ST SulTRAC

November 25, 2015

Ms. Pamela Molitor
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77 W. Jackson Blvd. (SR-6J)
Chicago, Illinois 60604

Subject: Final Risk Assessment Methodology
Bautsch-Gray Mine Site, Jo Daviess County, Illinois
Remedial Action Contract (RAC) 2 No. EP-S5-06-02
Work Assignment No. 186-RICO-B5TS

Dear Ms. Molitor:

This letter acknowledges the completion of the Final Risk Assessment Methodology following incorporation of U.S. Environmental Protection Agency (EPA) Draft Risk Assessment Methodology comments into the Draft Remedial Investigation (RI) Report. The bullets provided below summarize the chronology of the reports and correspondences leading to EPA approval of the Final Risk Assessment Methodology.

- Draft Risk Assessment Methodology was submitted to EPA on January 28, 2015.
- EPA comments of the Human Health portion of the Draft Risk Methodology were received by SulTRAC on January 29, 2015.
- EPA comments of the Ecological portion of the Draft Risk Methodology were received by SulTRAC on March 4, 2015.
- SulTRAC responded to EPA Human Health and Ecological comments on March 20, 2015.
- EPA comments were then incorporated into the Draft Risk Assessment (Appendix F of the RI Report) submitted on June 3, 2015.
- EPA acknowledged the incorporation of these comments into the Draft Risk Assessment and RI Report a letter dated October 28.

Therefore, the Draft Risk Assessment includes the Final Risk Assessment Methodology and the draft Risk Assessment Methodology document dated January 25, 2015, does not require revision.

If you have any questions about the enclosed document, please call me at (312) 201-7479.

Sincerely,

Robert Kondreck
SulTRAC Project Manager

cc: Charlene Falco, Illinois EPA Project Manager
Daniel Olsson, EPA Contracting Officer (letter only)
Mindy Gould, SulTRAC Program Manager (letter only)
File

DRAFT

RISK ASSESSMENT METHODOLOGY

BAUTSCH-GRAY MINE SITE

JO DAVIESS COUNTY, ILLINOIS

Prepared for

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) tasked SulTRAC to prepare a human health risk assessment (HHRA) and a screening level ecological risk assessment (SLERA) for the Bautsch-Gray Mine Site located in Jo Daviess County, Illinois (see Figure 1). Summaries of the basis, methodology, and contents of the draft HHRA and the SLERA reports are presented below.

2.0 HUMAN HEALTH RISK ASSESSMENT

The primary objective of the HHRA is to determine whether site contaminants pose a potential current or future risk to human health in the absence of remediation. The HHRA will be used to determine whether remediation is necessary at the site, provide justification for remedial action, and identify what exposure pathways must be remediated. The areas to be addressed in the risk assessment include the Bautsch-Gray Mine Site itself and any contamination that may have migrated from the site.

SulTRAC will conduct the HHRA for the Bautsch-Gray Mine Site consistent with EPA and state guidance. The guidance documents to be used in preparing the HHRA are listed below. This list is not comprehensive, and other EPA and state guidance documents, as well as documents prepared by other organizations, will be used as appropriate.

1. EPA. 1989. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part A)" (RAGS)*. Interim Final. Office of Emergency and Remedial Response (OERR). Washington, D.C. EPA/540/1-89/002. December.
2. EPA. 1991. "RAGS, Volume I: Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors." Interim Final. Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-03. March 25.
3. EPA. 1992. "Guidance for Data Usability in Risk Assessment (Part A) Final." OERR. Publication 9285.7-09A. April.
4. EPA. 2001. *RAGS, Volume 1 – Human Health Evaluation Manual Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments*. Final. Office of Superfund Remediation and Technology Innovation. Publication 9285.7-47. December.
5. EPA. 2002a. "Policy Considerations for the Application of Background Data in Risk Assessment and Remedy Selection, Role of Background in the CERCLA Cleanup Process." OSWER. OSWER 9285.6-07P. April 26.
6. EPA. 2002b. "Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. December.

7. EPA. 2003a. “Human Health Toxicity Values in Superfund Risk Assessments.” OSWER Directive 9285.7-53. December.
8. EPA. 2004b. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*. Final. OSWER. EPA/540/R/99/005. July.
9. EPA. 2005a. “Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens.” Risk Assessment Forum. EPA/630/R-03/003F. March.
10. EPA. 2005c. “Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.” Final. OSWER. EPA530-R-05-006. September.
11. EPA. 2009a. *RAGS, Volume 1: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*. Office of Superfund Remediation and Technology Innovation. EPA-540-R-070-002. January.
12. EPA. 2011. “Exposure Factors Handbook: 2011 Edition.” Office of Research and Development (ORD). EPA/600/R-090/052F. September.
13. EPA. 2013. “ProUCL Version 5.0.00 User Guide, Statistical Software for Environmental Applications for Data Sets With and Without Nondetect Observations.” ORD Site Characterization and Monitoring Technical Support Center (SCDMTSC). EPA/600/R-07/041. September.
14. EPA. 2015a. “Regional Screening Level (RSL) Summary Table, January 2015.” November.
15. EPA. 2014a. “User’s Guide for Regional Screening Levels (November 2014).” November.
16. Illinois Pollution Control Board (IPCB). 2013b. Title 35 of the *Illinois Administrative Code*, Part 742, “Tiered Approach to Corrective Action Objectives.” July 15.

As described in EPA’s RAGS (EPA 1989), the risk assessment will be conducted in four basic steps: (1) data evaluation and identification of chemicals of potential concern (COPC), (2) exposure assessment, (3) toxicity assessment, and (4) risk and hazard characterization. In addition, the HHRA will include a discussion and evaluation of significant sources of uncertainties in the risk assessment process as applied at the Bautsch-Gray Mine Site. Each of these risk assessment elements is summarized below.

2.1 DATA EVALUATION AND IDENTIFICATION OF COPCs

The HHRA will be based on available medium-specific analytical results associated with (1) remedial investigation (RI) – Phase I (May 12 through May 28, 2014), and (2) RI – Phase II (November 2014) conducted at the Bautsch-Gray Site (see Figure 2). Numerous soil, surface water, sediment, and biota (fish tissue) samples have been collected and analyzed in these investigations, as summarized below (see Figures 3, 4, and 5). It should be noted that the primary contamination associated with the Bautsch-Gray Mine site is metals. In fact, medium-specific samples were analyzed only for metals and no other analyte groups.

- Phase I
  - Background Soil Sampling –SulTRAC and EPA Field Environmental Decision Support (FIELDS) collected background soil samples from 10 locations near the site (three depth intervals – surface, 6 to 36 inches below ground surface [bgs], and approximately 8 to 10 feet bgs) and 14 locations (surface soil only) within Jo Daviess County. (Note: four of these near site locations [BK-BKG-01 through -04] along the Northern Mining Road, were found to have elevated metals concentrations and were switched to normal Phase I grid soil sample locations in Figure 3). A total of 44 samples were collected for laboratory analysis of target analyte list (TAL) metals (including mercury and cyanide) through EPA's Contract Laboratory Program (CLP).
  - Soil Decision Unit Sampling – SulTRAC collected a total of 101 laboratory samples and 267 X-ray fluorescence (XRF) samples from 203 locations surrounding the source areas. (Note: the addition of the four former background locations as described in the preceding bullet increases the total number of locations to 207). All laboratory samples were submitted for TAL metals including mercury and cyanide through EPA's CLP. In addition, 15 soil samples were submitted to for synthetic precipitation leaching procedure (SPLP) analysis and 15 soil samples for relative bioavailability analysis (RBA) through private laboratories.
  - Background Smallpox Creek Sampling – SulTRAC and EPA FIELDS collected nine background sediment samples from Smallpox Creek and one collocated surface water sample. All laboratory samples were analyzed for TAL metals including mercury and cyanide through EPA's CLP. The water sample was analyzed for dissolved and total TAL metals. One sediment sample was analyzed for grain size, pH, total organic carbon (TOC), and acid-volatile sulfide/simultaneously extracted metals (AVS/SEM) through a private laboratory.
  - Smallpox Creek (and tributaries) Sampling – SulTRAC and EPA FIELDS collected 43 Smallpox Creek sediment samples and six collocated surface water samples. All sediment samples were analyzed for TAL metals including mercury and cyanide through EPA's CLP. Water samples were analyzed for dissolved and total TAL metals through EPA's CLP. Six sediment samples were analyzed for grain size, pH, TOC, and AVS/SEM through a private laboratory.
  - Wetlands Sampling – SulTRAC and EPA FIELDS collected 32 (30 surface and two subsurface) wetlands sediment samples and three collocated surface water samples. All laboratory sediment samples were analyzed for TAL metals including mercury and cyanide through EPA's CLP. Water samples were analyzed for dissolved and total TAL metals through EPA's CLP. Four sediment samples were analyzed for grain size, pH, TOC, and AVS/SEM through a private laboratory.
  - Groundwater Investigation – A groundwater investigation was attempted; however, shallow groundwater was not encountered in sufficient quantities to collect samples for analysis of metals. Therefore, no groundwater samples were collected during the Phase I RI.
- Phase II
  - Northern mining road investigation – Nine XRF surface soil samples were collected from newly created decision units (DUs) located along the road north of the site.
  - Smallpox Creek adjacent soil and fish sampling investigation

        - 13 surface soil samples were collected from the creek banks adjacent to areas where metals concentrations in sediment exceeded the action levels proposed in the SulTRAC Field Sampling Plan, Revision 1 (SulTRAC 2014). Samples were analyzed for TAL metals through EPA's CLP.
        - Nine fish samples were collected in Smallpox Creek to evaluate human health risk if fish were consumed. Fish tissue samples were submitted to a private laboratory for analysis of metals only.
    - Wetlands perimeter investigation – 53 XRF surface soil samples were collected from DUs adjacent to the wetlands
    - Settling Pond investigation – 25 XRF surface soil samples (including one location just west of the pond) were collected from DUs within or adjacent to the pond
    - Southern side of tailings pile investigation – 65 XRF surface soil samples were collected from DUs south of the tailings pile

      (Note: 30 of the Phase 2 XRF soil samples were analyzed for TAL metals through EPA's CLP.)
    - Groundwater leaching investigation
        - One transect (A to A') was placed across source areas, and two transects (B to B' and C to C') intersect A to A' in the mine tailings pile and the overland flow route (see Figure 3).
        - A total of 15 borings were advanced with samples collected at three intervals below the tailings for a total 71 soil samples.
        - Each sample was analyzed for TAL metals and SPLP through EPA's CLP to determine the leachability of the chemicals of concern.
    - Ecological assessment – a habitat evaluation was performed.

All analytical results from RI Phases I and II will be evaluated in accordance with EPA's *Guidance for Data Usability in Risk Assessment (Part A) Final* (EPA 1992) to determine whether the data may be used in a quantitative risk assessment. The evaluation process will be documented as part of the HHRA. (Note: XRF data will be compared with samples sent to the CLP laboratory to develop correlation factors. XRF data that have been adjusted using the correlation factor will be used quantitatively in the risk assessment).

Medium-specific COPCs will be selected following the process described in EPA's RAGS (EPA 1989). The first step is to identify all chemicals positively detected in at least one sample, including (1) chemicals with no data qualifiers, and (2) chemicals with data qualifiers indicating known identities but estimated concentrations (for example, J-qualified data). As discussed in RAGS, this initial list of chemicals may be reduced based on the following factors:

- Evaluation of detection frequency. (Chemicals detected in less than 5 percent of samples and not potentially site-related will not be retained as COPCs.) (Note: before any chemical is eliminated based on frequency of detection, the presence of any areas of elevated concentrations [such as site-related areas with elevated contaminant levels] will be evaluated).

- Evaluation of essential nutrients
- Use of a concentration-toxicity screen (the most conservative [lowest]) of chemical-, receptor-, and medium-specific levels for each medium:

    - **Soil:** EPA Regional Screening Levels (RSL) (EPA 2014a) for residential soil and Illinois EPA's "Tiered Approach to Corrective Action Objectives" (TACO) Tier 1 residential soil remediation objectives (RO) (IPCB 2013b). The RSLs based on a target risk of 1E-06 and a target hazard quotient [HQ] of 0.1 will be used for selecting COPCs. Illinois EPA's non-TACO objectives will be used as a surrogate for constituents without TACO Tier 1 residential soil ROs (IPCB 2013b).

    - **Sediment:** Sediment screening values for the protection of human health are generally not available. Therefore, sediment screening values will be selected as described above for soil. Several exposure assumptions used in development of soil-based criteria are not likely relevant to this exposure medium because exposure to sediment is likely to be less intense and less frequent than exposure to soil. Thus, this screening for sediment is conservative.

Surface Water: Total and dissolved surface water data will be screened against the minimum of Illinois Water Quality Standards (IWQS) based on general use and the protection of human health (IPCB 2013a); Illinois Derived Water Quality Criteria (IWQC) for human health (IPCB 2013a); and National Water Quality Standards (NWQS) (EPA 2014b). If surface water-specific values are not identified from these sources for a given constituent, surface water results will be screened against tapwater RSLs (EPA 2015a) (based on a target risk of 1E-06 and a target HQ of 0.1).After these factors have been considered, chemicals with maximum detected concentrations exceeding screening levels or for which screening levels are not available will be retained as medium-specific COPCs. One-half of the maximum detection limit (DL) of constituents not detected in a given medium will be compared with the appropriate screening level to ensure that elevated DLs do not result in inappropriate exclusion of chemicals from further evaluation. The results of these comparisons may result in inclusion of a nondetected chemical as a COPC or a discussion of the potential impact of excluding such a chemical as part of the uncertainty discussion.

As described in EPA's RAGS, background screening was a secondary step in the COPC selection process (EPA 1989). However, based on more recent EPA guidance, background screening will not be considered in selecting COPCs for the Bautsch-Gray Site (EPA 2002a). Medium-specific chemical concentrations in soil, surface water, and sediment and associated risks and hazards measured on site and downgradient of the site will be compared with chemical concentrations and associated risks and hazards from background locations as part of the uncertainty assessment.

2.2 EXPOSURE ASSESSMENT

The exposure assessment presents the methods used to estimate the types and magnitudes of potential human exposure to COPCs in various media. EPA's RAGS defines exposure as human contact with a chemical or physical agent. The exposure assessment consists of three fundamental steps: (1) exposure setting characterization (including characterizing the site and potential receptors), (2) exposure pathway identification through a conceptual site model (CSM), and (3) exposure quantification. Each of these steps is briefly discussed below.

2.2.1 Exposure Setting Characterization

The exposure setting consists of the physical setting (including natural and man-made features), land uses, and the populations living near the site. This information forms the foundation for selecting potential receptors, exposure pathways, and exposure parameters (for example, how often a receptor may visit the site). The Bautsch-Gray Mine site is approximately 5 miles south of Galena, Illinois, on Blackjack Road (Figure 1). The site includes three principal sources: (1) an estimated 40 acres of mine tailings pile, (2) a horseshoe-shaped settling pond west of the mine tailings pile, and (3) contaminated soil along the overland flow route from the settling pond to Smallpox Creek (see Figure 2). These source areas were identified by EPA during the Hazard Ranking System (HRS) process for the Bautsch-Gray Mine site. All three source areas contain elevated levels of arsenic, cadmium, copper, lead, and zinc. The site is surrounded by forested area, residential property, intermittent agricultural fields, wetlands, and Smallpox Creek (see Figure 2). Contamination from the Bautsch-Gray Mine site is known to have affected a wetlands northwest of the site, a residential drinking-water well, and Smallpox Creek.

Consistent with the RI and for the HHRA, the Bautsch-Gray Site will be divided into six exposure areas (EA) for the purposes of evaluating potential soil exposures (see Figure 3):

- EA1 – Tailings Pile Collar Area (DUs surrounding the Mine Tailings Pile)
- EA2 – DUs along Remediated Residential Area and Remediated Settling Pond
- EA3 – Wetlands Perimeter
- EA4 – Northern Mining Road. (Note: samples along the Northern Mining Road were initially thought to represent background locations. However, these samples showed elevated metals concentrations, the result, apparently, of fugitive emissions from trucks transporting tailings. As a result, these sample locations were reclassified as part of EA4, although the sample identifier retains the original "BKG" or background designation.)
- EA5 – Overland Flow Route
    - EA5A – More concentrated central area

- EA5B – Less concentrated peripheral areas

- EA6 – Soil Adjacent to Smallpox Creek

In addition, potential surface water and sediment exposures will be evaluated for (1) Smallpox Creek and (2) the wetlands. The risk assessment will divide Smallpox Creek (SMPC) into four EAs (see Figure 5):

- SMPC1 – South of N. Rocky Hill Road to the north end of wetlands
- SMPC2 – Along the wetlands
- SMPC3 – South of the wetlands
- SMPC4 – South of the Overland Flow Route

Finally, as noted in Section 2.1, exposures and associated risks and hazards will be characterized at soil background locations in Jo Davies County within about 6.5 miles of the Bautsch-Gray Site (see Figure 4) and at surface water and sediment background locations in Smallpox Creek, upstream of the site (see SPMC 5 in Figure 5).

2.2.2 Exposure Pathway Identification

Exposure pathways to be considered in the HHRA will be identified through a human health CSM. The CSM links potential or actual contaminant releases to potential human exposures. Specifically, the CSM identifies (1) potential contaminant sources and mechanisms of release, (2) potential receptors and exposure pathways, and (3) exposure scenarios. Figure 6 presents the human health CSM for the Bautsch-Gray Mine site).

Consistent with EPA's RAGS, the Bautsch-Gray Site HHRA will consider only complete (or potentially complete) exposure pathways. As described in RAGS, an exposure pathway generally consists of four elements: (1) a source and mechanism of chemical release, (2) a retention or transport medium (or media in cases involving media transfer of chemicals), (3) a point of potential human contact with the contaminated medium, and (4) an exposure route (for example, ingestion). Multiple different types of potentially exposed human receptors will be considered in the HHRA. Each of these receptors is summarized below:

- **Current and Future Trespassers** (adolescents and adults): Evidence of current trespassing at the site has been identified (including the presence of shotgun shells and all-terrain vehicle [ATV] tracks) and is expected to continue under future land use conditions. Therefore, potential exposure by trespassers will be evaluated under both current and future land use conditions at each of the EAs listed above.

- **Current and Future On- and Off-Site Recreationalists** (children, adolescents, and adults): Smallpox Creek is known to be used for recreational purposes including, primarily, fishing. Potential exposure to surface water, sediment, and surface soil from the creek bank will be evaluated for adolescent and adult recreationalists. However, fish caught from Smallpox Creek may be brought home and fed to children. Therefore, potential exposure via ingestion of fish will be evaluated for child, adolescent, and adult receptors.

- **Future Residents** (children and adults): Currently isolated residences are located in the general site vicinity. Under future land use conditions, it is assumed that residents will live in and be potentially exposed to soil at each of the EAs listed above (see Figure 3). While exposure to groundwater via potable use is potentially complete (one nearby resident uses a private well for potable water), no groundwater was detected near the tails pile up to a depth of approximately 10 feet bgs. Borings were not extended to greater depths based on the assumption that metals concentrations detected in deeper groundwater would be indistinguishable from regional groundwater altered by local ore deposits. That is, any impact of groundwater from metals leaching from the tailings pile could not be differentiated from the impact of groundwater impacted by metals leaching from subsurface ore deposits. Therefore, no groundwater samples were collected during the RI, and potential groundwater exposures will not be quantified in the HHRA.

- **Future Commercial/Industrial Workers** (adults only): Currently, no commercial/industrial operations are located near the site. However, under future land use conditions, it will be assumed that commercial/industrial workers will be located in and potentially exposed to soil at each of the EAs listed above (see Figure 3). Potential exposure to groundwater will not be quantified, as described above for future residents.

- **Future Construction Workers** (adults only): Under future land use conditions, potential exposure to soil by construction workers in each of the EAs listed above will be evaluated.

- **Future Utility Workers** (adults only): Under future land use conditions, potential on-site exposure to soil by utility workers in each of the EAs will be evaluated.

The primary exposure scenarios at the site are expected to involve exposures to chemicals in soil, surface water, sediment, and fish tissue. Receptor-specific exposure scenarios to be considered in the HHRA are identified in Figure 6 and summarized below:

- **Current and Future Trespassers**
    - Inhalation of fugitive emissions to ambient air from surface and subsurface (future only) soil.
    - Incidental ingestion of and dermal contact with surface and subsurface (future only) soil.

- **Current and Future Recreationalists**
    - Incidental ingestion of and dermal contact with surface water and sediment in Smallpox Creek and the wetlands (sediment only) and via incidental ingestion of, dermal contact with, and inhalation of fugitive dusts from surface soil along the creek bank.
    - Ingestion of fish (fillets only) caught from Smallpox Creek.

- **Future Residents**
  - Inhalation of fugitive emissions to ambient air from surface and subsurface soil.
  - Incidental ingestion of and dermal contact with surface and subsurface soil.
  - Ingestion of homegrown produce raised in surface and subsurface soil.
  - Potential exposure via ingestion of and dermal contact with groundwater associated with potable groundwater use will not be quantified as described above.
- **Future Commercial/Industrial Worker**
  - Inhalation of fugitive emissions to ambient air from surface and subsurface soil.
  - Incidental ingestion of and dermal contact with surface and subsurface soil.
  - Potential exposure via ingestion of groundwater associated with potable groundwater use will not be quantified, as described above.
- **Future Construction Workers**
  - Incidental ingestion of, dermal contact with, and inhalation of fugitive emissions from subsurface soil (0 to 10 feet below ground surface [bgs]). No groundwater was detected up to approximately 10 feet bgs. Deeper groundwater samples were not collected, as described above.
- **Future Utility Workers**
  - Incidental ingestion of, dermal contact with, and inhalation of fugitive emissions from subsurface soil (0 to 10 feet bgs). No groundwater was detected up to approximately 10 feet bgs. Deeper groundwater samples were not collected, as described above.

2.2.3 Exposure Quantification

Receptor-specific exposures will be quantified using standard exposure dose equations that consider a variety of parameters including medium-specific COPC concentration (referred to as the exposure point concentration [EPC]), contact rate, the frequency and duration of exposure, and receptor-specific body weight. Consistent with EPA guidance, exposures will be quantified under both reasonable maximum exposure (RME) conditions (the maximum exposure reasonably assumed to occur) and central tendency exposure (CTE) conditions (the typical or average exposure).

Exposure parameters are based on standard default values or recommendations (not available for all receptors) as modified based on site-specific conditions. RAGS D Table 4s, which lists draft receptor-specific exposure factors, will be submitted under separate cover.

2.2.3.1 Exposure Point Concentrations

Medium-specific EPCs (with the exception of groundwater – see below) will be selected for most receptors as the lesser of the 95 percent upper confidence limit (UCL) of the mean and the maximum detected concentration at each exposure point. EPCs will be calculated as the 95 percent UCL on the mean for each exposure area using EPA's ProUCL Version 5.0.00 statistical software package (EPA 2013). The EPC will generally be selected as the 95 percent UCL of the statistical method recommended by ProUCL. However, following EPA guidance (2002b, 2013), this value may be estimated by either a 95, 97.5, or 99 percent UCL, depending on the sample size, skewness, and degree of censorship. Statistical treatment will not be conducted for constituents with fewer than four detected results in a minimum data set of 10 samples. In this circumstance, the maximum detected concentration will be used as the EPC. EPCs for construction workers will also be based on maximum detected concentrations at each exposure area consistent with EPA and Illinois EPA guidance (EPA 2002b, IPCB 2013).

2.2.3.2 Exposure Modeling

In addition to quantifying exposures based on direct medium measurements, the Bautsch-Gray Mine site HHRA will also model the concentrations of COPCs in soil that are taken up into homegrown produce. Generally, the uptake of COPCs from soil into produce will be modeled in a manner consistent with EPA guidance (EPA 2005c).

2.2.3.3 Intake Calculation Algorithms

EPA-derived algorithms will be used to calculate chronic daily intakes for each exposure route. The generic equations for calculating chemical intake are provided below (EPA 1989, 2009a):

$$I\ (\text{oral or dermal}) = \frac{C \times CR \times RBA \times EF \times ED}{BW \times AT}$$

$$I\ (\text{inhalation}) = \frac{C \times ET \times EF \times ED}{AT}$$

Where:

I = Intake: the amount of chemical at the exchange boundary from oral or dermal exposure (milligrams per kilogram [mg/kg]-day for oral and dermal exposure; milligrams per cubic meter [mg/m^3] for inhalation exposure)

C = Chemical concentration within the exposure medium: the EPC (for example, mg/kg for soil)

CR = Contact rate: the amount of contaminated medium contacted orally or dermally per unit of time or event; may be the ingestion rate or dermal contact rate (for example, milligrams per day [mg/day] for the ingestion rate of soil). The contact rate is not applicable to inhalation exposures.

RBA = Relative bioavailability (unitless); RBA is applicable only for ingestion exposures.

ET = Exposure time: number of hours of exposure (hours per day [hr/day]); exposure time is applicable only to inhalation exposures.

EF = Exposure frequency: how often the exposure occurs (days per year)

ED = Exposure duration: the number of years a receptor comes in contact with the contaminated medium (years)

BW = Body weight: the average body weight of the receptor over the exposure period (kilograms); applicable only to oral and dermal exposures

AT = Averaging time: the period over which exposure is averaged (days for oral and dermal exposures; hours for inhalation exposures).

For carcinogens, the averaging time is 25,550 days (oral and dermal exposures) and 613,200 hours (inhalation exposures) on the basis of a lifetime exposure of 70 years, which represents the average life expectancy.

For noncarcinogens, the averaging time is the exposure duration expressed in days (ED x 365 days/year) for oral and dermal exposures and in hours (ED x 365 days/year x 24 hr/day) for inhalation exposures.

Pathway-specific variations of the generic equations above will be used to calculate intakes of COPCs. The proposed receptor-specific exposure parameters used in variations of these equations will be presented in RAGS D Table 4s (to be submitted under separate cover).

One parameter in particular, RBA, warrants discussion at this point. Surface soil samples (0 to 6 inches bgs) were collected from various EAs at the site and analyzed for arsenic and lead RBA. Only a single outlier was found in the arsenic RBA data set (see Attachment A). This outlier (37 percent) was removed prior to performing summary statistics (see Attachment A). No outliers were found in the lead RBA data set. The results of these RBA samples are summarized below.

- Arsenic (n = 13; n = 12 after outlier removed)
  - RBA ranges from 22 to 28 (37 percent removed as outlier)
  - Mean RBA = 25 percent (mean RBA increases to 26 percent if outlier considered)

- Lead (n = 15)
  - RBA ranges from 26 to 83 percent

- Mean RBA = 56.4 percent

The default EPA-recommended RBA value for both arsenic (EPA 2012) and lead (EPA 2009b, 2009c) is 60 percent. As summarized above, the site-specific RBA for arsenic is less than one-half of its default value, while the site-specific lead RBA is about equal to its default value. The site-specific RBA results for arsenic suggest that arsenic may be less bioavailable at the site as compared with the national default value. However, to be health-protective, it is proposed that the default arsenic and lead RBA value of 60 percent be used in all receptor-specific soil ingestion exposure estimates. The impact of using the default RBA values, rather than the site-specific arsenic and lead RBA values, will be discussed in the uncertainty evaluation in the HHRA.

In addition, EPA guidance regarding evaluation of risk from early-life exposure to carcinogens recommends a different approach to estimating chemical intake for carcinogenic chemicals with a mutagenic mode of action (EPA 2005a). This guidance will be incorporated and used to modify the above equations, consistent with EPA's RSL User's Guide (EPA 2014a).

2.3 TOXICITY ASSESSMENT

The toxicity assessment identifies the toxicity factors that will be used to quantify potential adverse effects (including both carcinogenic and noncarcinogenic effects) on human health associated with potential exposure to site-specific COPCs. COPC-specific toxicity factors will be identified from EPA's RSL tables (EPA 2015a), which list toxicity values selected in accordance with EPA's revised recommended toxicity value hierarchy (EPA 2003a), summarized below.

- Tier 1 – EPA's Integrated Risk Information System (IRIS) (EPA 2015b)
- Tier 2 – EPA's provisional peer-reviewed toxicity values (PPRTV)
- Tier 3 – Other EPA and non-EPA sources of toxicity information, including, but not limited to, (1) the California Environmental Protection Agency (Cal/EPA) toxicity values, (2) the Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk levels (MRL), and EPA's Health Effects Assessment Summary Tables (HEAST).

Chronic noncarcinogenic toxicity factors will be used for all receptors.

2.4 RISK CHARACTERIZATION

Risk characterization combines the exposure estimates calculated in the exposure assessment with the toxicity factors identified in the toxicity assessment to calculate COPC-, exposure pathway-, and receptor-specific carcinogenic risks (risks) and noncarcinogenic hazards (hazards). Risks and hazards will be calculated following standardized methods described in EPA's RAGS (EPA 1989) and summarized below.

2.4.1 Characterization of Cancer Risk

Risks associated with exposure to chemicals classified as carcinogens are estimated as the incremental probability that an individual will develop cancer over a lifetime as a direct result of an exposure (EPA 1989). The estimated risk is expressed as a unitless probability.

Three steps are used in estimating cancer risks for chemicals classified as carcinogens. First, the chemical intake is multiplied by the chemical-specific slope factor (SF) (oral and dermal exposure) or the chemical-specific inhalation unit risk (IUR) (inhalation exposure) to derive a cancer risk estimate for a single chemical and pathway. The calculation is based on the following relationship:

- Chemical-Specific Cancer Risk (oral or dermal) = Intake (mg/kg-day) x SF $(mg/kg\text{-}day)^{-1}$
- Chemical-Specific Cancer Risk (inhalation) = Intake (mg/m^3) x 10^3 (µg/mg) x IUR $(\mu g/m^3)^{-1}$

Notes:
mg/m^3 = Milligrams per cubic meter
µg = Micrograms
kg = Kilograms
mg = Milligram

Second, the individual chemical cancer risks are added to estimate the cancer risk associated with exposure to multiple carcinogens for a single exposure pathway, as follows:

- Pathway-Specific Cancer Risk = ∑ Chemical-Specific Cancer Risk

Third, pathway-specific risks are summed to estimate the total cancer risk for each receptor.

2.4.2 Hazard

The potential for exposure that may result in adverse health effects other than cancer is evaluated by comparing the intake with a reference dose (RfD) (oral and dermal exposure) and with a reference concentration (RfC) (inhalation exposure) of each chemical not classified as a carcinogen, and of each carcinogen known to cause adverse health effects other than cancer. When calculated for a single chemical, the comparison yields a ratio termed the hazard quotient (HQ):

HQ (oral or dermal) = Intake (mg/kg-day)

$$\text{RfD (mg/kg-day)}$$

$$\text{HQ (inhalation)} = \frac{\text{Intake (mg/m}^3\text{)}}{\text{RfC (mg/m}^3\text{)}}$$

The HQs for all chemicals are summed to evaluate the potential for adverse health effects other than cancer from concurrent exposures to multiple chemicals, yielding a hazard index (HI) as follows:

$$\text{HI} = \sum \text{HQ}$$

Pathway-specific HIs are then summed to estimate a total HI for each receptor. An HI less than 1 indicates that adverse noncancer health effects are not expected. If the total HI exceeds 1, further evaluation in the form of a segregation of the HI via a target organ analysis may be performed to assess whether the noncancer HIs are a concern (EPA 1989). Target organ HIs greater than 1 may indicate a potential adverse effect. However, a target organ analysis will not be conducted in cases where the total HI exceeds 1 and the HQ for an individual COPC also exceeds 1 because the HQ results for the individual COPC already indicate that concern may be warranted.

2.4.3 Lead

Consistent with the sources of screening values to be used in the HHRA (see Section 2.1), potential risks from exposure to lead in soil by child and adult residents and adult commercial/industrial workers will be characterized by comparing the average concentration of lead in soil at each EA with the EPA RSLs (EPA 2015a). Specifically, risks to residential receptors will be characterized by comparing the average lead concentration in soil with the residential soil RSL of 400 mg/kg, which was calculated using the Integrated Exposure Uptake Biokinetic (IEUBK) model and default assumptions (EPA 2009b). Similarly, potential risks from exposure to lead in soil by adult commercial/industrial workers will be characterized by comparing the average lead concentration in soil with the industrial soil RSL of 800 mg/kg, which was calculated using the Adult Lead Model (ALM) (EPA 2009c, d).

Potential risks from exposure to lead in soil by trespassers, recreationalists, construction workers, and utility workers will be characterized by comparing the average concentration of lead in soil at each EA with receptor-specific screening levels calculated using the most recent version of EPA’s IEUBK model (EPA 2009b) (child recreationalists only) and ALM (2009c,d), dated June 21, 2009. The ALM is designed to ensure protection of a fetus from exposure to unacceptable blood lead levels in its mother.

2.5 UNCERTAINTY ASSESSMENT

The risks and hazards calculated as part of the Bautsch-Gray Mine site HHRA are subject to various degrees of uncertainty from a variety of sources associated with all the major phases of the HHRA process. The uncertainty assessment will identify and discuss the nature of the uncertainty (including direction [overestimation or underestimation] and magnitude) associated with the most significant sources of site-specific uncertainty (including particular assumptions and data limitations).

Furthermore, as discussed in Section 2.1, chemical concentrations in soil, surface water, sediment, and groundwater (and associated risks and hazards) measured on site and downgradient of the site will be compared with chemical concentrations (and associated risks and hazards) from background locations. These comparisons will be designed to inform risk managers regarding context for interpreting site-related exposures, risks, and hazards.

3.0 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

The primary objective of the SLERA is to address the contaminant identification, exposure assessment, toxicity assessment, and ecological risk characterization for the site.

SulTRAC will prepare the SLERA consistent with EPA guidance. The major guidance documents to be used in preparing the ERA will include the following:

1. EPA. 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (ERAGS). Interim Final. OSWER. EPA-540-R-97-006. OSWER 9285.7-25.
2. EPA. 1993. *Wildlife Exposure Factors Handbook*. ORD. EPA/600/R-93/187. Washington, D.C.
3. EPA. 1998. “Guidelines for Ecological Risk Assessment.” OSWER. EPA/630/R095-002F. April.
4. EPA. 1999. “Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.” Peer Review Draft. OSWER. EPA530-D-99-001. Washington, D.C.
5. EPA. 2013. “ProUCL Version 5.0.00 User Guide, Statistical Software for Environmental Applications for Data Sets With and Without Nondetect Observations.” ORD Site Characterization and Monitoring Technical Support Center (SCDMTSC). EPA/600/R-07/041. September.

SulTRAC will follow the basic protocols outlined in EPA’s Ecological Risk Assessment Guidance for Superfund (ERAGS) (EPA 1997) to evaluate potential risks to ecological communities. These steps are defined by three overall phases — problem formulation, analysis, and risk characterization — for ecological risk assessments. EPA defines these phases in an eight-step process. The first two steps constitute a SLERA, and the final six steps constitute a baseline ecological risk assessment (BERA). Presently, SulTRAC assumes that only a SLERA will be required for the site. Based on the results of the SLERA, SulTRAC will recommend and discuss with EPA the need for preparation of a full BERA.

3.1 SITE HABITATS

During NovemberJuly 2014, SulTRAC conducted a habitat evaluation of the Bautsch-Gray Mine site to gather data necessary to identify potential ecological receptors and develop a CSM for the ecological risk assessment (ERA) to be conducted for the site. Specifically, SulTRAC evaluated the following parameters: (1) water features and wetlands, (2) habitat types, (3) sensitive environments, (4) soils and land use, and (5) wildlife species.

3.1.1 General Site Ecological Information

The site is located in the Wisconsin Driftless Division ecoregion of Illinois. The Wisconsin Driftless Division is characterized by rugged terrain and high topographic relief. The area is composed mainly of hardwood forests with smaller areas of farmland and prairie. Black oak and white oak dominate well-drained soils. Mesic sites host sugar maple, basswood, and red oak. Wet soils of the floodplain support silver maple, American elm, and green ash. Cool, shaded cliffs consist predominantly of white pine, Canada yew, and white birch. Dry prairie and loess-covered prairie found in the uplands are dominated by little bluestem and side-oats grama (Schwegman 1973).

3.1.2 Water Features and Wetlands

In November 2014, SulTRAC conducted a habitat evaluation of the Bautsch-Gray Mine site to gather data necessary to identify potential ecological receptors and develop a CSM for the ERA. SulTRAC examined aerial photography to identify water features and wetlands in the project area. The main water feature in the project area is Smallpox Creek, which is north and west of the site. Blackjack Road bisects the site and crosses Smallpox Creek just north of the site. East of Blackjack Road and northwest of the tailings pile, Smallpox Creek is surrounded by agricultural fields on both banks with little to no riparian area. South of the agricultural fields is a potential wetland area. Smallpox Creek is surrounded by potential wetlands west of Blackjack Road and northwest of the tailings pile. West of the tailings pile is a horseshoe-shaped settling pond (SulTRAC 2014).

There was significant variance in the quality of habitat observed in Smallpox Creek. The stream displayed a large degree of bank erosion and downcutting through much of the area observed by SulTRAC. Areas with the lowest habitat quality were characterized by eroded banks and tended to occur in glide areas, where the stream displayed a lack of stream characteristics such as riffles, bends, and pools. In these areas, stream bed material was composed primarily of silt and mud, and there was a lack of attractive habitat features. The highest-quality habitat areas within the stream were observed directly west of the northern boundary of the tailings pile, directly downstream of a large logjam. In this area, the stream displayed characteristic stream features, including riffles, runs, and pools, with stream features spaced approximately every 5 to 7 bankfull widths. Erosion was less prevalent in these areas, and there was a large amount of attractive habitat features, including rootballs, branches, and patches of underwater vegetation. Bed material in these areas was composed primarily of fine gravel in riffles and runs, with silt prevalent in bends and pools. There was a high degree of shading of the stream throughout the area observed by SulTRAC, both by terrestrial vegetation and geological features. This shading likely provides some value as a habitat feature, but also prevents growth of aquatic vegetation.

The habitat evaluation occurred outside of the growing season, so it did not include wetland delineation of these areas. Vegetation was identified to the extent possible, and soils were not evaluated as part of the habitat evaluation. SulTRAC checked the National Wetland Inventory (NWI) database to identify potential wetlands at the Bautsch-Gray Mine site (U.S. Fish and Wildlife Service [USFWS] 2010 and 2014a). The NWI database identifies two freshwater ponds and a freshwater emergent wetland area (see Figure 7).

The freshwater pond at the northern boundary of the site is identified as Palustrine, Unconsolidated Bottom, intermittently exposed, and diked/impounded (PUBGh). The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergent vegetation, mosses, or lichens. The Unconsolidated Bottom class includes all wetlands with at least 25 percent cover of particles smaller than stones (less than 6 to 7 centimeters) and a vegetative cover less than 30 percent. Surface water is present throughout the year, except in years of extreme drought. The wetlands have been created or modified by a man-made barrier or dam that obstructs the inflow or outflow of water. The settling pond west of the tailings pile is identified as Palustrine, Unconsolidated Bottom, semipermanently flooded, and diked/impounded (PUBFh). The description is the same as the previous freshwater pond, except for the water regime. Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface (Cowardin and others 1979).

The freshwater emergent wetland is identified as a Palustrine, Emergent, seasonally flooded area (PEMC). The Palustrine System is as defined above. The Emergent class is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present during most of the growing season in most years. These wetlands are typically dominated by perennial plants. The water regime floods seasonally, indicating the presence of surface water for extended periods, especially early in the growing season but absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface (Cowardin and others 1979).

The freshwater pond area at the northern boundary of the site and wetland areas along Smallpox Creek were dominated by common reed (*Phragmites australis*) and cattails (*Typha* sp.). The settling pond area was dominated by unknown grasses. The southern end of the site includes a portion of bottomland forest that has received overland flow from the settling pond during storm events (SulTRAC 2014).

3.1.3 Habitat Types

SulTRAC identified the following 10 different habitat types shown on Figure 8: (1) tailings pile, disturbed – no vegetation, (2) settling pond, (3) overland flow area, (4) eastern bottomland forest, (5) western bottomland forest, (6) wetland, (7) disturbed woodland-grassland, (8) upper ridge, (9) downstream Smallpox Creek and surrounding area to Mississippi River, and (10) Mississippi River backwaters. A brief description of each habitat type is as follows:

1. The tailings pile is highly disturbed and contains only bare ground. No soil or organic matter is present to support vegetation. Thus, this area has little habitat value.

2. The settling pond shows evidence that it retains water during a portion of the growing season, but the area was dry during the site visit. The area consists primarily of unknown grasses. (Note: as part of remedial efforts at the settling pond, Hard Red Winter wheat seed was initially put down followed by "Special blend" and "Unigrass forage mix" [Weston 2013]).

3. The overland flow area occurs southwest of the settling pond. The habitat consists primarily of unknown grasses and few trees.

4. The eastern bottomland forest extends south of the settling pond and east of the overland flow area to the ridge. This habitat consists of a relatively narrow band of forest, and the habitat is similar to the western bottomland forest.

5. The western bottomland forest extends west and southwest of the settling pond, with Smallpox Creek running adjacent to the habitat. The forest includes a mixture of tree, shrub, and herbaceous species. Most species could not be identified but include eastern cottonwood (*Populus deltoides*), American basswood (*Tilia americana*), eastern black walnut (*Juglans nigra*), silver maple (*Acer saccharinum*), and several unknown shrubs, herbaceous plants, and grasses.

6. A large wetland is present east of Smallpox Creek. The wetland area is bisected by Blackjack Road. On both sides of the road, the wetland is dominated by common reed and cattails with no observed areas of open water.

7. The disturbed woodland-grassland habitat is located north of the tailings pond and east of the wetland area. Steep slopes are present from the wetland to the woodland-grassland but contain several trees, shrubs, and herbaceous plants. Most species could not be identified but include white ash (*Fraxinus americana*), garlic mustard (*Alliaria petiolata*), and Carolina horsenettle (*Solanum carolinense*), as well as several unknown shrubs and herbaceous plants. While some disturbed woodland-grassland areas were mowed, other areas support a mixture of woody and herbaceous species. Species include birch (*Betula* sp.), eastern cottonwood (*Populus deltoides*), eastern red cedar (*Juniperus virginiana*), goldenrod (*Solidago* sp.), Queen Anne's lace (*Daucus carota*), and several unknown plants and grasses.

8. The upper ridge habitat consists of a fairly steep-sloped area leading from the western and eastern bottomland forest to agricultural fields located at the top of the ridge. Species are similar in composition to the bottomland forested habitat and include a mixture of trees with some shrubs, and herbaceous species.

9. The downstream Smallpox Creek includes the portion of Smallpox Creek southwest of the overland flow area to the Mississippi River backwaters. This portion of Smallpox Creek is similar to the portion of the creek east of Blackjack Road in western bottomland forest. The surrounding habitat is currently farmed with little to no riparian area between the agricultural fields and the creek.

10. The Mississippi River backwaters area is located near the Mississippi River mile marker 562 and includes Stone Slough and Wise Lake, which are located within Pool 12 of the Upper Mississippi River. Pool 12 is part of the Upper Mississippi River National Wildlife and Fish Refuge and still has much of the natural river floodplain. Islands, side channels, and backwaters occur throughout Pool 12. Major fish species include bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), crappie (*Pomoxis* sp.), freshwater drum (*Aplodinotus grunniens*), largemouth bass (*Micropterus salmoides*), sauger (*Sander canadensis*), walleye (*Sander vitreus*), and white bass (*Morone chrysops*) (Iowa DNR 2014a).

3.1.4 Sensitive Environments

The Mississippi River Backwaters qualify as a sensitive environment according to the HRS because of its status as an Illinois Natural Areas Inventory (INAI) site. The forested area surrounding Smallpox Creek qualifies as a sensitive environment because of its potential habitat for federally endangered species including the Indiana bat (*Myotis sodalis*) and federally proposed as endangered northern long-eared bat (*Myotis septentrionalis*). Both species reside in forested areas underneath tree bark. The freshwater wetland area on the site also qualifies as a sensitive environment because of its potential habitat for the federally threatened eastern prairie fringed orchid (*Platanthera leucophaea*). This plant grows in a variety of habitats, but is often found in sunny wetland areas.

3.1.5 Soils and Land Use

The U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS) identifies nine different soil types within the site (Figure 9) (USDA NRCS 2014). Approximately 32 percent of the site is occupied by soils classified as mine dumps, which has been also identified as the mine tailings pile. Generally, the soil east and to the north of the mine tailings pile is classified as Fayette silt loam and occupies about 21 percent of the site. The Fayette series consists of well-drained soils formed in loess (USDA NRCS 2014). The soil making up the western portion of the site adjacent to Smallpox Creek is classified as Wakeland silt loam and Medary silty clay loam. The Wakeland series occupies about 12 percent of the site and consists of somewhat poorly drained soils formed in silty alluvium (USDA NRCS 2014). The Medary series occupies about 15 percent of the site and consists of moderately well drained soils with slow permeability (USDA NRCS 2014). Seaton silt loam, Zwingle silt loam, Birds silt loam, Dorchester silt loam, and Niota silt loam also occupy small portions of the site.

The majority of the area directly surrounding the tailings pile is currently agricultural fields separated by small wooded areas.

3.1.6 Wildlife Species

SulTRAC also documented wildlife species during the habitat evaluation, including direct visual observations or other evidence such as tracks or scat. SulTRAC observed mammals including white-tailed deer (*Odocoileus virginianus*) and eastern cottontail (*Sylvilagus floridanus*). SulTRAC also observed the scat of a canine predator, likely coyote (*Canis latrans*) or red or gray fox. SulTRAC also observed and heard several birds but could not identify each species. Birds that SulTRAC did identify include great blue heron (*Ardea herodias*), wild turkey (*Meleagris ocellata*), red-winged blackbird (*Agelaius phoeniceus*), black-capped chickadee (*Poecile atricapillus*), red-breasted nuthatch (*Sitta canadensis*), bluejay (*Cyanocitta cristata*), and several species of birds that could not be identified. In addition, SulTRAC heard and attempted to locate a woodpecker but was not able to identify the species.

SulTRAC also observed numerous aquatic or semi-aquatic species during fish sampling in Smallpox Creek. Fish species captured and identified in Smallpox Creek include bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), common shiner (*Luxilus cornutus*), common stoneroller (*Campostoma anomalum*), creek chub (*Semotilus atromaculatus*), johnny darter (*Etheostoma nigrum*), rainbow darter (*Etheostoma caeruleum*), northern pike (*Esox lucius*), white sucker (*Catostomus commersonii*), and yellow perch (*Perca flavescens*). SulTRAC also observed numerous northern leopard frogs (*Rana pipiens*) both within and adjacent to the creek.

3.1.7 Threatened and Endangered Species

As part of the habitat characterizations, lists of endangered or threatened species known to occur in Jo Daviess County were obtained from the USFWS (USFWS 2014b) and Illinois Department of Natural Resources (Illinois DNR) (Illinois DNR 2014a). Based on this review, it was determined that, at the countywide level of information, the list of state and federally listed threatened, endangered, potentially threatened, or species of concern that potentially occur in Jo Daviess County includes 37 plants and 24 animals that are identified on the state list (Illinois DNR 2014a) (Attachment B). The federal threatened and endangered species list for Jo Daviess County is provided in Table 3-1. The federal list identifies two plants, neither of which is included in the Illinois list, and four animals, one of which is not included in the Illinois list.

TABLE 3-1

FEDERAL THREATENED AND ENDANGERED SPECIES LIST FOR JO DAVIESS COUNTY, ILLINOIS (U.S. Fish and Wildlife Service 2014b)

Common Name	Scientific Name	Status
Eastern prairie fringed orchid	*Platanthera leucophaea*	Threatened
Prairie bush clover	*Lespedeza leptostachya*	Threatened
Indiana bat	*Myotis sodalis*	Endangered
Northern long-eared bat	*Myotis septentrionalis*	Proposed as Endangered
Higgins eye pearlymussel	*Lampsilis higginsi*	Endangered
Pleistocene snail	*Discus macclintocki*	Endangered

Of the 61 species identified on the state list, Illinois DNR (2014b) stated that only one, western sand darter (*Ammocrypta clarum*), potentially occurs at or near the site based on its known distribution and habitat preference. The western sand darter is most frequently found in large streams or rivers with slight to moderate current over a sandy bottom (Iowa DNR 2014b and Fuller and others 2014). Given the smaller size of Smallpox Creek, the presence of the western sand darter is not likely (See Table 3-2).

Table 3-2 also provides a summary of each federal threatened and endangered species and the potential for its presence at the site based on a review of available species-specific habitat requirements and habitats present at and adjacent to the site. The Eastern prairie fringed orchid (*Platanthera leucophaea*) is able to grow in a variety of habitats such as mesic prairie, meadows, bogs, and wetlands, preferring areas with full sun (USFWS 2014c). The large freshwater wetland present east of Smallpox Creek provides potential habitat for the eastern prairie fringed orchid. Prairie bush clover (*Lespedeza leptostachya*) is found in tallgrass prairies with gravelly soils (USFWS 2014d), and therefore is not expected to be found on the site, as the majority of the soil at the site is silt loam (USDA NRCS 2014).

The Indiana bat (*Myotis sodalis*) is most frequently found in small to medium river and stream corridors or wooded areas, roosting under the bark of dead or dying trees (USFWS 2014e). The northern long-eared bat (*Myotis septentrionalis*) prefers mature, interior forest environments, where it roosts underneath bark and in crevices of live and dead trees (USFWS 2014f). The area along Smallpox Creek west of the tailings pile is composed of relatively mature forest. The dead trees present serve as potential habitat for both the Indiana bat and the northern long-eared bat.

The Higgins eye pearlymussel (*Lampsilis higginsi*) lives in larger rivers in deep water with moderate current. This mussel is found only in the Mississippi River and three of its larger tributaries, and its presence near the site is not likely (USFWS 2014g). The Iowa Pleistocene snail (*Discus macclintocki*) is found only in algific talus slopes and therefore is not expected to be present at the site (USFWS 2014h).

TABLE 3-2

EVALUATION SUMMARY OF POTENTIAL PRESENCE OF STATE AND FEDERAL THREATENED AND ENDANGERED SPECIES

Special Status Species	Habitat	Source	Habitat Present in Study Area
State of Illinois Species			
Western sand darter (*Ammocrypta clarum*)	Medium to large-sized streams and rivers with moderate current	Iowa DNR 2014b	No
Federal Species			
Eastern prairie fringed orchid (*Platanthera leucophaea*)	Mesic prairies, meadows, bogs, wetlands	USFWS 2014c	Yes
Prairie bush clover (*Lespedeza leptostachya*)	Tallgrass prairies with gravelly soils	USFWS 2014d	No
Indiana bat (*Myotis sodalis*)	River and stream corridors, small wooded areas with dead or dying trees	USFWS 2014e	Yes
Northern long-eared bat (*Myotis septentrionalis*)	Mature, interior forest environments	USFWS 2014f	Yes
Higgins eye pearlymussel (*Lampsilis higginsi*)	Mississippi River and three of its larger tributaries	USFWS 2014g	No
Iowa Pleistocene snail (*Discus macclintocki*)	Algific talus slopes	USFWS 2014h	No

3.2 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

The SLERA will be conducted consistent with EPA ERAGS for Superfund sites (EPA 1997). Two steps are involved in conducting a SLERA: (1) problem formulation, and (2) screening level exposure estimate and risk calculation.

After Steps 1 and 2 have been completed, the site must be evaluated for one of the three possible decisions summarized below.

1. There is enough information to conclude that potential ecological risks are very low or nonexistent and therefore no further action is warranted at the site on the basis of ecological risk.

2. The information is not adequate to make a decision at this point, and the ERA process will proceed to a BERA (Steps 3 through 8).

3. The information indicates a potential for adverse ecological effects, and a more thorough study is necessary (a BERA).

The following sections discuss problem formulation and screening-level exposure estimates and risk calculations for the SLERA.

3.2.1 Problem Formulation

The objective of the problem formulation step is to collect sufficient information concerning the Bautsch-Gray Mine site to develop a CSM. The CSM will include a fate and transport diagram that traces the movement of contaminants through the ecosystem and identifies potential exposure pathways and receptors. One of the major goals of the CSM is to identify complete exposure pathways and receptors at potential risk. As noted in Section 1.0, previously collected information on the environmental setting has led to identification of the Bautsch-Gray Mine site's sources of contamination and preliminary characterization of the ecological habitats. The site has been divided into exposure areas on the basis of habitat cover type, current land use, and anticipated future development. As shown in Figure 8, exposure areas and their dominant habitat types are as follows:

- Mine Tailings Pile Area (disturbed – little or no vegetation)
- Settling Pond
- Overland Flow Route – Grassland Area
- East Bottomland Forest Area -Deciduous/Riparian
- West Bottomland Forest Area - Deciduous/Riparian
- Wetland
- Disturbed Woodland-Grassland
- Upper Ridge - Grassland Area
- Smallpox Creek - Riverine Area
- Mississippi River Backwater Area

Contaminants of potential ecological concern (COPEC) at the Bautsch-Gray Mine Site were identified based on historical operations and previous investigations. The data collected during the RI Phase I provide a general understanding of contaminants present in the various media and concentration levels. Additional data were collected during Phase II to fill the data gaps identified after the Phase I data were evaluated. The major COPECs currently identified include metals (arsenic, cadmium, copper, lead, mercury, and zinc). All the available data will be reviewed to identify all contaminants detected and to identify definitive COPECs for the SLERA.

The soils are the major contaminated media identified at the terrestrial portions of the site. Surface water and sediment are the focus of the various habitats associated with Smallpox Creek. The samples associated with the wetlands will be evaluated both as soils for the terrestrial receptors and as sediments for benthic receptors within the wetland.

During the ecological habitat evaluation, a variety of receptors were observed at the Bautsch-Gray Mine site, and other receptors, although not observed directly, are likely present. This information has been used to develop a preliminary CSM for the ERA (Figure 10). The CSM notes a number of complete exposure pathways for terrestrial receptors, including plants, invertebrates, birds, and mammals in the terrestrial portions of the Bautsch-Gray Mine site, and benthic invertebrates, fish, reptiles, amphibians, birds, and mammals associated with the surface water and sediment in Smallpox Creek.

Endpoints for a screening level assessment are any adverse effects on ecological receptors. The focus will be on plant, invertebrate, avian, and mammalian receptors for the terrestrial portions of the Bautsch-Gray Mine site (Mine Tailing Pile, Overland Flow Route – Grassland Area, East Bottomland Forest Area -Deciduous/Riparian, West Bottomland Forest Area - Deciduous/Riparian, Wetland Area, Disturbed Woodland-Grassland, and Upper Ridge - Grassland Area. The focus for the aquatic habitat portions of the site (Smallpox Creek, the Mississippi River Backwater Area, and Wetland Area) will be on benthic, aquatic (fish), and upper-trophic level, semi-aquatic avian, and mammalian receptors. The general ecological management goal that will guide selection of assessment endpoints is summarized below:

> *Ensure adequate protection of ecological systems within the impacted areas of the Bautsch-Gray Mine site by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs.*

The specific assessment endpoints for the SLERA are summarized below:

- Ensure adequate protection of terrestrial plant and soil communities and wetland communities, including native plant communities, by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs.

- Ensure adequate protection of mammal and bird populations by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs.

- Ensure adequate protection of threatened and endangered species (including candidate species) and species of special concern and their habitats by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs.

- Ensure adequate protection of the aquatic communities in Smallpox Creek, Mississippi River Backwater Area, and wetlands by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs posed by surface water and groundwater discharges.

- Ensure adequate protection of the aquatic-dependent avian and mammalian populations along the shoreline of Smallpox Creek by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs due to biotic uptake of COPECs in sediment and surface water.

"Adequate protection" generally is defined as protection of the growth, reproduction, and survival of local populations. That is, the focus is on ensuring the sustainability of the local population rather than on protection of every individual in the population, although federal- and state-identified threatened and endangered species will be considered individually.

It is anticipated that exposure will occur through direct contact, ingestion, and, to a lesser degree, dermal contact and inhalation. Several potential sources were reviewed to identify appropriate screening levels for the ERA. Based on this review, the endpoint measures for the terrestrial communities at the Bautsch-Gray Mine site will be soil screening levels available from the sources listed below. These sources will be used in the order of preference as they are listed. It is believed that this approach will provide a conservative screening level estimate of potential ecological risks.

1. EPA. 2010. Ecological Soil Screening Levels (Eco-SSLs). Last Updated October 20, 2010.

2a. Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory (ORNL), Oak Ridge, TN. 128 Pages. ES/ER/TM-85/R3.

2b. Efroymson, R.A., M.E Will, and G.W. Suter II. 1997. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes: 1997 Revision. ORNL, Oak Ridge TN. ES/ER/TM-126/R2.

2c. Efroymson, R.A., G.W. Suter, II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals for Ecological Endpoints. ORNL, Oak Ridge, TN. 50 Pages. ES/ER/TM-162/R2.

3. EPA. 2003b. Region 5 Ecological Screening Levels. August 22.

Screening-level concentrations protective for each of the major terrestrial and aquatic receptor groups noted above will be identified.

The endpoint measures for the aquatic communities of the Bautsch-Gray Mine site will be aquatic life water quality standards for the State of Illinois (IPCB 2013a). The concentrations in water will be compared with the IWQC values for chronic and acute exposures for the aquatic community (IPCB 2013a). If the ratio is greater than 1, a potential risk will be considered indicated. When constituent-specific criteria are not provided by the Illinois ambient water quality criteria, EPA's National Recommended Water Quality Criteria (NWQS) values will be used to evaluate potential risks (EPA 2014b). Finally, when constituent-specific criteria are not provided by these sources, EPA Region 5's ecological soil screening levels (Eco-SSLs) (EPA 2003b) will be used. Constituents for which no aquatic life criteria are available from the sources identified above will be carried forward into the expanded SLERA (Step 3a) for further risk evaluation.

The constituent concentrations in sediment will be compared with several sources for guidelines or criteria because no federal or state standards are available for sediment. The metals concentrations in sediment will be compared with the threshold effects concentrations from MacDonald, Ingersoll, and Berger (2000). Screening levels for all other constituents will be obtained from EPA Region 5 Eco-SSLs (EPA 2003b). Illinois-specific sediment background criteria also are available from IEPA's Bureau of Water documents titled "Sediment Classification for Illinois Inland Lakes" (Mitzelfelt 1996) and "Evaluation of Illinois Sieved Stream Sediment Data" (Short 1997). These criteria will be considered in interpreting the sediment screening level evaluation and in selecting constituents carried forward into the BERA.

3.2.2 Screening-Level Exposure Estimates and Risk Calculations

As noted in Section 3.1.3, the Bautsch-Gray Mine site consists of seven unique terrestrial habitats (1) Mine Tailing Pile - disturbed with little or no vegetation, (2) disturbed woodland-grassland, (3) settling pond, (4) wetlands, (5) grassland area – upper plateau, (6) grassland area – overland flow area, and (7) deciduous riparian area (East and West Bottomland Forests). The assessment will focus on the most biologically active portion of the surface soils from 0 to 12 inches bgs. The dataset for soil will be segregated by each exposure area and evaluated to identify the maximum detected concentration for each contaminant. This concentration will be used as the screening level exposure estimate. It will be assumed that the area use factor is 1, which assumes the organism will spend all its time at the site, that all contaminants are 100 percent bioavailable, and that the most sensitive life stage will be exposed. These assumptions also will be used to develop the screening levels noted above. An HQ will be calculated for each contaminant for each receptor group by determining the ratio of the exposure concentrations to the screening levels for each receptor group. If the HQ is greater than 1, a potentially unacceptable risk will be considered identified. The HQs for COPECs with the same toxic mechanism will be added to yield the HI for the habitat for habitats that do not have a COPEC HQ that exceeds 1. If this HI is greater than 1, a potentially unacceptable risk will be considered identified.

A preliminary review of the available data indicates that several habitats are expected to show HQs greater than 1 for at least one and likely several receptor groups. Based on these results, it is anticipated that risk managers will recommend an expanded SLERA for selected exposure areas.

One of the final objectives of the SLERA is to identify potential ecological risks that should be further characterized and refined in the expanded SLERA. This objective is accomplished by collecting additional data and developing more refined and realistic assumptions to estimate exposures, toxicities, and related risks. Understanding the ecological management goals for a site is important to effectively evaluate the associated ecological risks. Significant portions of the Bautsch-Gray Mine site have been used solely for industrial operations. Long-term land use associated with the site is uncertain.

The ecological evaluation identified a habitat — mine tailings pile — that represents the areas of the site used for past industrial purposes and that now contains the highest levels of contamination. The highly quality of the disturbed habitat is very low, in part because of the soils composition (or lack of soils), which limits the ability to support vegetation. The soils in this habitat are composed primarily of tailings from mining operations.

SulTRAC recommends excluding the disturbed habitat from any further evaluation. The current high levels of contamination and the physical nature of the soil identified in the habitat clearly represent a degraded habitat quality capable of supporting only limited growth of opportunistic species that will present no value as foraging habitat for wildlife. Based on the preliminary data, it is likely the SLERA will clearly show unacceptable risks, and further evaluation will not provide significant additional refinement of potential risks. The focus of the expanded SLERA will be the risks associated with the contamination identified in the remaining habitats that show a screening hazard quotient greater than one. These habitats have the highest quality at the Bautsch-Gray Mine site and represent the most valuable ecological resources at the site.

3.3 EXPANDED SCREENING ECOLOGICAL RISK ASSESSMENT

The expanded SLERA will be conducted on the habitats described above consistent with EPA's ERA guidance (Step 3a) for Superfund sites (EPA 1997). Each step involved in conducting an expanded SLERA is discussed below (problem formulation and study design and risk characterization).

3.3.1 Problem Formulation

The objective of problem formulation for an expanded SLERA is to establish the risk assessment goals and focus, characterize potential ecological effects, update the CSM, refine exposure pathways, and establish assessment endpoints.

As an initial step in an expanded SLERA problem formulation, COPECs identified during the SLERA will be re-evaluated to determine if it is appropriate for the expanded SLERA to focus on a reduced number of COPECs. The COPECs not carried forward into the expanded SLERA may include constituents that pose a negligible risk based on their maximum concentrations or that were detected in a very low percentage of samples (less than 5 percent).

As part of the problem formulation, SulTRAC will review the toxicity literature for the COPECs included in the expanded SLERA to identify toxicity reference values (TRV) based on the no observed adverse effect level (NOAEL) and the lowest observed adverse effect level (LOAEL). The toxicity mechanism and function (acute or chronic) for each TRV also will be identified.

Potentially complete exposure pathways will have been identified in the SLERA. Part of the next phase of the problem formulation will be to refine the CSM based on site-specific conditions. The fate and transport of each COPEC significantly affect potential exposures at the site and potential toxicity response. Metals are anticipated to be one of the prominent contaminant groups, and several major fate and transport factors may influence their movement at the Bautsch-Gray Mine site. The overriding concern associated with the fate and transport of metals is their bioavailability and ultimate movement within and through the food chain. Soil oxidation-reduction conditions and pH alter the solubility and bioavailability of metals. In addition, soil matrix conditions and how tightly the metals are bound within the tailings materials will affect bioavailability. These factors will be reflected in the bioaccumulation of contaminants in soil invertebrates and plants.

Endpoints to be evaluated in the risk assessments will be identified to complete the CSM for the problem formulation step. The assessment endpoints evaluated as part of the SLERA will be reviewed and modified as needed based on additional data collected during the RI Phase II. The BERA endpoints will focus on specific exposure pathways for a variety of receptors. These endpoints in the terrestrial portions of the Bautsch-Gray Mine Site may include the following:

- Function and viability of the terrestrial plant community
- Function and viability of the soil invertebrates community
- Function and viability of the herbivores mammalian community
- Function and viability of the soil invertebrate-consuming mammalian community
- Function and viability of the omnivores mammalian community
- Function and viability of the carnivores mammalian community
- Function and viability of the soil invertebrate-consuming avian community

- Function and viability of the omnivores avian community
- Function and viability of the carnivores avian community.

These endpoints in the aquatic habitats of the surface water may include the following:

- Function and viability of the aquatic community
- Function and viability of the omnivorous mammalian community along the shoreline
- Function and viability of the piscivorous avian community along the shoreline.

3.3.2 Study Design and Risk Characterization

The next step in the expanded SLERA will be to prepare a study design based on the problem formulation. The design will clearly identify the lines of evidence and the endpoint measures to verify achievement and maintenance of assessment endpoints. The following sections discuss the aquatic habitat study design, the terrestrial habitat study design, and the food-chain model (FCM).

SulTRAC will compare the data for concentrations in soil with screening levels for the plants and soil invertebrates. Medium-specific EPCs will be calculated using EPA's ProUCL Version 5.0 statistical program (EPA 2013). Both the median and 95 percent UCL values will be identified and used in the expanded SLERA. An HQ based on soil concentration and screening values will be calculated for each COPEC and receptor group to assess potential impacts.

SulTRAC will use an FCM to estimate the potential exposures to assess the potential impacts to other terrestrial receptors. These terrestrial receptors will include primary consumers, omnivores, and carnivores. The FCM will focus on mammalian and avian receptors.

Risks to upper-trophic level avian and mammalian species will be assessed using an FCM. The FCM assumes exposure to COPECs primarily through ingestion of contaminated environmental media (soil, sediment, and surface water) and prey. Exposure models estimate the mass of a COPEC internalized daily by a receptor per kilogram of body weight per day (the daily COPEC dosage). Estimates of exposure generally are based on knowledge of the spatial and temporal distribution of both COPECs and receptors and on specific natural and life history characteristics that influence exposure to COPECs. Results for soil samples collected from 0 to 1 foot bgs will be used in FCMs to estimate doses to avian and mammalian receptors.

Daily doses will be estimated for each COPEC and representative receptor when adequate data are available and these models are appropriate. These doses will then be compared with high and low TRVs to estimate the potential adverse biological effects on the receptor. The risk to each representative species will be characterized using an HQ approach based on this comparison.

The total exposure from ingestion for each receptor of concern will be calculated as the sum of the dietary exposure estimates. The following generic equation was adapted for each representative receptor:

$$\text{Dose}_{\text{total}} = \frac{([IR_{\text{prey}} \times C_{\text{prey}}] + [IR_{\text{soil}} \times C_{\text{soil}}]) \times SUF}{BW}$$

where:

$\text{Dose}_{\text{total}}$	=	Estimated dose from ingestion (milligrams per kilogram body weight-day [mg/kg/day])
IR_{prey}	=	Ingestion rate of prey (kilograms per day [kg/day])
C_{prey}	=	Concentration in dry weight of COPEC in prey (mg/kg)
IR_{soil}	=	Ingestion rate of soil (kg/day)
C_{soil}	=	Concentration in dry weight of COPEC in soil (mg/kg)
SUF	=	Site use factor (unitless)
BW	=	Adult body weight (kg)

The risk estimates will ensure that the assessment does not indicate little or no risk when a risk actually exists. Therefore, conservative assumptions will be used in this analysis in the absence of site- or species-specific data. Exposure will be assessed within the context of the following linear food chains to evaluate potential ecological effects on secondary consumer birds and mammals:

Soil → Plants → Northern Bobwhite
Soil → Plants → Meadow Vole
Soil → Invertebrates → Marsh Wren
Soil → Invertebrates → Short-tailed Shrew
Soil → Plants and Invertebrates → American Robin
Soil → Plants and Invertebrates → Deer Mouse
Soil → Small Mammals → American Kestrel
Soil → Small Mammals → Red Fox

Soil → Plants, Invertebrates, Small Mammals and Aquatic Life → Raccoon

Sediment → Benthos and Aquatic Life → Mink

Sediment → Benthos and Aquatic Life → Great Blue Heron or Kingfisher

Site-specific prey data may not be available for use in the dose calculation described above. Therefore, bioaccumulation models will be used to estimate the concentrations of COPECs in prey tissue based on the concentrations of COPECs in soil or sediment. Soil-to-biota or sediment-to-biota bioaccumulation models for small mammals may be used, either as simple bioaccumulation factors (BAF) that can be multiplied by the concentration in the soil or sediment, or as regression models that incorporate the concentration in soil or sediment to estimate the COPEC concentration in prey.

Updated ecological soil and sediment screening levels (Eco-SSLs), BAFs, and regressions will be used whenever available (EPA 2005b). Additional regression models and simple BAFs (Bechtel-Jacobs Company, LLC [Bechtel-Jacobs] 1998; ORNL 2013; Sample and Arenal 1999; Sample, Opresko, and Suter 1996; Baes, Sharp, Sjoreen, and Shor 1984) will be chosen if no Eco-SSL regression is available. A regression model will be applied only if the model is significant (the slope differs significantly [$p < 0.05$] from 0) and the coefficient of determination (R^2) is greater than or equal to 0.6. If these criteria are not met, another regression model or BAF will be selected to estimate bioaccumulation. The Eco-SSL (EPA 2005b) BAFs will be retained instead of default BAFs for chemicals without any alternative invertebrate BAFs. A default value of 1 will be used for chemicals without any available BAFs.

The overall risks to the ecological receptors will be presented using a weight-of-evidence approach. This approach considers the various COPECs present, the uncertainties associated with the data collection methods, toxicity data, and risk estimation methods. It will also evaluate the laboratory and field data and the consistency between them, and the impact of the data on the estimated risks. Presentation of the estimated risks based on both NOAEL and LOAEL TRVs will provide risk managers with an understanding of the potential range of risks for the ecological receptors. This understanding may also be used to develop site-specific remediation goals that could depend on the quality of the habitat to be protected or rehabilitated.

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FIGURES

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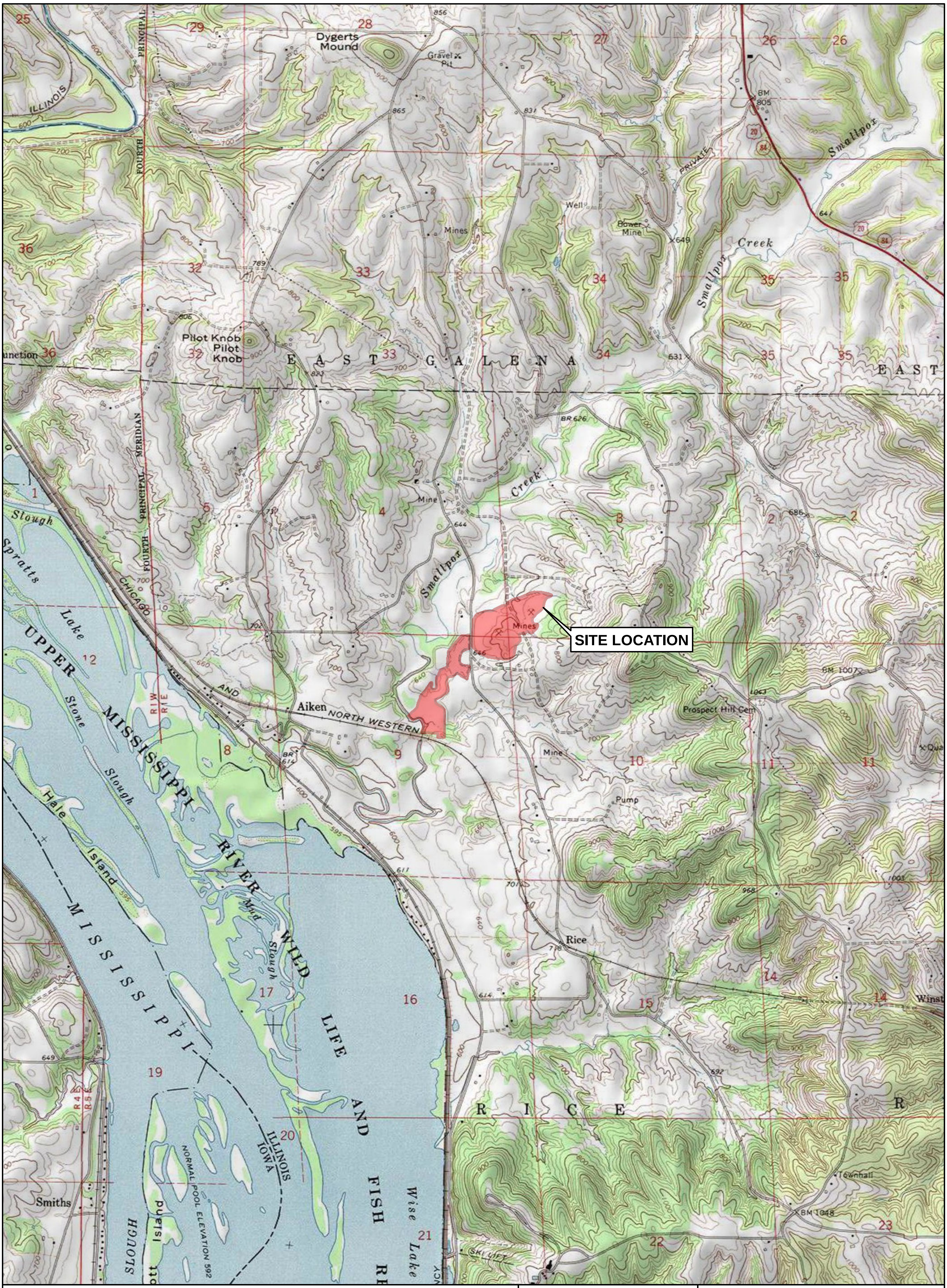

BAUTSCH-GRAY MINE SITE
GALENA, ILLINOIS

FIGURE 1
SITE LOCATION MAP

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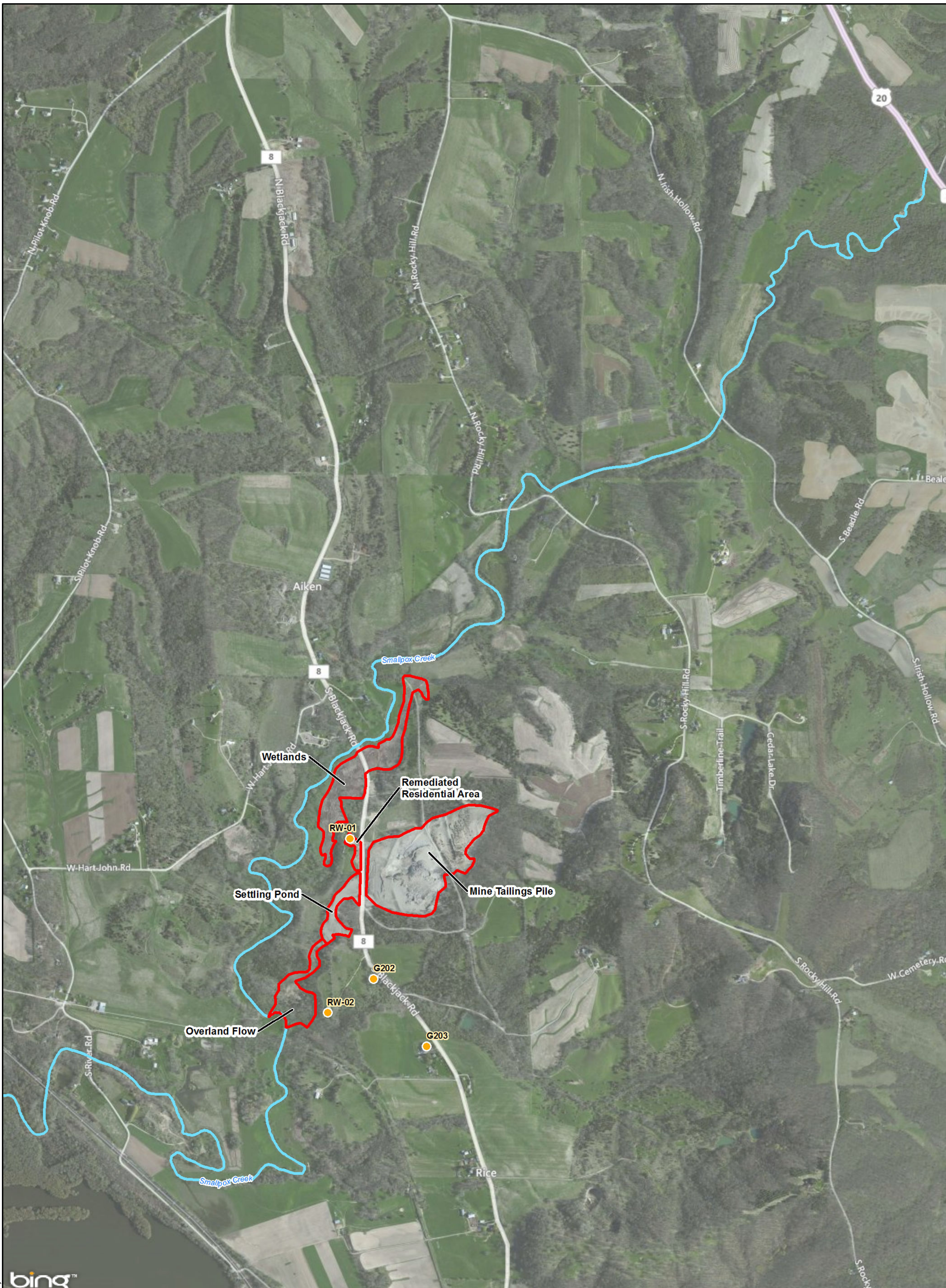

LEGEND

- Residential Well
- Area Boundary
- River

N

0 1,000 2,000 Feet

REFERENCE MAP

BAUTSCH-GRAY MINE SITE
GALENA, ILLINOIS

FIGURE 2
SITE LAYOUT MAP

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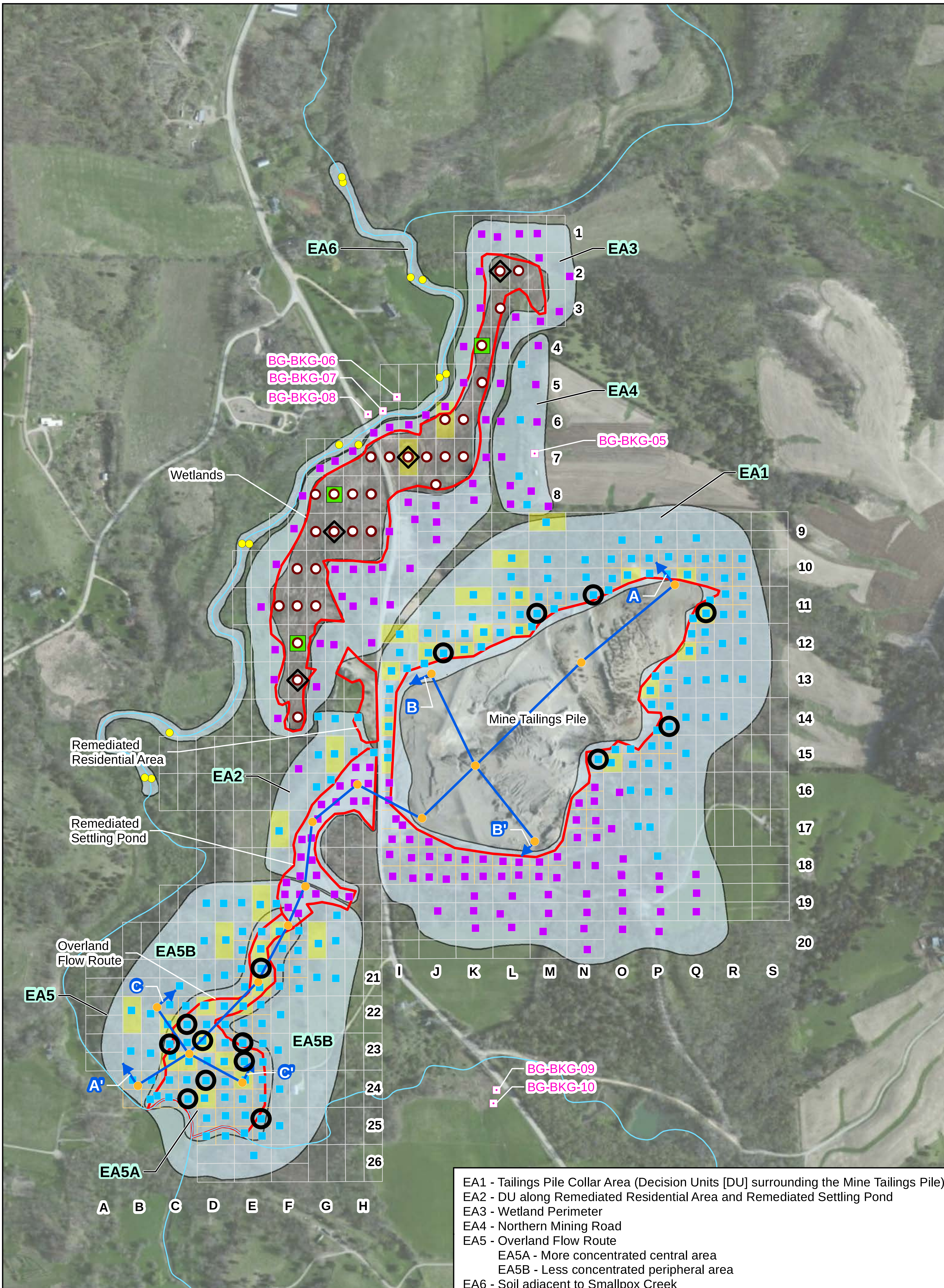

Legend

- Phase I - AVS/SEM, TOC, Grain Size, & pH Sample
- Phase I - SPLP & Bioavailability Sample
- Phase I - On-site Background Sample Location
- Phase I - Grid Surface Soil
- Phase I - Wetland Sample Location
- Phase I - Surface Water Sample Location
- Phase II - Bank Sample Location
- Human Health Soil Exposure Area
- Phase II - Soil Sample Location
- Phase II - Borehole Location
- Phase I - Subsurface Sample
- 100' x 100' Decision Unit
- 200' x 100' Decision Unit
- Area Boundary
- Creek
- Transect Line

N

0 625 1,250 Feet

BAUTSCH-GRAY MINE SITE
GALENA, ILLINOIS

FIGURE 3
HUMAN HEALTH SOIL EXPOSURE AREAS AND SAMPLE LOCATIONS

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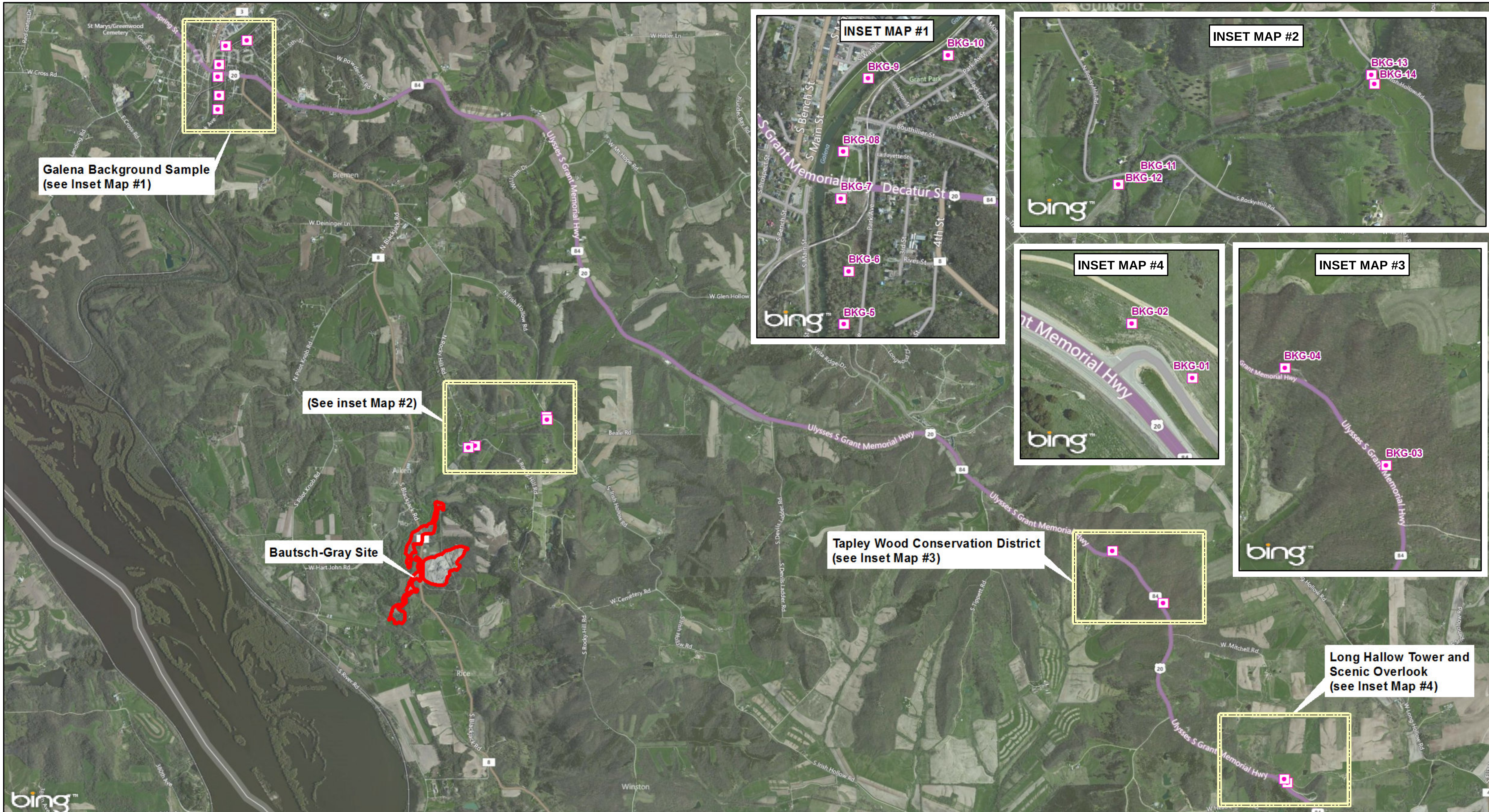

Legend

Site Background Sample Locations

Area Boundary

N

2,000 0 2,000 Feet

BAUTSCH-GRAY MINE SITE
GALENA, ILLINOIS

FIGURE 4
JO DAVIESS BACKGROUND SAMPLING LOCATION MAP

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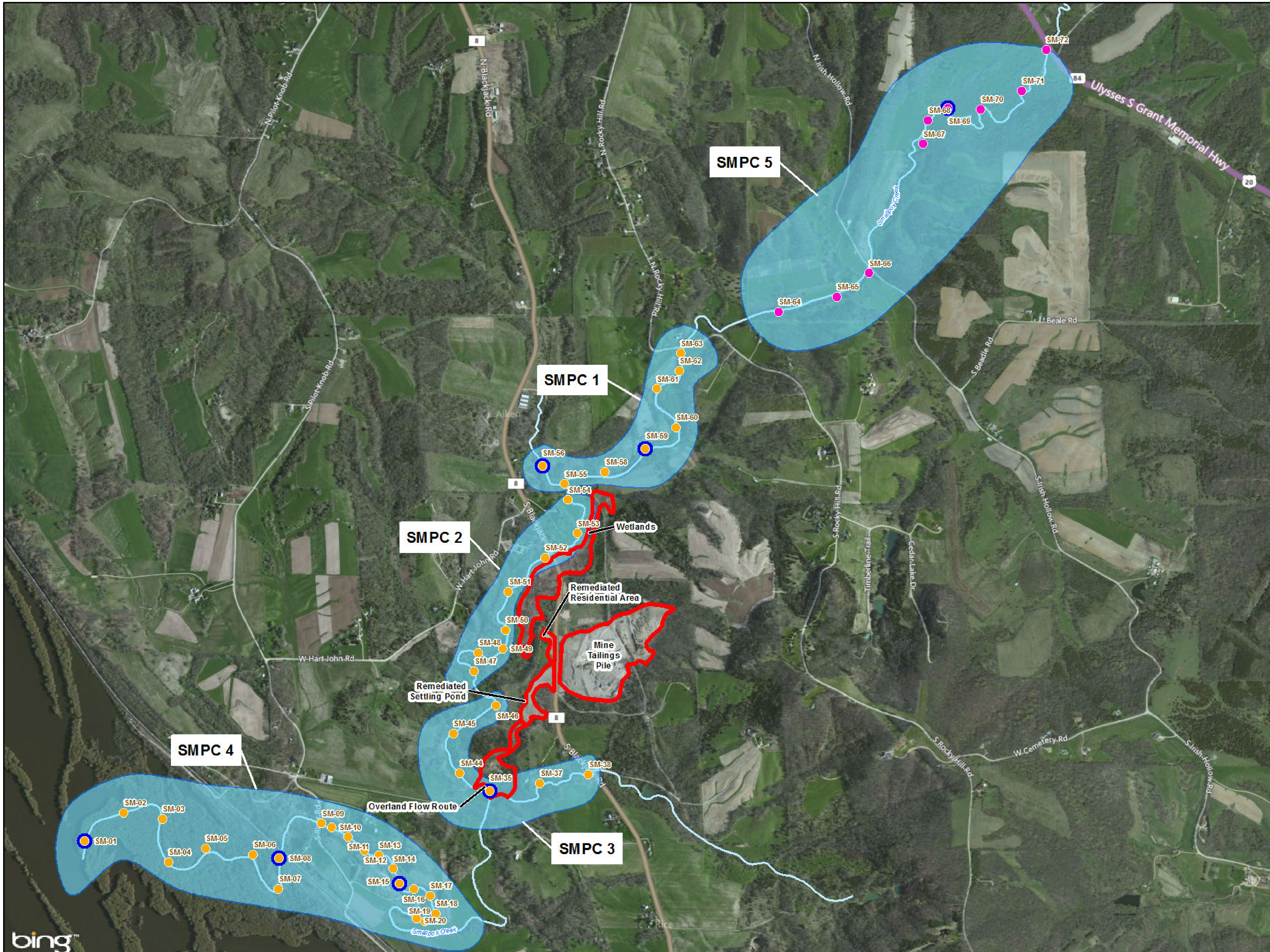


Legend

- Phase I Background Sediment Sample Location
- Phase I Sediment Sample Location
- Phase I Surface Water Sample Location
- Area Boundary
- Human Health Surface Water/ Sediment Exposure Area
- Creek

SMPC Smallpox Creek

Note:
Biota (fish) samples were collected from Smallpox Creek using backpack electric shock units. Discrete sample locations are not available.

N

1,000 0 1,000 Feet

REFERENCE MAP

Site Location

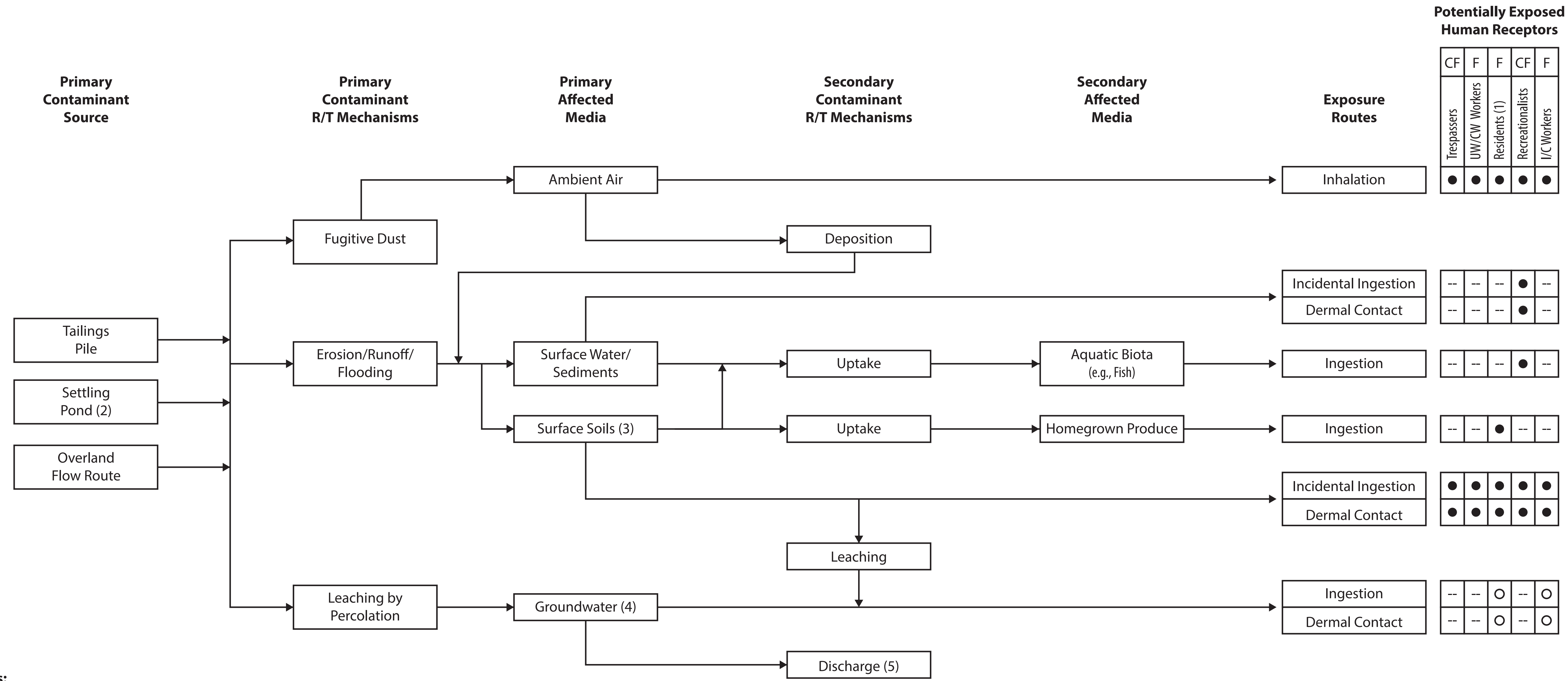
Illinois

BAUTSCH-GRAY MINE SITE
GALENA, ILLINOIS

FIGURE 5
HUMAN HEALTH SURFACE WATER AND SEDIMENT EXPOSURE AREAS AND SAMPLE LOCATIONS

ST SulTRAC

G:\G1852\186 Bautsch-Gray Mine\MXD\2015-01 RAI\Fig5-HumanHealthWaterExposure.mxd m.banh
1/28/2015



Notes:

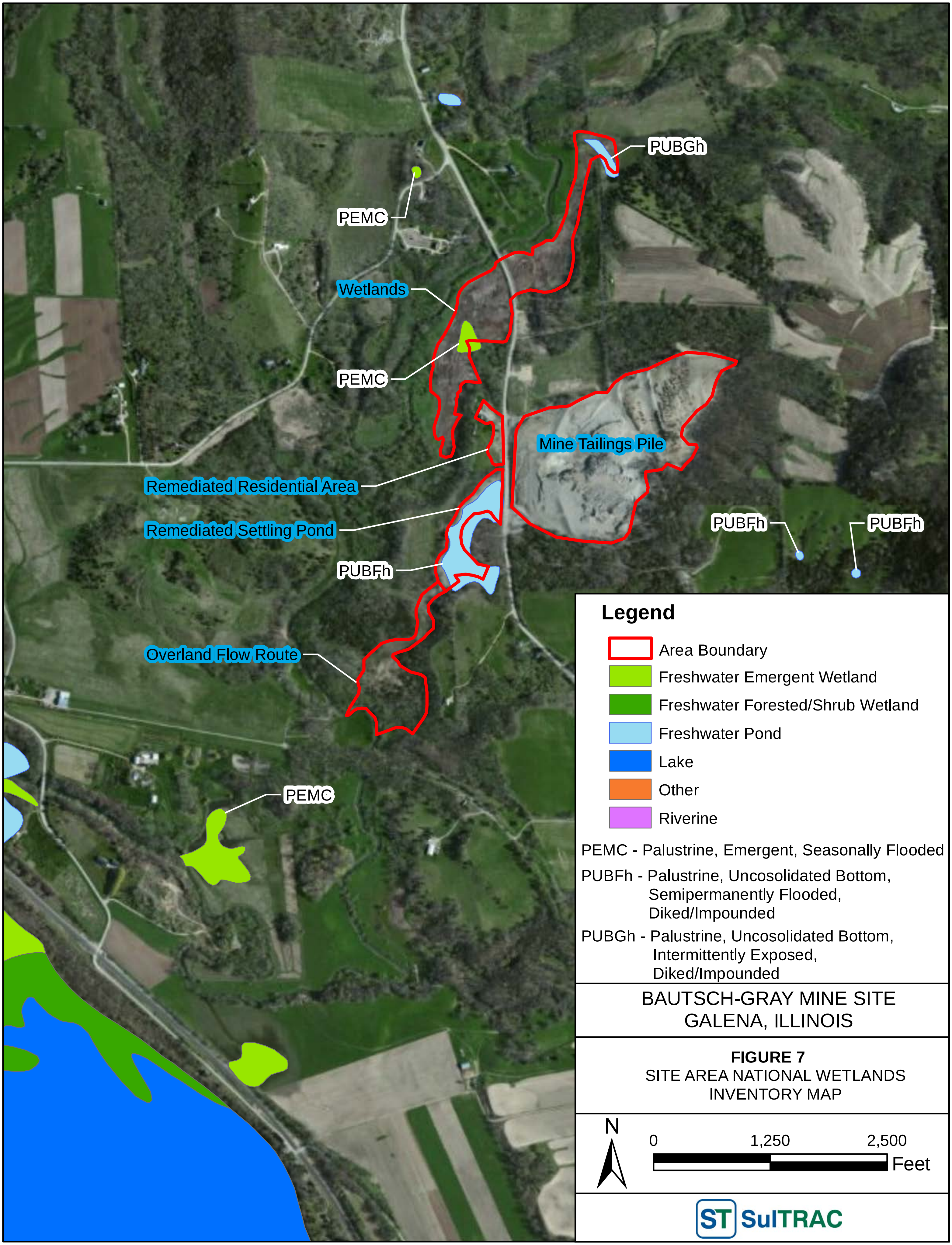
C = Current
CW = Construction Worker
F = Future
I/C = Industrial/Commercial
R/T = Release/Transport
UW = Utility Worker
● = Potentially complete exposure pathway – retain for quantitative analysis
O = Potentially complete, but insignificant exposure pathway – will not be retained for quantitative analysis
-- = Incomplete exposure pathway -- will not be considered in the Human Health Risk Assessment (HHRA)

1) Though a limited number of residents are currently located near the site, no current residential properties were sampled as part of the Remedial Investigation.
2) The Settling Pond has been remediated by placing a vegetative cover over the soil.
3) The same R/T mechanisms, affected media, and exposure routes also apply to subsurface soil directly (CW and UW) and if brought to the surface (trespassers, residents, and I/C workers).
4) Chemical concentrations in area groundwater are thought to be in large part the result of leaching from natural ore formations. Leaching from the primary contaminant sources may or may not have modified groundwater concentrations. No groundwater was detected up to 10 feet below ground surface (bgs). No groundwater samples were collected in the remedial investigation. See section 2.2.2 of the draft risk methodology for more details.
5) Groundwater may discharge to nearby Smallpox Creek or wetland areas depending on groundwater flow direction and depth to groundwater. Because no groundwater was detected up to 10 feet bgs, groundwater discharge to Smallpox Creek is expected to be minimal.

BAUTSCH-GRAY MINE
GALENA, ILLINOIS

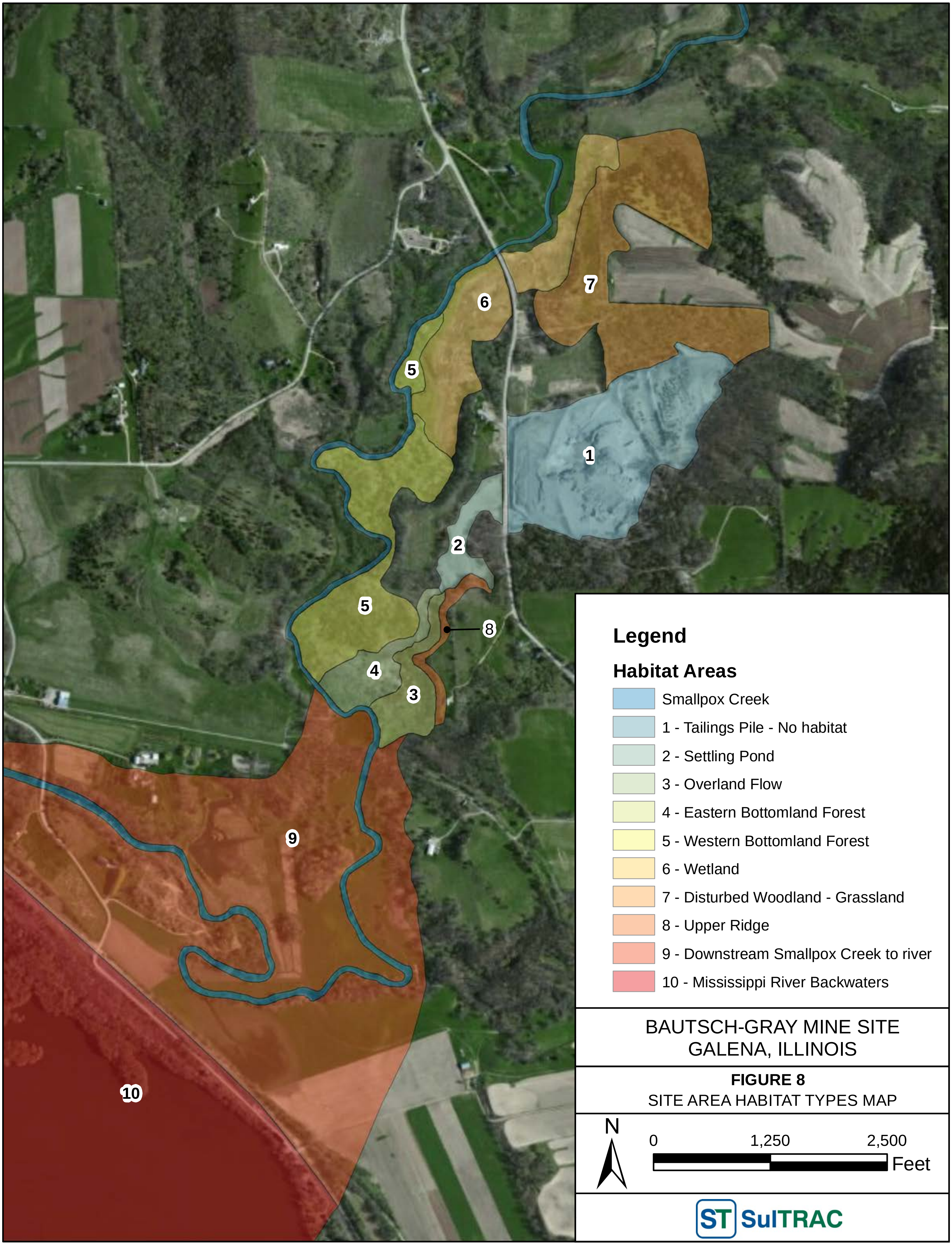
FIGURE 6
HUMAN HEALTH
CONCEPTUAL SITE MODEL

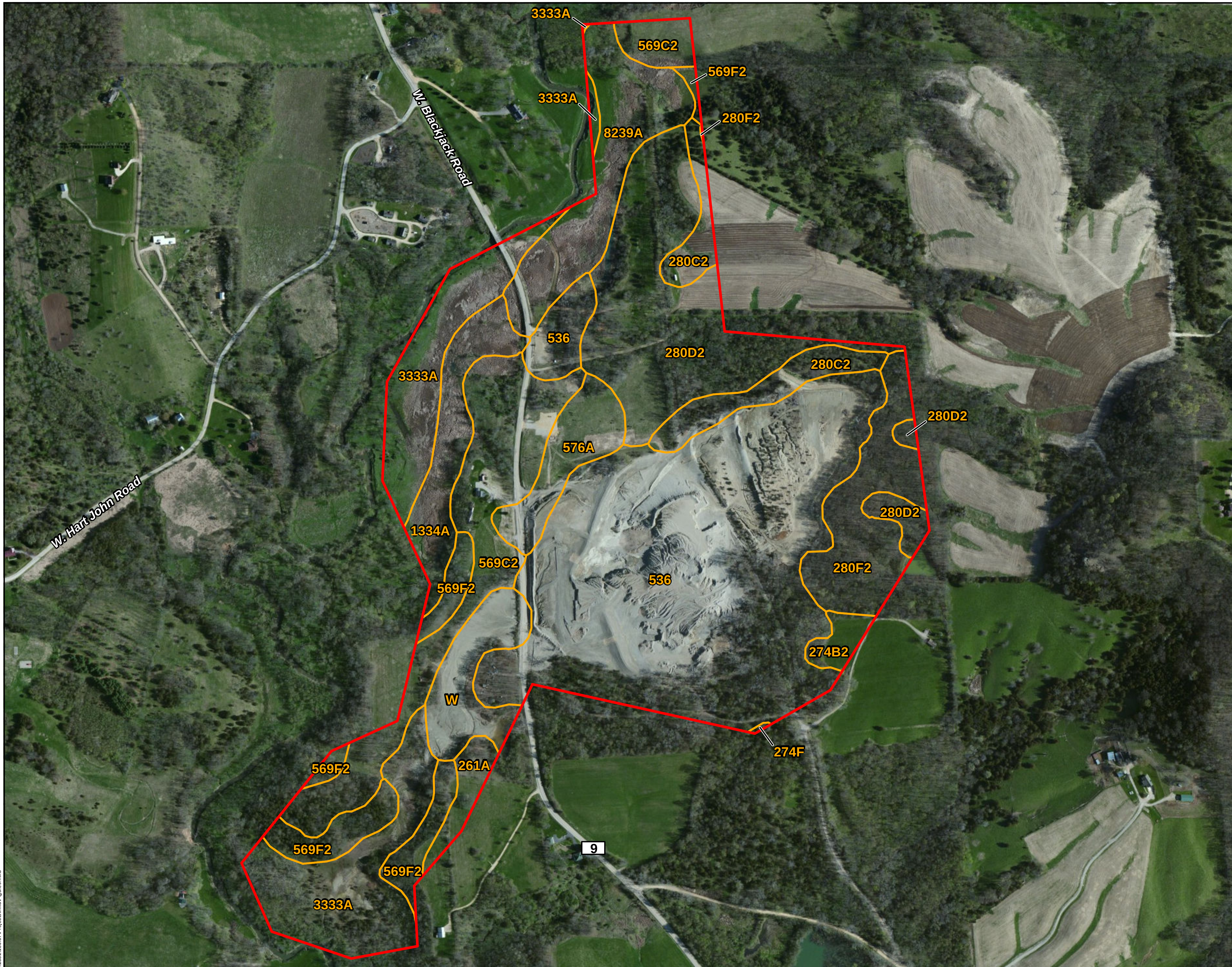
SulTRAC



BAUTSCH-GRAY MINE SITE
GALENA, ILLINOIS

FIGURE 7
SITE AREA NATIONAL WETLANDS INVENTORY MAP


1
2
3
4
5
5
5
6
7
8
9
10
Legend
Habitat Areas
Smallpox Creek
1 - Tailings Pile - No habitat
2 - Settling Pond
3 - Overland Flow
4 - Eastern Bottomland Forest
5 - Western Bottomland Forest
6 - Wetland
7 - Disturbed Woodland - Grassland
8 - Upper Ridge
9 - Downstream Smallpox Creek to river
10 - Mississippi River Backwaters
BAUTSCH-GRAY MINE SITE
GALENA, ILLINOIS
FIGURE 8
SITE AREA HABITAT TYPES MAP
N
0
1,250
2,500
Feet
ST SulTRAC



Legend

Area of interest (AOI)

Soil map unit polygon

Map Unit Symbol	Map Unit Name
261A	Niota silt loam, 0 to 2 percent slopes
274B2	Seaton silt loam, 2 to 5 percent slopes, eroded
274F	Seaton silt loam, 18 to 35 percent slopes
280C2	Fayette silt loam, 5 to 10 percent slopes, eroded
280D2	Fayette silt loam, 10 to 18 percent slopes, eroded
280F2	Fayette silt loam, 18 to 35 percent slopes, eroded
536	Dumps, mine
569C2	Medary silty clay loam, 3 to 12 percent slopes, eroded
569F2	Medary silty clay loam, 15 to 45 percent slopes, eroded
576A	Zwingle silt loam, 0 to 2 percent slopes
1334A	Birds silt loam, undrained, 0 to 2 percent slopes, frequently flooded
3333A	Wakeland silt loam, 0 to 2 percent slopes, frequently flooded
8239A	Dorchester silt loam, 0 to 2 percent slopes, occasionally flooded
W	Water

N

0 250 500

Feet

Source: ESRI, ArcGIS Online, World Imagery Basemap Service, 2011. USDA-NRCS, Jo Daviess County, Illinois Soil Survey, Version 11, September 23, 2014.

BAUTSCH-GRAY MINE
GALENA, ILLINOIS

FIGURE 9
SITE AREA SOILS MAP

EPA REGION 5 RAC 2 | REVISION 0 | JANUARY 2015

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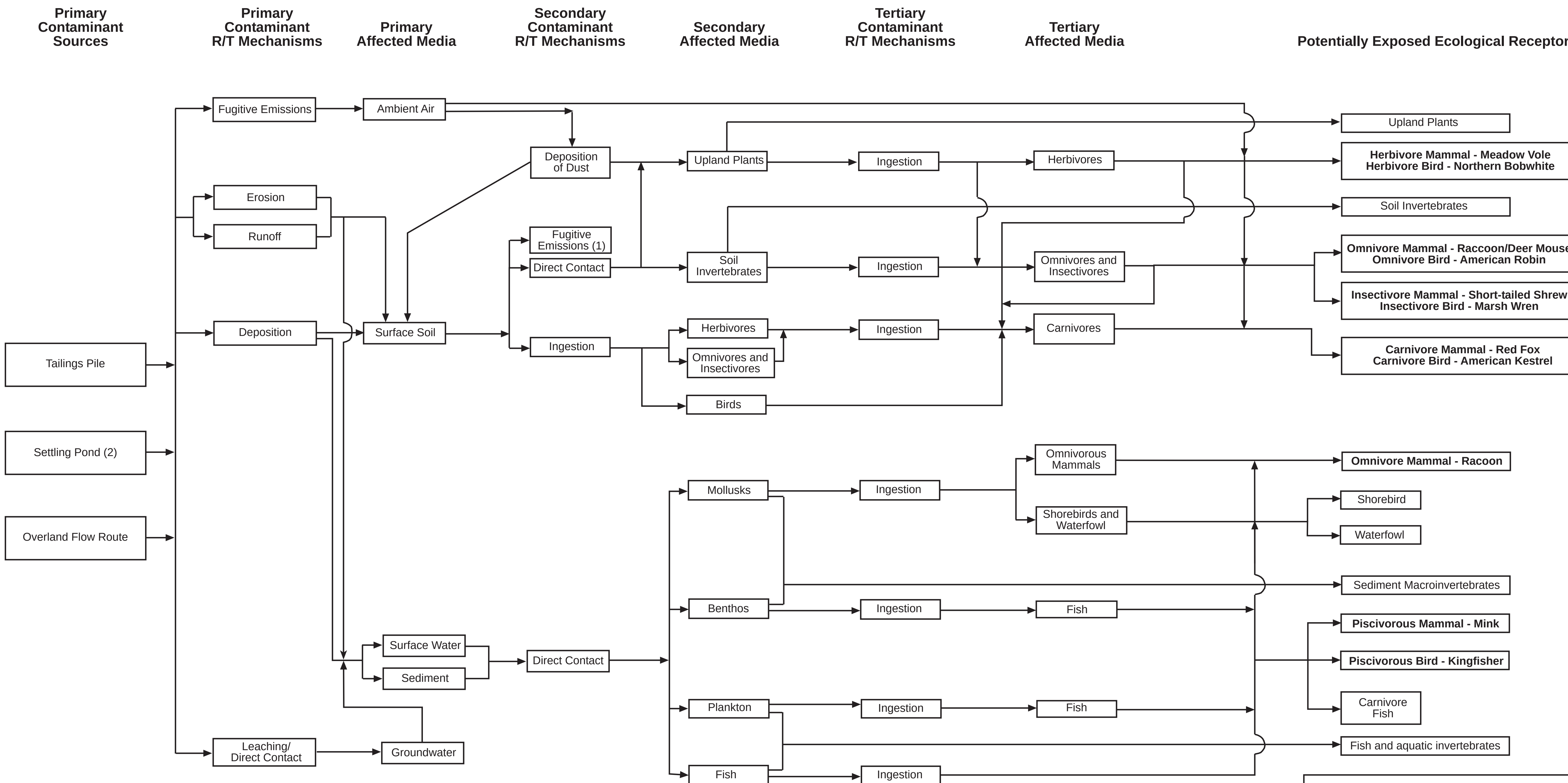

Notes:
R/T - Release/Transport
1 - As shown under primary contaminant R/T Mechanisms.
2 - The settling pond has been remediated by placing a vegetative cover over the soil.
Bold Text - Included in food chain model.

BAUTSCH-GRAY MINE SITE
GALENA, ILLINOIS

FIGURE 10
ECOLOGICAL
CONCEPTUAL SITE MODEL

ST SulTRAC

X:\S\1852\186\07\FH10\Bautsch_Gray_Conceptual_Site_Model_Sultrac.FH10

ATTACHMENT A

RBA RESULTS AND OUTLIER ANALYSIS FOR LEAD AND ARSENIC IN SOIL

TABLE 1 . Preliminary Summary Of In Vitro Bioassay Results -- Lead

Sample	ID	Pb in <250u bulk soil ug/kg	mass soil (g)	calc Pb #1	ICP Pb (ug/l)	solution amt (l)	% Pb IVBA	%RBA Predicted based on Drexler and Brattin, 2007
SO-E23-NW		3184475	1.00659	3205.46	23024	0.1	72	63
SO-E21-NE		1798559	1.0036	1805.03	12327	0.1	68	60
SO-P14-SE		625633	0.99816	624.48	1870	0.1	30	26
SO-E23-SW		2697233	1.0053	2711.53	19709	0.1	73	64
SO-Q11-SE		419611	0.98799	414.57	1240	0.1	30	26
SO-M11-SW		3354297	1.00431	3368.75	22227	0.1	66	58
SO-D24-NW		3089939	1.00495	3105.23	21893	0.1	71	62
SO-E25-NE		434088	1.01151	439.08	3488	0.1	79	70
SO-E23-SW-D		2589154	1.00123	2592.34	18240	0.1	70	62
SO-C22-SE		4232351	1.01241	4284.87	30696	0.1	72	63
SO-N15-NE-D		2424286	1.01073	2450.30	17722	0.1	72	63
SO-D23-NW		2181593	1.00976	2202.89	15444	0.1	70	62
SO-C23-NW		511882	1.00904	516.51	4902	0.1	95	83
SO-C24-SE		547796	1.0083	552.34	4493	0.1	81	71
SO-J12-SE		2712288	1.00123	2715.62	11029	0.1	41	36
SO-N11-E		753432	1.01328	763.44	3739	0.1	49	43
SO-N15-NE		2618355	1.00423	2629.43	16897	0.1	64	56

Notes:

(yellow) Mean of these two RBA values is 63; this mean value replaces the two individual values in the statistics

(blue) Mean of thes two RBA values is 59.5; this mean value replaces the two individual values in the statistics

TABLE 2 . Preliminary Summary Of In Vitro Bioassay Results -- Arsenic

Sample	ID	As in <250u bulk soil ug/kg	mass soil (g)	calc As #1	ICP As (ug/l)	solution amt (l)	% As IVBA	%RBA Predicted based on Brattin et al, 2013
SO-E23-NW		43522	1.00659	43.81	54	0.1	12	27
SO-E21-NE		59271	1.0036	59.48	59	0.1	10	26
SO-P14-SE		85861	0.99816	85.70	28	0.1	3	22
SO-E23-SW		36268	1.0053	36.46	49	0.1	13	28
SO-Q11-SE		84260	0.98799	83.25	36	0.1	4	22
SO-M11-SW		47832	1.00431	48.04	38	0.1	8	25
SO-D24-NW		46324	1.00495	46.55	41	0.1	9	25
SO-E25-NE		12434	1.01151	12.58	DL	0.1		
SO-E23-SW-D		35142	1.00123	35.18	38	0.1	11	26
SO-C22-SE		45937	1.01241	46.51	55	0.1	12	27
SO-N15-NE-D		38926	1.01073	39.34	56	0.1	14	29
SO-D23-NW		50295	1.00976	50.79	43	0.1	8	25
SO-C23-NW		11200	1.00904	11.30	32	0.1	28	37
SO-C24-SE		13370	1.0083	13.48	DL	0.1		
SO-J12-SE		58279	1.00123	58.35	36	0.1	6	24
SO-N11-E		49315	1.01328	49.97	30	0.1	6	23
SO-N15-NE		40021	1.00423	40.19	50	0.1	13	27

Notes:

(yellow) Mean of these two RBA values is 27; this mean value replaces the two individual values in the statistics

(blue) Mean of thes two RBA values is 28; this mean value replaces the two individual values in the statistics

Table 3. RBA Outlier Results for Bautsch-Gray Soil -- Lead

Outlier Tests for Selected Uncensored Variables

User Selected Options

Date/Time of Computation 1/20/2015 10:45:27 AM

From File Outlier Input_Lead in Soil at Bautsch-Gray

Full Precision OFF

Dixon's Outlier Test for BG Pb RBA Results	**Lead RBA**
	63
Number of Observations = 15	60
10% critical value: 0.472	26
5% critical value: 0.525	63
1% critical value: 0.616	26
	58
1. Observation Value 83 is a Potential Outlier (Upper Tail)?	62
	70
Test Statistic: 0.277	63
	59.5
For 10% significance level, 83 is not an outlier.	62
For 5% significance level, 83 is not an outlier.	83
For 1% significance level, 83 is not an outlier.	71
	36
2. Observation Value 26 is a Potential Outlier (Lower Tail)?	43

Test Statistic: 0.227

For 10% significance level, 26 is not an outlier.
For 5% significance level, 26 is not an outlier.
For 1% significance level, 26 is not an outlier.

Table 4. RBA Outlier Results for Bautsch-Gray Soil -- Arsenic

Outlier Tests for Selected Uncensored Variables

User Selected Options

Date/Time of Computation	1/20/2015 10:51:34 AM
From File	Outlier Results for Bautsch-Gray Soil -- Arsenic
Full Precision	OFF

Dixon's Outlier Test for BG As RBA Results	As RBA
	27
Number of Observations = 13	26
10% critical value: 0.467	22
5% critical value: 0.521	27
1% critical value: 0.615	22
	25
1. Observation Value 37 is a Potential Outlier (Upper Tail)?	25
	27
Test Statistic: 0.667	28
	25
For 10% significance level, 37 is an outlier.	37
For 5% significance level, 37 is an outlier.	24
For 1% significance level, 37 is an outlier.	23
2. Observation Value 22 is a Potential Outlier (Lower Tail)?	
Test Statistic: 0.167	
For 10% significance level, 22 is not an outlier.	
For 5% significance level, 22 is not an outlier.	
For 1% significance level, 22 is not an outlier.	

ATTACHMENT B

ILLINOIS THREATENED AND ENDANGERED SPECIES
JO DAVIES COUNTY

Illinois Threatened and Endangered Species by County

Illinois Natural Heritage Database

as of October 2014

Important Note: The Illinois Natural Heritage Database is updated daily with data pertaining to threatened and endangered species occurrences in Illinois. Please check this website quarterly for updates to this list or contact Database staff directly at tara.kieninger@illinois.gov or (217)782-2685.

Please note that because many birds observed in the state are merely migrants passing through, we typically only track those sightings which have evidence of breeding (nest with young, breeding and/or nesting behavior in adults, juveniles observed, etc.). We normally do not track instances where a bird is observed perched on a tree branch, flying in the air, or feeding unless other evidence of breeding is witnessed or there is an existing breeding record for the species in the area.

State Status:

LE - listed as endangered

LT - listed as threatened

Scientific Name	Common Name	State Protection	# of occurrences	Last Observed
Jo Daviess				
Acipenser fulvescens	Lake Sturgeon	LE	1	1998-09-14
Adoxa moschatellina	Moschatel	LE	1	1986-05-23
Alasmidonta viridis	Slippershell	LT	1	2010-09-14
Amelanchier interior	Shadbush	LT	2	1995
Ammocrypta clarum	Western Sand Darter	LE	4	2007
Asclepias lanuginosa	Wooly Milkweed	LE	1	1995
Bartramia longicauda	Upland Sandpiper	LE	2	2008-07-10
Besseya bullii	Kittentails	LT	1	2011-09-23
Bouteloua gracilis	Blue Grama	LE	1	2011-09-30
Canis lupus	Gray/timber Wolf	LT	3	2013-02-15
Carex inops ssp. heliophila	Sedge	LE	1	1985-05-26
Carex prasina	Drooping Sedge	LT	1	1996-06-25
Carex woodii	Pretty Sedge	LT	1	2007
Ceanothus herbaceus	Redroot	LE	2	2006-06-07
Circaea alpina	Small Enchanter's Nightshade	LE	2	1987
Clematis occidentalis	Mountain Clematis	LE	1	2003-08-20
Conioselinum chinense	Hemlock Parsley	LE	1	1996-09-19
Corylus cornuta	Beaked Hazelnut	LE	1	1992-07-16
Crotalus horridus	Timber Rattlesnake	LT	4	2011-09-04
Cyperus grayoides	Umbrella Sedge	LT	1	1997
Dendroica cerulea	Cerulean Warbler	LT	1	2008-08
Discus macclintocki	Iowa Pleistocene Snail	LE	1	1994-08-31
Ellipsaria lineolata	Butterfly	LT	3	2013-09-04
Elymus trachycaulus	Bearded Wheat Grass	LT	1	1997
Emydoidea blandingii	Blanding's Turtle	LE	3	2007-07-12
Equisetum pratense	Meadow Horsetail	LT	5	2011-06-28
Gymnocarpium dryopteris	Oak Fern	LE	1	1991
Hackelia deflexa var. americana	Stickseed	LE	3	1995-06-27
Hemidactylium scutatum	Four-toed Salamander	LT	2	2010-05-22
Heterodon nasicus	Plains Hog-nosed Snake	LT	1	2009-06
Hudsonia tomentosa	False Heather	LE	1	2011-09-30
Hybopsis amnis	Pallid Shiner	LE	2	2010-06-28
Juniperus communis	Ground Juniper	LT	1	1994-06-08
Lampsilis higginsii	Higgins Eye	LE	2	2010-05-25
Lanius ludovicianus	Loggerhead Shrike	LE	1	2014-06
Lathyrus ochroleucus	Pale Vetchling	LT	1	1987
Ligumia recta	Black Sandshell	LT	4	2013-09-04
Luzula acuminata	Hairy Woodrush	LE	1	2008-FA
Mirabilis hirsuta	Hairy Umbrella-wort	LE	2	2003-08
Myotis sodalis	Indiana Bat	LE	1	1954
Nocomis micropogon	River Chub	LE	1	1972-05-09

Scientific Name	Common Name	State Protection	# of occurrences	Last Observed
Jo Daviess				
Nothocalais cuspidata	Prairie Dandelion	LE	1	2012-04-27
Notropis texanus	Weed Shiner	LE	2	2010
Opuntia fragilis	Fragile Prickly Pear	LE	1	2011-09-23
Polanisia jamesii	James' Clammyweed	LE	1	2011-09-30
Primula mistassinica	Bird's-eye Primrose	LE	1	2004-10-21
Rosa acicularis	Rose	LE	2	2003-08-20
Salvia azurea ssp. pitcheri	Blue Sage	LT	1	1997
Schizachne purpurascens	False Melic Grass	LE	1	2009-05-06
Solidago sciaphila	Cliff Goldenrod	LT	8	2013-08-20
Speyeria idalia	Regal Fritillary	LT	1	2006-06-23
Stygobromus iowae	Iowa Amphipod	LE	1	1965-11-30
Sullivantia sullivantii	Sullivantia	LT	3	2011-06-14
Symphoricarpos albus var. albus	Snowberry	LE	1	1995
Terrapene ornata	Ornate Box Turtle	LT	1	2012
Tropidoclonion lineatum	Lined Snake	LT	1	2009-06-04
Ulmus thomasii	Rock Elm	LE	1	1988-05-12
Viola blanda	Hairy White Violet	LE	1	1968
Viola canadensis	Canada Violet	LE	2	2006-06-02
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	LE	1	1992-07-08
Zigadenus elegans	White Camass	LE	2	2011-06-14

Jo Daviess **Total # of Species** **61**