/L for lead. So the sample concentration for lead is 0.001, and then multiply by 3 resulting in a background concentration of 0.003 mg/L.

Summary descriptions of the observed release samples are included in Table 3-3. Analytical results from the observed release samples meeting the observed release criteria are included in Table 3-4. As documented in Table 3-4, an observed release to a drinking water well, sample G201, is documented while the well was still active (Ref. 6).

Table 3-3 Observed Release Ground Water Sample Descriptions

Sample ID	Sample Medium	Sample Location	Distance from Source 1	Depth (feet below ground surface)	Date	Reference
G201	Water	Residential well	220 ft	80	10/24/00	46, p. 38; 10
BG-RW01-100609	Water	RW-01	220 ft	80	10/06/09	14, p. 6, 20; 10

Table 3-4 Observed Release Ground Water Sample Concentrations

Sample ID	Hazardous Substance	Hazardous Substance Concentration ppm	Adjusted Concentration based on bias (Ref. 3)	MDL (mg/L)	3 X Background (mg/L)	References
Release for Year 2000						
G201	Lead	0.026	No adjustment needed	0.0007	0.003	47, p. 19; Ref. 50, Table 2, p. 41
Release for Year 2009						
BG-RW01-100609	Lead	0.027 B	No adjustment needed	0.00005	0.003	14, Table 2-A, p. 41, 120, 135; 64, pp. 29, 646

B – Compound was found in the blank and the sample (Ref. 14, p. 149)

The lead concentration is qualified B because lead was detected in the blank (Ref. 14, p. 149; Ref. 64, p. 62), however, it is not otherwise qualified. Due to these findings the “B” value does not call into question the presence of the analyte or accuracy of the sample concentration as documented in the data validation report (Ref. 14, pp. 120, 149).

mg/L – Milligrams per liter

MDL – Method detection limit

The byproducts such as mine tailings containing lead produced on the Bautsch-Gray Mine milling process area (mine tailings) and the ground water collected from the adjacent residential ground water well indicate that the mine tailings led to the contamination of the ground water with lead (Ref. 4, pp. 16, 19, 47, 48).

Attribution

The following documentation presents evidence that the contamination found in the residential well can be associated to all three sources at the Bautsch-Gray Mine. Lead is associated with the three sources at the facility (see Section 2.2 of this HRS documentation record).

The Bautsch Gray Mine milling process area consisted of the Gray Mill which began processing ore from the Gray (Heer) ore body in 1944 and shortly thereafter on the Bautsch (Ref. 19, p. 4). The Gray mill was designed originally to handle 600 tons of ore per day; by revisions in both primary and secondary crushing and by adding a ball mill the capacity was subsequently raised to 850 tons per day, but was treating approximately 1,050 tons per day (Ref. 19, p. 18). The Federal Bureau of Mines conducted a drilling project which identified a small zinc-lead deposit of roughly 400,000 tons, based largely on the drilling of the Heer (Gray) property (Ref. 19, p. 4). The commercial ore minerals are sphalerite and galena, with accompanying pyrite, marcasite, and considerable vein calcite (Ref. 19, p. 7). The large quantity of uncontained mine tailings generated from the mining process remains at the mine and contains lead and other metals (Ref. 4, pp. 16, 19, 47, 48).

Residential well samples collected from the adjacent property (Table 3-4 of this HRS documentation record) indicate that hazardous substances have migrated to the aquifer supplying this home with drinking water. Samples collected from the sources associated with the Bautsch-Gray Mine identify arsenic, cadmium, copper, lead and zinc. Samples collected from the residential well of the adjacent property reveal a significant increase of lead in ground water which exceeds the MCL for lead of 0.015 mg/L (Ref. 2, p. 24; see Section 2.4 and Table 3-4). Toxicity Characteristic Leaching Procedure (TCLP) testing was conducted on three sample locations which were collected, one from each of the three sources, during the 2010 ESI (Ref. 4, pp. 18, 46). TCLP is used to determine if a waste has toxicity characteristics in amounts that meet or exceed regulatory limits causing it to be

regulated as hazardous waste. The TCLP test method 1311 can be found in the EPA publication SW-846 (Ref. 65). The TCLP was designed to predict whether a waste is likely to leach chemicals into ground water. Results of the TCLP analysis revealed that lead values have exceeded regulatory levels (5 ppm) according to: Title 35, Subtitle G, Chapter 1, Subchapter C, Section 721.124 of the Environmental Regulations for the State of Illinois (Ref. 4, p. 54). Geology and hydrology are discussed in Section 3.0.1.1 of this HRS documentation record and document the routes of contaminants to the aquifer. At the Bautsch-Gray Mine, the primary source of recharge to the sandstone aquifers is precipitation percolating through the glacial deposits where the Galena-Platteville dolomite or older rocks are the uppermost bedrock formation (Ref. 45, p. 9).

In order to determine whether the significant increase in lead in the residential well is attributable to the Bautsch-Gray Mine milling process area and the settling pond or is the result of a source or sources other than the sources identified at the Bautsch-Gray Mine, two online EPA databases (Enviromapper and TRI Explorer) (<http://www.epa.gov/enviro/html/em/index.html>) were searched for a one-mile radius around Source 1. These databases revealed no facilities within one mile of the Bautsch-Gray Mine (Ref. 51, p. 2).

Although neither database revealed any facilities within the area, there is information pertaining to the Marsden-Blackjack (Blackjack) Mine located approximately 0.6 mile north-northwest of Bautsch-Gray Mine (located on Figure 1). The Blackjack Mine in the Galena District has produced more zinc ore than any other mine in Illinois. Its production is said to have been more than a million and a half tons of ore. The mine is 4 miles by road south of Galena on the same "range", or trend of ore deposition, as the Pilot Knob mine, the Gill-Fisher mine, the Pittsburg Mine, the Gray mine, and the Bautsch drilling. The Blackjack Mine was discovered in 1854 and worked for lead until 1860; since then it has been worked intermittently for zinc. According to the topographic map (Ref. 7) the Blackjack Mine was located in Section 4 of Range 1 East and Township 27 North. It is documented that the ore from the Blackjack Mine was milled at the former Gray Mill (which is now the mine tailings pile) in 1949 (Ref. 29, p. 1450). The Blackjack Mine is located approximately 0.6 mile northwest of the observed release well (identified as G201 and BG-RW01-100609 on figures) (Ref. 44, p. 77 and Figures 1 and 8 of this HRS documentation record), whereas the observed release well is located adjacent to Source 1 on Bautsch-Gray Mine (Figure 3 and Figure 8).

There are at least three bedrock aquifers in the vicinity of the Bautsch-Gray Mine. The first is the Galena-Platteville formation, which underlies the unconsolidated overburden (Ref. 44, p. 56), generally beginning 5 to 25 feet below ground surface (Ref. 22) and is approximately 225 to 344 feet thick (Ref. 5, p. 14, Figure 10). It overlies the Ancell aquifer and sometimes forms part of the confining unit for that aquifer, although it is locally productive (Ref. 44, p. 56). At the Bautsch Gray Mine, the primary source of recharge to the sandstone aquifers is precipitation percolating through the glacial deposits where the Galena-Platteville dolomite or older rocks are the uppermost bedrock formation (Ref. 45, p.

9). The Midwest Bedrock Aquigroup comprises the aquifers in this area of study. Because most wells tapping the Midwest Bedrock Aquigroup are open to several aquifers as well as to the Middle Confining Unit, the aquigroup behaves more or less as a single hydraulic system (Ref. 44, p. 61). In the area of the Bautsch Gray Mine, the Galena-Platteville unit is highly dissected by streams (Ref. 44, p. 72). Based on water level measurements at the Illinois State Water Survey, the assumption can be made that ground water movement from the Bautsch-Gray Mine is toward the Mississippi River (Ref. 44, p. 72).

Natural discharge to rivers from the sandstone aquifer occurs where riverbeds are cut into the Galena-Platteville dolomite or older formations, and piezometric levels are higher than river levels. Rivers currently receiving water from the deep aquifer are the Mississippi north of Thompson (Ref. 45, p. 9). The majority of private wells in the area are completed in the Galena-Platteville aquifer (Ref. 43).

The first is the Galena-Platteville formation, which underlies the unconsolidated overburden (Ref. 44, p. 56), generally beginning 5 to 25 feet below ground surface (Ref. 22) and is approximately 225 to 344 feet thick (Ref. 5, p. 14, Figure 10). Piezometric surface maps of northwestern Illinois were based on water level measurements on file at the State Water Survey and available geologic information (Ref. 44, p. 72). The piezometric surface contours for the Galena-Platteville unit indicate a ground water ridge in northern Jo Daviess County in an area that topographically is the highest in the state (Ref. 44, p. 72). From the ground water ridge, ground water flows to the southwest toward the Mississippi River (Ref. 44, p. 72). The Bautsch-Gray Mine is located in this area. The primary source of recharge to the sandstone aquifers is precipitation percolating through the glacial deposits where the Galena-Platteville dolomite or older rocks are the uppermost bedrock formation (Ref. 45, p. 9).

The byproducts produced on the Bautsch-Gray Mine milling process area (mine tailings) and the ground water collected from the adjacent residence indicates that the mine tailings led to the contamination of the Galena-Platteville portion of the Midwest Bedrock aquifer with lead (Ref. 4, Tables 7, p. 54; Ref. 14, p. 11, 14; Ref. 12, p. 20).

A likelihood of release factor category value of 550 is assigned for an aquifer – based on the observed release to the residential well (Ref. 1, Sec. 3.1.3).

Ground Water Likelihood of Release Factor Category Value: 550

3.2 Ground Water Pathway – Waste Characteristics

Evaluate the waste characteristics factor category for an aquifer based on two factors: toxicity/mobility and hazardous waste quantity. Evaluate only those hazardous substances available to migrate from the sources at the site to ground water (Ref. 1, p. 51601).

3.2.1 Toxicity/mobility

For each hazardous substance, assign a toxicity factor value, a mobility factor value, and a combined toxicity/mobility factor value (Ref. 1, p. 51601, sect. 3.2.1).

3.2.1.1 Toxicity

Assign a toxicity factor value to each hazardous substance as specified in Ref. 1, Section 2.4.1.1.

The toxicity for lead is 10,000 (Ref. 2, p. 9, BI-8).

3.2.1.2 Mobility

Assign a mobility factor value to each hazardous substance for the aquifer being evaluated as follows: For any hazardous substance that meets the criteria for an observed release by chemical analysis to one or more aquifers underlying the sources at the site, regardless of the aquifer being evaluated, assign a mobility factor value of 1.

Because lead meets the criteria for observed release (see Table 3-4 of this HRS documentation record), it is assigned a mobility factor value of 1.

3.2.1.3 Calculation of toxicity/mobility factor value

Assign each hazardous substance a toxicity/mobility factor value from Ref. 1, Table 3-9, based on the values assigned to the hazardous substance for the toxicity (10,000) and mobility (1) factors (Ref. 1, p. 51602).

Toxicity/Mobility Factor Value for lead = 10,000

3.2.2 Hazardous Waste Quantity

The hazardous waste quantity values for all sources are summed (Ref. 1, p. 51591). Based on this value, select a hazardous waste quantity factor value for the pathway from HRS Table 2-6.

Source No.	Source Type	Source Hazardous Waste Quantity
1	Pile	117,612
2	Surface Impoundment	14,718
3	Contaminated Soil	6.2777647

Source 1 + Source 2 + Source 3 = Sum of the Source Hazardous Waste Quantity Value
 $117,612 + 14,718 + 6.2777647 = 132,336.2777647$ yields a value of 10,000 (Ref. 1, Table 2-6)

For the Bautsch-Gray Mine ground water pathway, a value of 10,000 is assigned to the hazardous waste quantity factor value (See Section 2.4.2 of this HRS documentation record).

Ground Water Pathway Hazardous Waste Quantity Factor Value: 10,000

3.2.3 Calculation of waste characteristics factor category value.

Multiply the toxicity/mobility and hazardous waste quantity factor values subject to a maximum product of 1×10^8 .

Toxicity/mobility factor value X hazardous waste quantity factor value.

$10,000 \times 10,000 = 1 \times 10^8$ (subject to a maximum of 1×10^8)

Based on this product, assign a value from Ref. 1, Table 2-7 to the waste characteristics factor category.

Waste Characteristics Factor Value = 100

3.3 Targets

Evaluate the targets factor category for an aquifer based on four factors: nearest well, population, resources, and Wellhead Protection. Evaluate these four factors based on targets within the target distance limit specified in section 3.0.1.1 and the aquifer boundaries specified in section 3.0.1.2. Determine the targets to be included in evaluating these factors for an aquifer as specified in section 3.0 (Ref. 1, p. 51602).

3.3.1 Nearest Well

In evaluating the nearest well factor, include both the drinking water wells drawing from the aquifer being evaluated and those drawing from overlying aquifers as specified in Section 3.0.

The three wells sampled in 2000 indicate that they are drilled to depths of 80 ft., > 100 ft and 285 ft. The undulation of the surrounding area and the information that there has been dissolution and enlarging of joints and fractures (Ref. 44, p. 57; Ref. 10; Ref. 48), indicates that water movement is essentially unimpeded, both vertically and laterally (Ref. 5, p. 13).

If there is an observed release by direct observation for a drinking water well within the target distance limit, assign Level II concentrations to that well. However, if one or more samples meet the criteria for an observed release for that well, determine if that well is subject to Level I or Level II concentrations as specified in Ref. 1, sections 2.5.1 and 2.5.2. Use the health based benchmarks from Ref. 1, Table 3-10 in determining the level of contamination.

One of the health-based benchmarks for the ground water migration pathway is MCLs (Ref. 1, Table 3-10). The MCL for lead is 0.015 mg/L (Ref. 2, p. 24, BII-8). Sample results from the residential well indicated that lead exceeded the MCL of 0.015 mg/L in sample G201, which contained 0.026 mg/L lead (Ref. 47, p. 19). If the concentration of any applicable hazardous substance from any sample equals or exceeds its benchmark concentration, consider the sampling location to be subject to Level I concentrations for that pathway (or threat) (Ref. 1, p. 51593, section 2.5.2).

Assign a value for the nearest well factor as follows: If one or more drinking water wells is subject to Level I concentrations, assign a value of 50 (Ref. 1, p. 51602-51603, Section 3.3.1).

3.3.2 Population

In evaluating the population factor, include those persons served by drinking water wells within the target distance limit specified in Ref. 1, section 3.0.1.1. The target distance limit defines the maximum distance from the sources at the site over which targets are evaluated. Use a target distance limit of 4 miles for the ground water migration pathway (Ref. 1, p. 51595, section 3.0.1.1).

The City Administrator of Galena was contacted concerning the public water availability in the vicinity of the Bautsch Gray Mine. According to the City Administrator, the public water availability ends at the intersection of 4th Street and Blackjack Road, which is located on the southeast side of Galena. Private wells (primarily completed in the Galena-Platteville aquifer) supply the residents living south of Galena (Refs. 43; 66, p. 1).

There are 3 people living in the residence located directly to the west of the Bautsch-Gray Mine milling process area (Ref. 39, p. 1).

Individuals using private wells located within the 4-Mile TDL

Distance (miles)	Population
0 - ¼	3
¼ - ½	38
½ - 1	65
1-2	180
2-3	407
3-4	0*
Total	693

Ref. 17, page 2 explains how the population data was determined.

* This population was not included as it largely comprises a portion of the city of Galena (Ref. 17, Figure 2).

3.3.2.2 Level I Concentrations

Sum the number of people served by drinking water from points of withdrawal subject to Level I concentrations. Multiply this sum by 10. Assign this product as the value for this factor (Ref. 1, p. 51603, section 3.3.2.2).

There are three people living in the residence in which sample G201 was collected which revealed lead above the MCL for drinking water (Ref. 2, p. 24; Ref. 39; Ref. 47, p. 19).

3 people living at the residence X 10 = Level I Concentration Value of 30 (Ref. 1, p. 51603).

3.3.2.3 Level II Concentrations

There were no targets associated with Level II concentrations.

3.3.2.4 Potential Contamination

Determine the number of people served by drinking water from points of withdrawal subject to potential contamination. Do not include those people already counted under the Level I and Level II concentration factors.

Assign distance weighted population values from Table 3-12 to this population: Use the "Other than Karst" portion of Table 3-12. For this portion of the population, determine the number of people included within each "Other than Karst" distance category in Table 3-12. Assign a distance weighted population value for each distance category based on the number of people included within the distance category (Ref. 1, p. 51603-51604, section 3.3.2.4).

The City Administrator of Galena was contacted concerning the public water availability in the vicinity of the Bautsch-Gray Mine. According to the City Administrator, the public water availability ends at the intersection of 4th Street and Blackjack Road, which is located on the southeast side of Galena. Private wells (predominantly completed in the Galena-Platteville aquifer) supply the residents living south of Galena (Refs. 43; Ref/ 66, p. 1).

Distance (miles)	Population	Distance Weighted Population values for Potential Contamination Factor (Ref. 1, Table 3-12)
0 - ¼	0	0
¼ - ½	38	33
½ - 1	65	17
1-2	180	30
2-3	407	68
3-4	0	0
Total	693	148

(Ref. 17, p. 2)

Sum of Distance-Weighted Population Values: 148

Sum of Distance-Weighted Population Values/10: 14.8

Potential Contamination Factor Value: 14.8 (Ref. 1, Section 3.3.2.4).

3.3.3 Resources

There are no documented resources for this aquifer.

3.3.4 Wellhead Protection Area

There are no wellhead protection areas near the Bautsch-Gray Mine.

4.0 SURFACE WATER MIGRATION PATHWAY

4.0.1 Migration Components

Overland/Flood Migration to Surface Water Component

According to the HRS, surface water threats that result from migration of hazardous substances from a source at the site to surface water via overland flow and flood include the drinking water, human food chain, and environmental threats (Ref. 1, Sec. 4.0.1). For the Bautsch-Gray Mine, the human food chain and environmental threats are scored for the overland/flood migration component of the surface water migration pathway.

Ground Water to Surface Water Migration Component

The ground water to surface water migration component of the surface water migration pathway may exist at the Bautsch-Gray Mine but was not scored.

4.0.2 Surface Water Categories

According to the HRS, rivers include: perennially flowing waters from point of origin to the ocean or to coastal tidal waters, whichever comes first, and wetlands contiguous to these flowing waters (Ref. 1, Sec. 4.0.2). At the Bautsch-Gray Mine, Smallpox Creek is the primary focus of the surface water pathway analysis. Smallpox Creek is located to the southwest of the Bautsch Gray Mine milling process area (Ref. 7).

4.1 OVERLAND/FLOOD MIGRATION COMPONENT

4.1.1.1 Definition of Hazardous Substance Migration Pathway for Overland/Flood Component

The hazardous substance migration path from the sources includes both the overland segment and the in-water segment (Ref. 1, Section 4.1.1.1).

Overland Segment

The overland segment is defined as the portion of the hazardous substance migration pathway beginning at a source and proceeding down-gradient to the probable point of entry (PPE) to surface water (Ref. 1, Sec. 4.1.1.1).

According to field observations and topographic maps of the area, excess surface water from the Bautsch-Gray Mine milling process area could flow in four separate directions into four PPEs. Regardless of the four routes, each empties into Smallpox Creek and eventually the Mississippi River (Ref. 4, p. 24).

First, excess surface water flow could travel north within the ditches that parallel Blackjack Road (Ref. 4, p. 25). Surface water travels through the ditches approximately ¼ mile to the north before emptying into Smallpox Creek just east of the Blackjack Road Bridge (Ref. 4, p. 25). This overland flow pathway and the PPE to Smallpox Creek are shown in yellow in Figure 5 as PPE-1.

The second route became prominent during heavy rain activities during the summer of 2009 (Ref. 4, p. 11). Excess surface water has carried excess mine tailings and deposited them on Blackjack Road and within the residential property (Ref. 4, p. 11). From the residential property, excess surface water continues to travel in a northwest direction following the natural contours of the land before reaching a wetland approximately 0.1 mile from the mine tailings pile (Ref. 4, p. 25). Once reaching the wetland there is no discernible flow, but there are several ditches that channel the water toward Smallpox Creek to the north, northwest and west (Ref. 4, p. 25). Referring to the topographic map in Figure 1, there is an intermittent drainage to the north which empties into Smallpox Creek near the bridge north of the mine tailings pile (Ref. 7, Figure 5). This overland flow pathway and the PPE into Smallpox Creek are shown in blue-green in Figure 5 as PPE-2.

The other two routes are the most analytically and visibly documented to be impacting Smallpox Creek (Ref. 4, p. 25). Excess surface water and mine tailings are channeled to the west from the mine tailings pile to the settling pond (Ref. 4, p. 25). From the settling pond, excess surface water and mine tailings migrate west and follow the natural contours of the land before reaching Smallpox Creek approximately 0.2 miles from the settling pond (Ref. 4, p. 25). From the settling pond, excess surface water follows the natural contour of the terrain forming a “fan-shaped” area of contaminated soil (Ref. 4, p. 26). This area of contaminated soil empties into Smallpox Creek at two different PPEs. One PPE is located at sample X206 (shown in Figure 5 in pink as PPE-3) and the other at sample X207 (shown in Figure 5 in green as PPE-4) (Ref. 4, pp. 26, 43).

The furthest upstream PPE, PPE-1, is located at the bridge which is north of the mine tailings pile (Figure 5).

Smallpox Creek is listed as a lower perennial water body according to U.S. Geological Survey topographic maps (Ref. 7).

Probable Point of Entry

The probable point of entry (PPE) is the point at which the overland segment of a hazardous substance migration path intersects with surface water. The PPE is assigned as the point at which entry of the hazardous substances to surface water is most likely. There are four PPEs for the Bautsch-Gray Mine (Ref. 4, p. 24). Figure 5 illustrates the PPEs for the Bautsch-Gray Mine.

Surface Water Segment

The in-water segment begins at the most upstream PPE (PPE 1) and continues in the direction of flow for the distance established by the target distance limit (TDL), 15 miles downstream of the most downstream PPE (PPE-4) (Ref. 1, Sec. 4.1.1.2). The 15-mile TDL is depicted in Figure 6 of this report.

4.1.1.2 Target Distance Limit

The TDL defines the maximum distance over which targets are considered in evaluating the surface water pathway (Ref. 1, Sec. 4.1.1.2). According to the HRS, the TDL for the watershed extends 15 miles along the surface water or to the most distant sample point that meets the observed release criteria described in Section 4.1.3.1 below (Ref. 1, Sec. 4.1.1.2). The TDL for the Bautsch-Gray Mine begins at PPE 1 at the confluence of the overland flow route and Smallpox Creek to 15 miles downstream of the most downstream PPE, PPE-4 (Figure 5 and 6).

The USGS Topographic Map of the Bellevue, IL quadrangle indicates that Smallpox Creek is a perennial water body (Ref. 7; 4, p. 26). From the PPE, surface water continues to flow for 3.74 miles before joining with the Mississippi River. Once present in the Mississippi River, the flow continues south for an additional 11.26 miles before reaching the 15-mile TDL near mile marker 550 (Figure 6). Figure 6 of this HRS documentation record illustrates this 15-mile TDL.

Targets within or contiguous to the hazardous substance migration path are subject to actual contamination if the target is located at or between the PPE and any sampling point that meets the criteria for an observed release (Ref. 1, Sec. 4.1.1.2). All targets located between PPE 1 and sediment sample X210 (Figure 3 of this HRS documentation record) are subject to actual contamination (observed releases at these sample locations are described in Section 4.1.4.1 of this HRS documentation record). Sediment samples were collected according to the Bureau of Land Sampling Procedures Guidance Manual for sediments (Ref. 16, p. 10.6).

The distance from PPE-1 to subsequent samples, wetlands and the 15 mile TDL was calculated using GIS software. The distance was determined based on the locations of the sediment samples as logged into the Global Positioning System (GPS) unit upon the time of collection, and then transferred to the GIS program. These locations were then placed on the digitized and rectified aerial photograph of the area. Sample locations are depicted in Reference 4, p. 43, Figure 6.

Topographic map (Bellevue Quadrangle) was downloaded from <http://www.isgs.uiuc.edu/nsdihome/webdocs/drags/drgorder24bymap.html> and manipulated in GIS Software (Ref. 17, p. 3). The 15 mile TDL was found by using the ruler function in

GIS and following the surface water pathway from the furthest upstream PPE (PPE-1), to the most downstream PPE (PPE-4) and 15 miles downstream from PPE-4 (Ref. 17, p. 3, Figure 6 of this HRS documentation record).

4.1.2 Drinking Water Threat

The drinking water threat was not evaluated for the Bautsch-Gray Mine.

4.1.3 Human Food Chain Threat

4.1.3.2 Human Food Chain Threat – Waste Characteristics

4.1.3.2.1 Toxicity/Persistence/Bioaccumulation

The factors that compose the toxicity/persistence/bioaccumulation factor value are discussed in the following subsections; the factor values are presented in Table 4-5 of this HRS documentation record. Only those hazardous substances that are available to migrate from the sources at the site to surface water in the watershed via the overland/flood migration path are evaluated.

Table 4-1: Human Food Chain Toxicity/Persistence/Bioaccumulation Factor Values

Hazardous Substance	Toxicity Factor Value	Persistence Factor Value*	Toxicity/Persistence Factor Value (HRS Table 4-12)	Bioaccumulation Food Chain Freshwater	Tox/Per/Bio Factor Values (HRS Table 4-16)	Reference
Arsenic	10,000	1	10,000	5	50,000	Ref. 2, p. BI-1
Cadmium	10,000	1	10,000	5,000	50,000,000	Ref. 2, BI-2
Copper	0	1	0	500	0	Ref. 2, p. BI-3
Lead	10,000	1	10,000	5	50,000	Ref. 2, p. BI-8

* Based on the values for rivers.

Use the hazardous substance with the highest toxicity/persistence/bioaccumulation factor value for the watershed to assign the value to this factor.

Toxicity/Persistence/Bioaccumulation Factor Value: 5×10^7 (Ref. 1, Section 4.1.3.2.1.4)

4.1.4.2.2 Hazardous Waste Quantity

The hazardous waste quantity values for all sources are summed (Ref. 1, p. 51591). Based on this value, select a hazardous waste quantity factor value for the pathway from HRS Table 2-6.

Source 1 + Source 2 + Source 3 = Sum of the Source Hazardous Waste Quantity Value
 $117,612 + 14,718 + 6.3 = 132,336.3 = 10,000$ (Ref. 1, Table 2-6)

For Bautsch-Gray Mine surface water pathway, a value of 10,000 is assigned to the hazardous waste quantity factor value (See Section 2.4.2 of this HRS documentation record).

Surface Water Pathway Hazardous Waste Quantity Factor Value: 10,000

4.1.4.2.3 Calculation of Human Food Chain Threat –Waste Characteristics Factor Category Value

For the hazardous substance selected for the watershed (cadmium), use its toxicity/persistence factor value (10,000) and bioaccumulation potential factor value (5,000) as follows to assign a value to the Toxicity/Persistence/Bioaccumulation Value (Ref. 1, Table 4-16).

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

Multiply the toxicity/persistence factor value x the hazardous waste quantity factor value for the watershed, subject to a maximum product of 1×10^8 .

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

Then multiply this product by the bioaccumulation potential factor value, subject to a maximum product of 1×10^{12} .

$$(1 \times 10^8) \times 5000 = 5 \times 10^{11}$$

Based on this second product, assign a value from HRS, Table 2-7 (Section 2.4.3.1) to the human food chain threat – waste characteristics. From HRS, Table 2-7, a waste characteristics factor value category value of 560 is assigned for the surface water human food chain threat of the overland/flood migration component (Ref. 1, Table 2-7).

Waste Characteristics Factor Category Value: 560

4.1.3.3 Human Food Chain Threat – Targets

On May 11, 2010, interviews were conducted with residents surrounding the Bautsch-Gray Mine to determine if any property owners caught and ate fish from Smallpox Creek. During face-to-face interviews it was indicated that a nearby property owner has been catching and eating fish and clams from Smallpox Creek for many years (Ref. 53, p. 1). This individual

also mentioned making chowder on many occasions from the clams. On a survey conducted during this interview, it was determined that the entire family consumed bull heads, sun fish and catfish from Smallpox Creek (Ref. 53, pp. 1-2). Because it is not certain that the area fished is within the zone of actual contamination, the area fished is assessed as being further downstream than sample location X210.

Fishing does take place in the Mississippi River. Pool 12 of the Upper Mississippi River extends 26.3 miles from Lock and Dam 12 in Bellevue to Lock and Dam 11 in Dubuque. Pool 12 contains 12,349 acres of aquatic habitat. Pool 12 encompasses most of the natural river floodplain and is bounded by limestone bluffs for much of its length. Pool 12 has islands, side channels, and backwaters throughout most of its length. Unlike many pools, the lower reach of Pool 12 is not an open expanse of water. Pool 12 is also part of the Upper Mississippi River National Wildlife and Fish Refuge (<http://www.iowadnr.gov/idnr/Fishing/Wheretofish/MississippiRiver/MississippiRiverPool12.aspx>) (Ref. 54, p. 3). There are also fish advisories for Pool 12 which limits the consumption of walleye, sauger, largemouth bass, smallmouth bass, white bass or northern pike (http://www.iowadnr.gov/Portals/idnr/uploads/fish/fish_consumption_advisories.pdf) (Ref. 55, p. 3). There are also Fishing reports for Pool 12 <http://hotspotoutdoors.com/wisconsin-pool10-12.html> (Ref. 56, pp. 11-12).

A web page mentions catching plenty of fish to “fill the freezer”, from the tail waters near the Iowa city of Bellevue (Ref. 57, p. 5) Bellevue and the surrounding waters are within the 15 mile TDL (Ref. 7; Figure 6). Although the “fill the freezer” comment does not specifically mention the eating of these caught fish, it does suggest that these fish are caught and eaten. <http://www.walleyecentral.com/forums/showthread.php?t=50329>. (Ref. 57, p. 5). This information is used to identify that people actually seek, catch and consume human food chain fish in the in-stream segment of the Mississippi River which is being evaluated within the 15 mile TDL.

Pool 13 of the Upper Mississippi River extends 34.2 miles from Lock and Dam 13 near Clinton to Lock and Dam 12 in Bellevue. Pool 13 contains 28,117 acres of aquatic habitat. The upper and middle portions of the pool contain many islands, channels, and backwaters while the lower pool is a broad expanse of open water. Limestone bluffs line much of the shoreline in Pool 13. The Maquoketa River empties into the Mississippi River in Pool 13. The Iowa DNR’s Green Island Wildlife Management Area is located below the mouth of the Maquoketa River. Pool 13 is also part of the Upper Mississippi River National Wildlife and Fish Refuge. <http://www.iowadnr.gov/idnr/Fishing/Wheretofish/MississippiRiver/MississippiRiverPool13.aspx>. There are no current fish advisories for Pool 13 (Ref. 58).

There are fishing guide services available for Pool 13 of the Mississippi River. <http://www.fisheadtackle.com>, which suggests that people actively seek and fish these waters (Ref. 59, p. 5). The owner of this fishing guide service has also produced a video explaining the cleaning of fish for eating purposes (Ref. 59, p. 10, 13).

Other information was collected from the Iowa Department of Natural Resources (Iowa DNR). From the Bellevue Research Station, when talking of the mortality of tagged fish, it mentions that fish were harvested by ice anglers (Ref. 67, p. 3). There is also a document discussing the harvest of walleye and sauger (Ref. 68 p. 3).

The fishery is subject to potential human food chain contamination due to a hazardous substance (copper) having a bioaccumulation potential factor value of equal to or greater than 500 is present in a sediment sample from the watershed at a level that meets the criteria for an observed release to the watershed, but this sample was not collected in an area of Smallpox Creek that is known as a fishery. Thus the fishery within the TDL is subject to potential food chain contamination (Ref. 1, Section 4.1.3.3, p. 51620).

4.1.3.3.1 Food Chain Individual

Since there is an observed release of a hazardous substance having a bioaccumulation potential factor of equal to or greater than 500 (copper) to the surface water in the watershed and there is a fishery present anywhere within the TDL, assign a value of 20 (Ref. 1, Section 4.1.3.3.1, p. 51620).

Food Chain Individual = 20

4.1.3.3.2 Population

There are no Level I or Level II concentrations within a known fishery.

4.1.3.3.2.3 Potential human food chain contamination

On May 11, 2010, interviews were conducted with residents surrounding the Bautsch-Gray Mine to determine if any property owners caught and ate fish from Smallpox Creek. During face-to-face interviews it was indicated that a nearby property owner has been catching and eating fish and clams from Smallpox Creek for many years (Ref. 53, p. 1). This individual also mentioned making chowder on many occasions from the clams. On a survey conducted during this interview, it was determined that the entire family consumed bull heads, sun fish and catfish from Smallpox Creek (Ref. 53, pp. 1-2). Because it is not certain that the area fished is within the zone of actual contamination, the area fished is assessed as being further downstream than sample location X210, and scored as potential contamination.

Although there is documentation of human consumption of fish within the 15 mile TDL, there is no reasonable production estimate that can be made at the time of scoring.

Targets = 20

Human Food Chain Threat Score

$(\text{Likelihood of Release} \times \text{Waste Characteristics} \times \text{Targets}) / 82,500$
 $(550 \times 560 \times 20) / 82,500 = 74.66$

Human Food Chain Threat Score = 74.66

4.1.4 Environmental Threat

4.1.4.1 Environmental Threat – Likelihood of Release

Observed Release by Chemical Analysis

Sediment samples collected from Smallpox Creek (X206-X210) all exceeded three times the background levels for copper and X206, X207, X209 and X210 exceeded three times background for lead using X204 and X205 for background concentrations (Ref. 4, p. 52, Table 5). Sediment sample locations from the 2009 ESI sampling events are shown in Figure 6, Reference 4. Analytical data from the 2009 ESI sampling event supports an observed release by chemical analysis to Smallpox Creek, which is presented below.

Background Samples

Illinois EPA collected several sediment samples during the 2009 ESI to document background concentrations of inorganics (Ref. 4, Table 5). Upon review of the data, it has been determined to utilize sediment samples X204 and X205 as the background samples due to being up-gradient of the PPE. Another reason to utilize X204 and X205 as the background sample is to screen out the possible influence of contamination from the Marsden-Blackjack Mine located up-stream of the Bautsch-Gray Mine (Figure 1).

The samples used to document background sediment conditions, X204 and X205, were collected from a depth of 0-6 (X204) and 6-12 (X205) inches below the surface of the sediment. X204 consisted of a brown sand and gravel (Ref. 4, p. 45, Table 1). X205 consisted of a brown sand and gravel with a small amount of silt (Ref. 4, p. 45, Table 1). Sample X204 (Sediment 12) was collected from Smallpox Creek in approximately 2 feet of water (Ref. 49, p. 27). Sample X205 (Sediment 11) was collected from Smallpox Creek in approximately 1.5 ft of water (Ref. 49, p. 27). The background sediment samples (X204 and X205) were of similar makeup and consistency as the other sediment samples collected from Smallpox Creek (Ref. 4, p. 45, Table 1). The background samples were collected during the same sampling event as the release samples, at approximately the same depth (0-6 and 6-12 inches) (Ref. 4, p. 45, Table 1), using the same sampling protocols and were analyzed for the same sample parameters (target analyte list for inorganics in accordance with EPA CLP Statement of Work) (Contract No. EP-W-08-064) (Ref. 15, p. 4, 17). The background sediment samples were analyzed for the target analyte list for inorganics by Bonner Analytical Testing Company, located at 2703 Oak Grove Road, Hattiesburg, Mississippi, in accordance with EPA CLP SOW using Methods CLP SOW ILM05.4 (Ref. 15, p. 4, 17). EPA's Superfund Field Services Section validated the analytical results for

the background sediment sample; analytical results for this data package are provided in Reference 15, p. 4-9. Sediment samples were collected according to the Bureau of Land Sampling Procedures Guidance Manual for sediments (Ref. 16, p. 10.6).

Table 4-2 Background Sediment Sample Descriptions

Sample ID	Sample Medium	Sample Location	Depth	Date	References
X204 (ME0012)	Sediment	Smallpox Creek	0-6 inches	11/16/09	4, p. 45, Table 1; 15, p. 13; 49, p. 27
X205 (ME0013)	Sediment	Smallpox Creek	6-12 inches	11/16/09	4, p. 45, Table 1; 15, p. 13; 49, p. 27

Background Concentration

The table below provides a summary of the concentrations of hazardous substances detected in the background samples collected from the Smallpox Creek during the 2009 ESI. The analytical data package and data validation report from the sampling event are provided in Reference 15. The HRS states that “if the Sample Quantitation Limit is less than or equal to the sample measurement. Then an observed release is established as follows: if the background concentration is not detected or is less than the detection limit, an observed release is established when the sample measurement equals or exceeds the sample quantitation limit. If the background concentration equals or exceeds the detection limit, an observed release is established when the sample measurement is 3 times or more above the background concentration (Ref. 1, p. 51589, Table 2-3). X204 was selected to represent background concentrations due to the higher concentration of contaminants.

Table 4-3 Background Sediment Sample Concentrations

Sample ID	Hazardous Substance	Sample Concentration (mg/kg)	Adjusted Conc. (mg/kg)	Background Concentration (mg/kg) (3 x background)	SQL (Ref. 13, p. 37-38). (mg/kg)	References
X204 (ME0012)	Arsenic	11.1	11.1	33.3	1.27	15, p.13, 16, 30, 62, 67, 71
	Cadmium	11.9	11.9	35.7	0.64	
	Copper	1.9 J-	2.318	6.954	3.18	
	Lead	101 J	145.44	436.32	1.27	

Sample ID	Hazardous Substance	Sample Concentration (mg/kg)	Adjusted Conc. (mg/kg)	Background Concentration (mg/kg) (3 x background)	SQL (Ref. 13, p. 37-38). (mg/kg)	References
X205 (ME0013)	Arsenic	11.1	11.1	33.3	1.09	15, p.13, 16, 31, 62, 67, 71
	Cadmium	10.8	10.8	32.4	0.55	
	Copper	1.1 J-	1.342	4.0261	2.73	
	Lead	95.1 J	136.944	410.832	1.09	

mg/kg

milligrams per kilogram

SQL

Sample Quantitation Limit

J

The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample. Unknown bias

J-

The result is an estimated quantity, but the result may be biased low.

Adjusted Concentrations:

The inorganic samples ME0012 and ME0013 are associated with an ICP serial dilution percent difference which is not in control for copper, lead, and zinc. Hits are qualified "J" and non-detects are qualified "UJ" (Ref. 15, p. 7 and 8). According to Ref. 3, p. 8, Exhibit 3 for a background sample which is of unknown bias, the concentration is multiplied by the adjustment factor (lead, 1.44) (Ref. 3, p. 18).

The inorganic samples results for ME0012 and ME0013 are affected by an interference check "A" sample (ICSA) for which false negative concentration values greater than the absolute value of the MDL were obtained. Hits less than 10 times the absolute value of the ICSA are qualified "J-" for copper (Ref. 15, pp. 8-9). According to Ref. 3, p. 8, Exhibit 3 for a background sample which is biased low, the concentration is multiplied by the adjustment factor (Copper is 1.22 [Ref. 3, p. 18]).

The inorganic samples ME0012 and ME0013 have analyte concentrations reported above the method detection limit (MDL) but below the CRQL. Results are qualified "J" for copper (Ref. 15, p. 9).

Calculating Adjusted (Sample-Specific) Quantitation Limits (SQL) from CRQLs

Adjusted Limit (mg/kg) = $C \times W_m / W_r \times V_r / V_m \times 1/S \times DF$ (Ref. 13, pp. 37-38).

Where:

C = Contract Required Quantitation Limit

W_m = Minimum method-required wet sample weight (g)

W_r = Reported wet sample weight (g)

V_m = Method-required final sample volume (mL)

V_r = Reported final sample volume (mL)

S = % solids/100

DF = Sample Dilution Factor

Observed Release Samples:

All samples were analyzed for total metals, mercury and cyanide (Ref. 15, p. 45). Arsenic, cadmium, copper, lead and zinc were present in the sources associated with the Bausch-Gray Mine and were also documented in the release samples, and consequently, have been selected and used in the HRS scoring process. Of the five sediment samples collected downstream of the facility and analyzed for inorganics, four meet the criteria presented in

HRS Table 2-3 for establishing an observed release by chemical analysis (Ref. 1, Table 2-3) for copper and two sediment samples for lead. The inorganic concentrations in these sediment samples are greater than three times the established appropriate background level. The established appropriate background level is 11.1 for arsenic, 11.9 mg/kg for cadmium, 1.9 mg/kg for copper, 101 mg/kg for lead; taking into account bias based on the analytical data is necessary and applying the appropriate factors (Ref. 30, p. 7, 29) (for arsenic multiply 11.1 by 3) the background level for arsenic is 33.3, (for cadmium multiply 11.9 mg/kg by three) the background level is 35.7 mg/kg for cadmium. Due to a low bias for copper (Ref. 15, pp. 8-9), 1.9 is multiplied by 1.22 resulting in 2.32 and then multiplied by 3 reveals a background concentration of 6.954 mg/kg. Due to an unknown bias for lead, 101 is multiplied by the concentration factor 1.44 (Ref. 3, p. 18) resulting in 145.44 which is then multiplied by 3 resulting in 436.3 mg/kg for a lead background concentration.

Summary descriptions of the observed release samples are included in Table 4-3. Analytical results from the observed release samples are included in Table 4-4.

Table 4-4 Observed Release Sediment Sample Descriptions

Sample ID	Sample Medium	Sample Location	Distance from PPE 1	Depth	Date	Reference
X206	Sediment	Smallpox Creek	5477.08 ft	12-24 inches	11/16/09	4, p. 45, Table 1; 17, p. 3; 49, p. 26, 56
X207	Sediment	Smallpox Creek	5688.08 ft	0-6 inches	11/16/09	4, p. 45, Table 1; 17, p. 3; 49, p. 25, 56
X208	Sediment	Smallpox Creek	6897.08 ft	0-6 inches	11/16/09	4, p. 45, Table 1; 17, p. 3; 49, p. 22, 56
X209	Sediment	Smallpox Creek	7305.48 ft	6-12 inches	11/16/09	4, p. 45, Table 1; 17, p. 3; 49, p. 21-22, 56

Sample ID	Sample Medium	Sample Location	Distance from PPE 1	Depth	Date	Reference
X210	Sediment	Smallpox Creek	7651.98 ft	6-12 inches	11/16/09	4, p. 45, Table 1; 17, p. 3; 49, p. 21, 56

Distances from PPE 1 were calculated using georeferenced aerial photos and a GIS program (Ref. 17, p. 3).

The HRS states that “if the sample measurement is greater than or equal to the SQL, then an observed release is established as follows: if the background concentration is not detected or is less than the detection limit, an observed release is established when the sample measurement equals or exceeds the sample quantitation limit. If the background concentration equals or exceeds the detection limit, an observed release is established when the sample measurement is 3 times or more above the background concentration (Ref. 1, p. 51589, Table 2-3).

Table 4-5 Observed Release Sediment Sample Concentrations

Sample ID	Hazardous Substance	Hazardous Substance Concentration ppm	Adjusted Concentration based on bias (Ref. 3)	SQL (mg/kg) (Ref. 13, p. 37-38).	3 X Background (mg/kg) (X205)	References
X206 (ME0014)	Copper	7 J-	7	3.77	6.954	15, p. 13, 16, 31, 62, 67, 71
	Lead	986 J	684.7	1.51	436.3	15, p. 13, 16, 31, 62, 67, 71
X207 (ME0015)	Copper	31.1 J-	31.1	3.41	6.954	15, p. 13, 16, 32, 62, 67, 71
X209 (ME0017)	Copper	7.4 J-	7.4	2.87	6.954	15, p. 14, 16, 35, 62, 67, 71
X210 (ME0018)	Arsenic	33.9	33.9	1.42	33.3	15, p. 14, 16, 35, 62, 67, 71
	Copper	380 J	311.5	3.56	6.954	
	Lead	2070 J	1437.5	1.42	436.3	

mg/kg milligrams per kilogram
 SQL Sample quantitation limit

J – The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample (Ref. 15, p. 10).

J- - The result is an estimated quantity, but the result may be biased low (Ref. 15, p. 10).

Adjusted Concentrations:

All of the inorganic samples listed here which were analyzed for copper and lead are associated with an ICP serial dilution percent difference which is not in control.

Hits are qualified “J” and non-detects are qualified “UJ” (Ref. 15, p. 7).

The following results are affected by an interference check “A” sample (ICSA) for which false negative concentration values greater than the absolute value of the MDL were obtained. The sample contains Al, Ca, Fe or Mg at a level comparable to that of the

ICSA. Hits less than 10 times the absolute value of the ICSA are qualified “J-“, non-detects are qualified “UJ”. Hits greater than 10 times are not qualified. Samples ME0014-ME0017 analyzed for copper (Ref. 15, p. 8-9).

Calculating Adjusted (Sample-Specific) Quantitation Limits (SQL) from CRQLs
Adjusted Limit (mg/kg)= $C \times W_m/W_r \times V_r/V_m \times 1/S \times DF$ (Ref. 13, p. 37-38)

Where:

C = Contract Required Quantitation Limit

W_m = Minimum method-required wet sample weight (g)

W_r = Reported wet sample weight (g)

V_m = Method-required final sample volume (mL)

V_r = Reported final sample volume (mL)

S = % solids/100

DF = Sample Dilution Factor

Attribution

The following documentation presents evidence that the contamination found in the sediments of Smallpox Creek can be attributed to all three sources at the Bautsch-Gray Mine. Arsenic, cadmium, copper, lead and zinc are associated with the sources at the facility (see Section 2.2 of this HRS documentation record).

Samples collected from all three Sources (mine tailings pile, settling pond and contaminated soil) contain elevated levels of arsenic, copper and lead (Section 2.2). These contaminants are associated with the activities that have occurred at the Bautsch-Gray Mine. Samples collected along the overland flow route from the settling pond to the area of contaminated soil contained elevated levels of arsenic, copper and lead (Section 2.2 of this documentation record).

The mine tailings pile has been stockpiled in a large visible pile on the east side of Blackjack road. The mine tailings material that is present has the general appearance of gray/brown beach sand with dark striations throughout (Ref. 4, p. 19). The material is very porous and contains large pieces of metal that once made up the mining operations (Ref. 4, p. 19). Throughout the tailings pile are eroded valleys and channels that generally slope toward the west (Ref. 4, p. 19). There are large, “canyon-like” ridges throughout the central portion of the tailings pile in which birds burrow into the side walls for nests (Ref. 4, p. 19). Observations made during the ESI indicated that the tailings pile, at its highest point, is approximately 40 feet above the surrounding terrain (Ref. 4, p. 19). The size of the mine tailings pile has been calculated as 1,528,956 square feet utilizing Figure 7 of the 2009 ESI (Ref.4, p. 44) and a GIS program (Ref. 17, p. 2).

The hazardous substances arsenic, cadmium, copper, lead, nickel and zinc (Ref. 4, p. 19) were detected in five waste samples from Source 1, collected during the CERCLA ESI (Ref 4, p. 19).

The settling pond is approximately 191,331 square feet in size (Ref. 17, p. 2). An aerial photograph indicates that the settling pond was in place in 1970. The settling pond utilized the natural contours of the land along with a dam along the western boundary to retain tailings materials (Ref. 4, p. 20). The tailings materials enter into the settling pond by way of an overflow pipe originating from the tailings pile (Ref. 4, p. 20). Source 2 was diked and helps to retain a portion of the excess runoff (Ref. 4, p. 20). There was an overflow pipe located along the western portion of the settling pond (Ref. 18, p. 15). On Figure 2 of this documentation record, this is at the intersection of the Settling pond (Source 2) and the Defined Channel of mine tailings (Source 3). During the 2009 ESI, the dike that has suppressed the tailings within the settling pond had broken (Ref. 4, p. 22). Due to this break, the overland flow continues to be impacted from mine tailings flowing from the settling pond (Ref. 4, p. 22). At this time, the dike is still breached and allowing mine tailing material to continue along the overland flow route to Smallpox Creek (Ref. 62, p. 1).

Samples from Source 2 were collected during the CERCLA ESI of 2010 (Ref. 4, pp. 20). Samples X215 – X218 were all collected within the area designated as the settling pond (Source 2) (Ref. 4, p. 20). Samples X215-X218 document the presence of the following hazardous substances; arsenic, cadmium, copper, lead and zinc (Ref. 4, p. 49, Table 3).

Tailings material that was once present in the settling pond has resulted in an area of contaminated soil (Ref. 4, p. 21). The mine tailings migrate from the settling pond area, through the overflow pipe located along the southwestern portion of the settling pond to the overland flow route (Ref. 18, p. 15). During the 2009 ESI, the dike that has suppressed the tailings within the settling pond had broken (Ref. 4, p. 22). Due to this break, the overland flow was impacted from mine tailings flowing from the settling pond (Ref. 4, p. 22). Contaminated sediments, from up gradient sources, have been deposited along this overland flow route to Smallpox Creek, resulting in an area of contaminated soil (Ref. 18, p. 16). This area of contaminated soil follows the natural contour of the terrain (Ref. 4, p. 21). The terrain of the contaminated soil area has a slight slope that appears to be toward the west and southwest. Due to the topography, the mine tailings are spread throughout the area in a fan shaped pattern (Ref. 4, p. 21). This fan-shaped pattern contains mine tailings on the surface and stressed vegetation throughout (Ref. 4, p. 21).

The contaminated soil (Source 3) can be identified by using samples X103 through X108 (Ref. 4, p. 21). These samples were taken in the area believed to have been impacted by the overflow of mine tailings (Ref. 4, p. 21). All five locations contained levels of arsenic, cadmium, lead, copper and zinc that met or exceeded observed release criteria (Ref. 4, p. 21). These inorganic contaminants can be attributed to those found in up-gradient sources (Ref. 4, p. 21-22). Using a scaled aerial photograph and visual observations made during the Expanded Site Inspection, an area of 4.9 acres of contaminated soil was determined (Ref. 4, p. 22). The area of the contaminated soil was determined to be 198,594 sq feet (Ref. 17, p. 1).

When compared to soil background Samples X101 and X102, all five sampling locations from Source 3 contained levels of arsenic, cadmium, lead, copper and zinc that met or exceeded observed release criteria (Ref. 4, p. 21, 50). These inorganic contaminants can be attributed to those found in up-gradient sources (Ref. 4, p. 21-22).

Sediment samples collected from Smallpox Creek indicate that contaminants from the operations at the Bautsch-Gray Mine have migrated to Smallpox Creek (Table 4-4). The overland flow path is discussed in Section 4.1 of this documentation record.

A photograph of surface water drainage from the mine tailings pile to the settling pond is depicted in Reference 14, p. A-5). Visual evidence of mine tailings flowing from the settling pond to the contaminated soil area are depicted in a photograph on page A-7 of Reference 14. Visual evidence of mine tailings in the area of contaminated soil south of the settling pond dike is documented in the sample photographs of the 2000 ESI (Ref. 4, p. 72-73).

Sediment samples collected from Smallpox Creek (Table 4-4 of this HRS documentation record) indicate that hazardous substances have migrated to Smallpox Creek. Samples collected from the sources associated with the Bautsch-Gray Mine identify arsenic, cadmium, copper, lead and zinc. Samples collected from the sediments of Smallpox Creek reveal arsenic, copper, and lead at concentrations meeting the criteria for documenting an observed release (Ref. 1, Table 2-3). Overland flow routes and drainage pathways from the sources are discussed in Section 4.1 of this HRS documentation record and document the overland flow routes of contaminants to Smallpox Creek.

In order to determine whether the significant increase in arsenic, copper, and lead downstream of the Bautsch Gray Mine milling process area and the settling pond is the result of a source or sources other than the sources identified at the Bautsch-Gray Mine, two online EPA databases (Enviromapper and TRI Explorer) (<http://www.epa.gov/emefdata/em4ef.home>) were searched for a one-mile radius around the Bautsch-Gray Mine. There are no other facilities within a one-mile radius of the Bautsch-Gray Mine (Ref. 51, p. 2).

Although neither database revealed any facilities within the area, there is information pertaining to the Marsden-Blackjack Mine. The Marsden-Blackjack Mine in the Galena District has produced more zinc ore than any other mine in Illinois (Ref. 40, p. 3). Its production is said to have been more than a million and a half tons of ore (Ref. 40, p. 3). The mine is 4 miles by road south of Galena on the same "range", or trend of ore deposition, as the Pilot Knob mine, the Gill-Fisher mine, the Pittsburg Mine, the Gray mine, and the Bautsch drilling (Ref. 40, p. 3). At least two large piles of waste rock remain on the property that appears to be possibly impacting Smallpox Creek (Ref. 4, p. 23). According to the topographic map (Ref. 7) the Marsden-Blackjack mine was located Section 4 of Range 1 East and Township 27 North. It is assumed that the milling process occurred at that location. The topographic map depicts a tributary to Smallpox Creek leading away

from the area of the Marden-Blackjack Mine (Ref. 7). Although there is the possibility that the Marsden-Blackjack Mine may be contributing to contamination of Smallpox Creek, information gathered during the 2009 ESI clearly depicts the overland flow route and subsequent PPEs from the Bautsch-Gray Mine to Smallpox Creek.

The location of the Marsden-Blackjack Mine is depicted on Figure 1 of this documentation record. The Marsden-Blackjack Mine is approximately 0.6 mile to the north-northwest of the Bautsch-Gray Mine (Figure 1). Background sediment samples (X204 and X205) collected during the 2009 ESI were collected downstream from the Marsden-Blackjack Mine (Figure 4).

The byproducts produced on the Bautsch Gray Mine milling process area (mine tailings) and the sediments collected from Smallpox Creek indicate that the mine tailings led to the contamination of the sediments in the Smallpox Creek with arsenic, copper, and lead (Ref. 4, Tables 2 and 5).

Surface Water Environmental Threat Likelihood of Release Factor Category Value: 550

4.1.4.2 Environmental Threat – Waste Characteristics

4.1.4.2.1 **Ecosystem Toxicity/Persistence/Bioaccumulation**

The factors that compose the toxicity/persistence/bioaccumulation factor values are presented in Table 4-5 of this HRS documentation record. Only those hazardous substances that are available to migrate from the sources at the site to surface water in the watershed via the overland/flood migration path are evaluated (Ref. 1, Sections 4.1.4.2.1 and 4.1.2.2).

Table 4-6: Ecosystem Toxicity/Persistence/Bioaccumulation Factor Values

Hazardous Substance	Source No	Ecosystem Toxicity Factor Value	Persistence Factor Value*	Ecosystem Toxicity/Persistence Factor Value (HRS Table 4-12)	Bioaccumulation Environment Freshwater	Ecotox/Per/Bio Factor Values (HRS Table 4-16)	Reference
Arsenic	1, 2, 3	10	1	10	5	50	Ref. 2, p. BI-1
Cadmium	1, 2	10,000	1	10,000	50,000	500,000,000	Ref. 2, p. BI-2
Copper	1, 2, 3	1,000	1	1,000	5,000	5,000,000	Ref. 2, p. BI-3
Lead	1, 2, 3	1,000	1	1,000	50,000	50,000,000	Ref. 2, p. BI-8
Zinc	1, 2, 3	10	1	10	50,000	500,000	Ref. 2, p. BI-12

* Based on the values for rivers

Use the hazardous substance with the highest ecosystem toxicity/persistence/bioaccumulation factor value for the watershed to assign the value to this factor.

Ecosystem Toxicity/Persistence/Bioaccumulation Factor Value: 5×10^8 (based on cadmium)

4.1.4.2.2 Hazardous Waste Quantity

The hazardous waste quantity values for all sources are summed (Ref. 1, p. 51591). Based on this value, select a hazardous waste quantity factor value for the pathway from HRS Table 2-6.

Source 1 + Source 2 + Source 3 = Sum of the Source Hazardous Waste Quantity Value
 $117,612 + 14,718 + 6.2777647 = 132,336.2777647$ yields a value of 10,000 (Ref. 1, Table 2-6)

For Bautsch-Gray Mine surface water pathway, a value of 10,000 is assigned to the hazardous waste quantity factor value (See Section 2.4.2 of this HRS documentation record).

Surface Water Pathway Hazardous Waste Quantity Factor Value: 10,000

4.1.4.2.3 Calculation of Environmental Threat –Waste Characteristics Factor Category Value

For the hazardous substance selected for the watershed (cadmium), use its ecosystem toxicity/persistence factor value (10,000) and bioaccumulation potential factor value (50,000) as follows to assign a value to the waste characteristics factor category. First multiply the toxicity/persistence factor value and the hazardous waste quantity factor value for the watershed, subject to a maximum product of 1×10^{12} .

Toxicity/Persistence factor value x hazardous waste quantity factor value:
 $10,000 \times 10,000 = 1 \times 10^8$

Then multiply this product by the bioaccumulation potential factor value for this hazardous substance, subject to a maximum product of 1×10^{12} .

$1 \times 10^8 \times 50,000 = 5 \times 10^{12}$

Based on this second product, assign a value from HRS, Table 2-7 (Section 2.4.3.1) to the environmental threat – waste characteristics. From HRS, Table 2-7, a waste characteristics factor value category value of 1,000 is assigned for the surface water environmental threat of the overland/flood migration component (Ref. 1, Table 2-7).

Waste Characteristics Factor Category Value: 1000

4.1.4.2 Environmental Threat – Targets

According to the HRS, the sensitive environments factor is used to determine the environmental threat – targets factor category for each watershed. Sensitive environments are divided into two components: the sensitive environments listed in HRS Table 4-23 and wetlands (Ref. 1, Sections 4.1.4.3 and 4.1.4.3.1).

Level I Concentrations

Level I concentrations cannot be established because the observed release to surface water is based on sediment samples (Refs. 1, Section 4.1.4.3.1, Table 4-22).

Level II Concentrations

There are no targets subject to Level II concentrations.

4.1.4.2.1 Sensitive Environments

4.1.4.3.1.1 Level I Concentrations

Level I contaminant concentrations cannot be established because the observed release to surface water is based on sediment samples (Refs. 1, Section 4.1.4.3.1, Table 4-22).

4.1.4.3.1.2 Level II Concentrations

Most Distant Level II Sample

Sample ID:

Distance from the probable point of entry:

4.1.4.3.1.3 Potential Contamination

Sensitive Environments

According to the IDNR Ecological Compliance Assessment Tool (EcoCAT) has determined that protected resources in the area include Casper Bluff Illinois Natural Areas Inventory (INAI) Site, Mississippi River Backwaters – Jo Daviess County INAI site, Casper Bluff Land and Water Reserve, weed shiner (*Notropis texanus*) and western sand darter (*Ammocrypta clarum*) (Ref. 20, p. 1). The Mississippi River Backwaters-Jo Daviess

County INAI site, the weed shiner (*Notropis texanus*) and the western sand darter (*Ammocrypta clarum*) were used in the HRS documentation record for scoring purposes for potential contamination. The occurrence of the weed shiner and the western sand darter has been documented near the confluence of Smallpox Creek and the Mississippi River (Ref. 61, p. 1). The Mississippi River Backwaters – Jo Daviess County INAI site is located along Smallpox Creek and the Mississippi River (Ref. 42, p. 1, 3). The Upper Mississippi River National Wildlife and Fish Refuge is located along the Mississippi River and Smallpox Creek meanders through a portion of this Refuge (Ref. 7).

Potential contamination exists for the Mississippi River Backwaters – Jo Daviess County INAI site (Ref. 25, p. 12), the Upper Mississippi River National Wildlife and Fish Refuge (Ref. 7) and the habitat for the weed shiner and the western sand darter (Ref. 20, p. 1).

Rating values for sensitive environments can be found in Ref. 1, Table 4-23.

Habitat known to be used by State designated endangered or threatened species (weed shiner): 50

Habitat known to be used by State designated endangered or threatened species (western sand darter): 50

State designated Natural Areas (Mississippi River Backwater – Jo Daviess County): 25

National or State Wildlife Refuge (Upper Mississippi River National Wildlife and Fish Refuge): 75

Wetlands

Wetland delineation was conducted using the National Wetlands Inventory data downloaded and used in an ArcMap application. The National Wetlands Inventory data was downloaded from the U.S. Fish and Wildlife Service's Wetlands Online Mapper (<http://wetlandsfws.er.usgs.gov/wtlnds/launch.html>) (Ref. 17, p. 1; Ref. 52). Designated wetlands are present along Smallpox Creek (Refs. 17, p. 1; 52). These wetlands can be viewed in Figure 7. The wetlands found along Smallpox Creek and the Mississippi River consists of Palustrine Emergent and Palustrine Forested (Ref. 52).

Utilizing Geographic Information Software and the National Wetlands Inventory Maps (Ref. 17 and data downloaded from the U.S. Fish and Wildlife Service's Wetlands Online Mapper) (Ref. 52), the wetland frontage located between the X210 and the 15-mile TDL was calculated (Geographic Information Software program, Ref. 17, p. 2) and subject to potential contamination. The wetland frontage was measured (Ref. 17, p. 3) as defined in 40 CFR 230.3 (Ref. 1, Section 4.1.4.3.1.1). See Table 4-10 below for a summary of HRS-eligible wetlands along Smallpox Creek which are subject to potential contamination.

Table 4-7: Wetland Frontage – Potential Contamination

Wetland Location	Wetland Class	Wetland frontage (feet)	References
Isolated and located on Smallpox Creek	Palustrine emergent seasonally flooded (PEMC)	647	Ref. 17, p. 3; 52
Located along Smallpox Creek	Palustrine emergent seasonally flooded (PEMC)	24	Ref. 17, p. 3; 52
Located along Smallpox Creek and the Mississippi River	Palustrine freshwater forested/shrub wetland (PF01CH)	11,348.91	Ref. 17, p. 3; 52
TOTAL		12,019.9 (2.27 miles)	Ref. 17, p. 3

Wetlands rating values for the Surface Water Migration Pathway (From Ref. 1, p 51625, Table 4-24)\

Total length of wetlands : 2.27 miles = 75 assigned value

The remaining wetlands located between the confluence of Smallpox Creek with the Mississippi River and the 15 mile TDL are subject to potential contamination (Ref. 24, p. 29). Even though there are wetlands along the Mississippi River they do not significantly add to the overall site score, thus they were not utilized in the documentation record.

Due to the unknown flow of Smallpox Creek an estimated flow of 1,000 to 10,000 cubic feet per second (cfs) was estimated.

From Table 4-13: Surface Water Dilution Weights for a small to moderate stream which has flow characteristics of greater than 1,000 to 10,000 cfs is assigned a dilution weight of 0.001 (Ref. 1, p.51613).

According to HRS Table 4-24, 2.27 miles of wetland frontage along Smallpox Creek corresponds to an assigned wetlands value of 75. The calculation of the potential contamination factor value entails adding the sum of the sensitive environment rating values (50 + 50 + 25 + 75) and the value assigned to the total length of wetland frontage along the area of potential contamination (75) (Ref. 1, Sec. 4.1.4.3.1.3), multiplying by the dilution weight assigned value and dividing by ten for each surface water body.

$$[(200 + 75) \times 0.001] / 10 = 0.0275$$

Potential Contamination Factor Value: 0.0275 (Ref. 1, Section 4.1.4.1.1)