BACKGROUND SOIL LEAD CONCENTRATIONS IN THE BIG RIVER WATERSHED

Version 2

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ACRONYMS AND ABBREVIATIONS

BRMTS	Big River Mine Tailings Site
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLP	Contract Laboratory Program
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
EDXRF	energy dispersive x-ray fluorescence
FSP	field sampling plan
ICP-AES	inductively coupled plasma-atomic emission spectroscopy
Integral	Integral Consulting Inc.
OU1	Operable Unit 1
TAL	target analyte list
UCL	upper confidence limit
UPL	upper prediction limit
USGS	U.S. Geological Survey
WCLD	Washington County Lead District

EXECUTIVE SUMMARY

Elevated levels of lead have been found in soils, sediments, and floodplain deposits of the Big River watershed. Given the unique geological setting of this area, with lead mineralization present at the earth's surface throughout the region, it is evident that a significant portion of this lead is naturally occurring in soils.

Early surficial mining and smelting (pre-1860s) resulted in redistribution of lead from the diggings and extensive areas with elevated soil lead concentrations, generally in the range of 400 to 1,200 mg/kg lead. Because the townships in St. Francois country grew up around the early mines and furnaces, many of the existing residential areas coincide with areas where surficial diggings were located.

Existing data sets from the U.S. Environmental Protection Agency (EPA) and the U.S. Geological Survey indicate that background soil lead concentrations in the Big River watershed are elevated and variable, with 20 to 35 percent of the samples exceeding EPA's residential cleanup goal of 400 mg/kg lead. A formal background soil lead study, which is described in this report, produced similar results, with 39 percent of samples exceeding EPA's residential cleanup goal.

Concentrations of lead in soil of the Big River watershed are characterized by concentrations that are generally less than 200 mg/kg, with a population of samples with elevated lead concentrations in the range of 400 to 1,200 mg/kg. These latter samples are predominantly located in areas where early surficial mining and smelting occurred, but also occur throughout the Big River watershed. Variability in lead concentrations is high, with individual samples having concentrations greater than 10,000 mg/kg. The large variability of background lead concentrations results in elevated background reference values, as characterized by 95th upper confidence limits. Because of these elevated background reference values, residential soil lead concentrations in OU1 are generally indistinguishable from background.

1 INTRODUCTION

Elevated levels of lead have been found in soils, sediments, and floodplain deposits of the Big River watershed. Given the unique geological setting of this area, with lead mineralization present at the earth's surface throughout the region, it is evident that a significant portion of this lead is naturally occurring in soils. In addition, early surficial mining and smelting (pre-1860s) appears to have caused redistribution of lead from the diggings, resulting in extensive areas with elevated soil lead concentrations. The U.S. Environmental Protection Agency (EPA) defines background at Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites as:

> "substances or locations that are not influenced by the releases from a site, and are described as naturally occurring or anthropogenic:
>
> 1. Naturally occurring – substances present in the environment in forms that have not been influenced by human activity; and,
> 2. Anthropogenic – natural and human-made substances present in the environment as a result of human activities (not specifically related to the CERCLA site in question).
>
> Some chemicals may be present in background as a result of both natural and man-made conditions" (USEPA 2002).

This last statement applies to the Big River watershed, where elevated background soil lead concentrations are due to both naturally occurring mineralized soils, the human activity of early surficial mining and smelting, and the use of leaded paint. This report addresses background lead in soils of the Big River watershed that is the result of naturally mineralized soils and the anthropogenic activity of surficial mining and associated smelting activities.

This report reviews the existing background data sets for the Big River watershed, which are available from EPA and the U.S. Geological Survey (USGS), as well as additional samples collected by Integral Consulting Inc. (Integral) as part of a background soil lead study. The background study was designed primarily to establish background soil lead concentrations in the portion of St. Francois County designated by EPA as Operable Unit 1 (OU1) of the Big River Mine Tailings Site (BRMTS) (residential soils) but includes data from the Washington County Lead District (WCLD) to help quantify the extent to which surficial mining would have contributed lead to soils. The background study also includes sampling of Bonneterre outcrop rock to evaluate lead concentrations in the geologic materials that are contributing lead to soils.

2 GEOLOGIC CONTROLS ON LEAD IN SOIL IN SOUTHEAST MISSOURI

The occurrence of lead in the soils of southeast Missouri is linked to the occurrence of lead in the underlying bedrock. Elevated soil lead concentrations, in the range of 1,000 to 10,000 mg/kg, have been reported in soils overlaying mineralized bedrock in other lead mining districts (USGS 1976). Furthermore, geochemical exploration studies, such as those conducted by Huff (1952), have demonstrated that soil lead concentrations will be elevated wherever lead ore occurs near the surface (Figure 2-1). Huff observed repeatedly that the presence of a vein of galena created an area with elevated soil lead concentrations. In the example shown in Figure 2-1, the soils around the lead vein contained lead concentrations up to 4,000 mg/kg, and the width of the soil zone that exceeded 400 mg/kg (EPA's residential soil standard) was approximately 270 ft. In an area like OU1, where lead ore veins in bedrock are common and broadly dispersed, elevated soil lead concentrations will be prevalent.

The stratigraphic sequence in the upper Big River watershed, which includes both the BRMTS and the SE Missouri Barite District[1], is comprised of the following geological formations (Figure 2-2):

1. Eminence dolomite
2. Potosi dolomite
3. Derby-Doe Run dolomite
4. Davis shale
5. Bonneterre dolomite
6. Lamotte sandstone
7. St. Francois Mountains Supergroup (Rhyolite).

The St. Francois Mountain Supergroup is an intrusive volcanic rock that forms the core of the St. Francois Mountains, located at the southern edge of the watershed. The upper limit of the Lamotte sandstone marks the lower boundary of the lead ore mineralization. The Bonneterre dolomite is the host rock for the disseminated lead ore extracted from the hard rock mines at the BRMTS. The Davis shale overlays the Bonneterre and presented a low-conductivity barrier to the mineralizing fluids moving upwards through the Bonneterre. As a result, galena was deposited at the contact between the Bonneterre and the Davis formations. The Eminence and

[1] The area that is referred to as the "SE Missouri Barite District" in this report was defined using the Missouri Department of Natural Resources (MDNR) Inventory of Mining Opportunities and Prospects (IMOP) Database (MDNR 2008). The polygon was created by encircling the highest density of barite and lead mines occurring in the vicinity of Potosi and Richwoods.

Potosi dolomites are the host rocks for the lead and barite ore in the SE Missouri Barite District (Figure 2-3). To the south, in the area of the BRMTS, the Eminence and Potosi have eroded away. This erosion left the Davis, Derby-Doe Run, and Bonneterre as the dominant bedrock, and deposited lead from the eroded formations in the residuum soils (Figure 2-4).

The Davis-Bonneterre contact (Figure 2-4) refers to a line tracing the location where the contact of the Davis shale and Bonneterre dolomite is at the bedrock surface. Because of variations in uplift and surface erosion, it traces a sinuous path through the BRMTS OU1. As discussed above, the Davis shale acted as an aquitard to the upward movement of mineralizing fluids through the Bonneterre and resulted in the deposition of galena at the interface between the two geological units. Subsequent weathering and erosion exposed this contact and the galena deposits associated with it (Figure 2-5). In OU1, much of the area where historical surficial mining occurred is found along this contact line, which indicates that rich galena deposits were found at these locations.

During mineralization of the Bonneterre dolomite, ore-bearing fluids filled faults and fractures in the rock (Figure 2-6). Chemical weathering of the dolomite, which is largely a process of dissolution of the rock, formed a red-clay residuum overlaying the bedrock. The low solubility of galena resulted in concentration of this mineral in the residuum and a surface expression of the lead ore (Figure 2-6). The activity of surficial mining (described below) removed some of the galena but left behind disturbed areas with elevated lead concentrations. These residual lead concentrations in the 100s to 1,000s of mg/kg are far lower than the original ore concentrations, but still include concentrations exceeding EPA's action level.

During mineralization of the Eminence and Potosi dolomites that form the bedrock surface in the SE Missouri Barite District, ore-bearing fluids filled faults, joints, and vugs. Galena was deposited near the central flow structures and barite was deposited on a more widespread basis (Kaiser et al. 1987). This mineralization occurs in much of St. Francois County, the northeast portion of Washington County, and the southwest portion of Jefferson County. Solution weathering of the Eminence and Potosi dolomites formed the red-clay residuum overlaying the bedrock. The lower solubility of galena and barite resulted in concentration of these minerals in the red-clay residuum. This type of weathering is associated with little soil movement; because of this, the patterns of galena and barite deposition in the residuum reflect their patterns in the host rock (Figure 2-7). The activity of surficial mining (described below) removed some of the lead and barite ores but left behind a disturbed area with elevated lead concentrations.

In southeast Missouri, two forms of lead ore were encountered, massive and disseminated. The massive galena consisted of large chunks of ore (up to hundreds of pounds), and was primarily encountered in surficial deposits. These massive galena deposits were mined during the surficial lead mining eras of the BRMTS OU1, the WCLD, and portions of southwest Jefferson County. Disseminated lead, which consisted of smaller galena crystals distributed throughout the rock, was the primary form of lead ore mined during the hardrock mining era at the

BRMTS; disseminated lead occurred throughout the depth of the Bonneterre at varying concentrations, as shown in a rock section for the Bonneterre mine (Figure 2-8). Typical ore grades for the Old Lead Belt were 4 to 6 percent lead (AIME 1917).

3 CONTRIBUTIONS FROM HISTORICAL LEAD DIGGINGS

Mining of surficial deposits of lead ore dates to the 1720s in the Big River watershed. This early mining was extensive and intense, as indicated by the following quote from the book *Opening the Ozarks* (Schroeder 2002):

> "Because the lead ore occurred over tens of thousands of acres of land, no person could monopolize mining. Should someone seize a miner's pits, the latter could go elsewhere and find more lead…..Naturalist John Bradbury reported that out of forty sites dug in the Richwoods area, thirty-eight contained lead ore. "

The earliest lead mining in the Big River watershed occurred in areas that are now encompassed by the BRMTS OU1, the WCLD, and portions of southwest Jefferson County. This early mining involved the extraction of large crystals of galena and was associated with local and inefficient processing and smelting of the extracted ore.

The extent of this surface mining is demonstrated by an 1824 map (Figure 3-1) (American State Papers 1824), which showed widespread surface diggings of lead occurring throughout southeast Missouri.

3.1 SURFICIAL LEAD MINING IN ST. FRANCOIS COUNTY

The earliest mining of lead in St. Francois County exploited surface and near-surface deposits of galena. This historical surface mining extracted massive crystals of galena that were found either in the residuum or occurred in crevices and caves in the uppermost portion of the bedrock. With the arrival of the diamond drill, many areas of historical surface mining were, subsequently, the locations of underground mining. The locations of historical surface mining are presented in Figure 3-2. This map is based on documentation of surficial mining contained in early maps and historical documents (Schoolcraft 1819; American State Papers 1824, 1826; Swallow 1855; Buckley 1908; Dake 1930). The boundaries of the lead diggings should be considered both approximate and an underestimate of overall area because only the most significant diggings would have been documented. Additional evidence of the wide-scale existence of surficial mining in St. Francois County is provided by the fact that the U.S. government reserved parcels of land because land surveys had indicated that lead ores existed on these parcels (American State Papers 1826), and the history of Spanish and French land grants for lead mining prior to the Louisiana Purchase in 1803 (Schroeder 2002). The remains of surface mining are evident even today (Figure 3-3).

3.2 LEAD MINING IN THE WCLD AND JEFFERSON COUNTY

Documented mining for lead in the WCLD dates to 1725 with the discoveries of galena at Old Mines and Mine Renault. The first deposits of galena were found at the surface; later, shallow pits (roughly 10 ft deep) were dug to extract the ore. The galena, and co-occurring barite, was found in a red clay matrix. Similar discoveries were being made in Jefferson County by the early 1800s. While early mining did not extend deep into the subsurface, the areal extent was significant. One early report noted, in reference to the WCLD, "…this area may be considered as one extensive lead digging, for there is scarcely a township on which there has not been, at some period, more or less mining…" (Swallow 1855). Figure 3-4 provides an indication of the surface mining that is documented to have occurred in this region.[2] The boundaries of the lead diggings should be considered both approximate and an underestimate of overall area because only the most significant diggings would have been documented.

The opening of the underground mines tapping the disseminated lead in the Bonneterre formation in St. Francois County in the early 1880s resulted in a rapid shift away from the residuum lead mines of the WCLD and Jefferson County. By the 1920s, the only lead production from the WCLD was as a byproduct of the barite diggings (Dake 1930). However, barite mining with its associated release of lead-bearing materials continued in the WCLD throughout the 20th century. In Jefferson County, surficial lead mining occurred during the same period as in the WCLD.

3.3 EARLY ORE PROCESSING

Extraction of ores from the soils and residuum was achieved by hand sorting or by the use of rocker boxes. These methods only removed the largest pieces of galena. The rocker boxes had holes such that only materials greater than 3/4 to 1 inch in size were retained; the remainder of the material was left on the ground surface. The efficiency of this process was approximately 50 percent (Weigel 1953). This is a conservative estimate because it relies on milling efficiency records collected by St. Joseph Lead Company between 1865 and 1869, at which time the processes would have been more efficient than during the peak period of surficial lead mining (1820s through 1850s).

Two primary methods were used for the smelting of lead ores: the log and ash furnaces, and the scotch hearth furnace. The earliest mines used log furnaces, in which cleaned ore (ideally, these were fist-sized pieces of galena) was roasted for an extended period of time with a large quantity of wood. Recoveries from log furnaces were typically about 50 percent (Schoolcraft 1819; Swallow 1855). In ash furnaces, which were introduced at some locations in approximately 1800 (MDNR 1988), residual ash from the log furnace was crushed and re-

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[2] The same set of references used to document surface mining in St. Francois County were used to create these additional areas, along with a map of surface mining in the WCLD.

roasted, yielding an additional 15 percent lead recovery (Schoolcraft 1819; Swallow 1855). The scotch hearth, which was introduced in a limited number of locations in approximately 1836 (MDNR 1988), could recover between 70 and 75 percent of the lead from galena ore; with the balance going into the slag and fumes (Middleton 1905). Scotch hearth furnaces required a source of forced air (i.e., the "blast"), which was typically generated by water power, and therefore, many of these furnaces were located on streams. Based on these recovery rates it is estimated that smelting efficiency during the surficial lead mining era was approximately 66 percent.

Table 3-1 provides a summary of early lead production in St. Francois, Washington, and Jefferson counties. Between 1725 and 1869, production of lead from Washington County amounted to slightly over 77,000 tons; for the same period production in St. Francois and Jefferson counties was estimated at 39,000 tons and 11,000 tons, respectively (total of 127,000 tons of lead, Table 3-1). Assuming an average ore extraction rate of 50 percent (Weigel 1953), and an average smelting efficiency of 66 percent, the production of these 127,000 tons of lead would have resulted in approximately 260,000 tons of lead as smelter emissions and lead-bearing solid wastes (Table 3-1) that is now distributed throughout the soils, sediments, and floodplain deposits of the Big River watershed.

4 EXISTING BACKGROUND SOIL LEAD DATA

This section reviews four sets of data that were collected prior to the Integral study discussed in Section 5 of this report. Of these four data sets, two were collected by EPA, and two were collected by the USGS. This section reviews these background soil lead data.

4.1 U.S. EPA DATA SETS

EPA has produced two data sets containing soil lead concentration data that is relevant to establishing background concentrations in OU1.

4.1.1 BRMTS Ecological Risk Assessment

The BRMTS ecological risk assessment (ERA; USEPA 2006) included 10 background soil samples. The study design and methods used are provided in the field sampling plan (FSP; Black & Veatch 2005). Analytical data from the ERA was provided by EPA to Integral. Coordinates for three of the sampling locations were either missing or unclear: BKG02 and BKG05 were missing coordinates, and BKG04 included two sets of conflicting coordinates. In addition, the available electronic copy of the ERA was of insufficient image quality to allow digitization of the sample location maps. Because of this, sample locations provided in Table 3 of the FSP (Black & Veatch 2005) were used to establish the location of these three samples. A summary of each set of coordinates is provided in Table 4-1.

Soil samples were collected from the 0 to 12 inch soil interval, and were analyzed under the EPA Contract Laboratory Program (CLP) for target analyte list (TAL) metals (Black & Veatch 2005).

The BRMTS FSP (Black & Veatch 2005) states that “background locations were chosen upwind from the chat piles/tailings areas.” However, the FSP then states that “Because there is a reasonably high likelihood that soils in upwind locations of the chat and tailings piles are contaminated with metals, Black & Veatch will use a background lead concentration of 60 mg/kg as a reference.” In the ERA (USEPA 2006), 9 of the 10 background locations were reclassified as “off-pile locations” because lead concentrations in these samples exceeded the 60 mg/kg value that EPA had arbitrarily set as a “background” value (Table 4-1). No attempt appears to have been made to identify the source(s) of the lead in these samples.

Locations of these 10 samples were compared with the mining-related buffers and EPA Halos, which are defined in Section 5. None of these samples was found to be located in proximity to a known mining-related lead source. As a result, they are legitimate background samples.

Results are presented in Table 4-1 and on Figure 4-1. Three of these 10 soil samples (30 percent) exceeded EPA's cleanup standard for lead in residential soils (400 mg/kg). These samples contained lead concentrations of 546; 3,580; and 10,900 mg/kg.

4.1.2 WCLD Ecological Risk Assessment

The ERA for the Washington County Lead District – Potosi Site (USEPA 2008b) contains data for 11 soil samples collected in the WCLD. These samples are identified as being "mining impacted." The ERA also states that "Background locations within the boundaries of the Potosi Site are not available due to the widespread nature of the mining" (EPA 2008b). Lead in "mining impacted" soils of the WCLD results from surficial mining for lead and barite, which was conducted in the same manner as the surficial lead mining in the BRMTS OU1. Thus, these data are considered representative of background samples for the purposes of characterizing soil lead concentrations resulting from surficial mining in OU1.

Soil samples were collected from the 0 to 12 inch soil interval and analyzed under the EPA CLP for TAL metals (USEPA 2008a). Results are presented in Table 4-2 and on Figure 4-2. Four of these 11 soil samples (36 percent) exceed EPA's cleanup standard for lead in residential soils of 400 mg/kg. These four samples contained lead concentrations of 1,160; 1,560; 2,150; and 2,540 mg/kg lead.

4.2 USGS DATA SETS

The USGS has produced two data sets that also help define background soil lead concentrations in the Big River watershed.

4.2.1 PLUTO Database

The USGS has developed a nationwide database of soil geochemistry called PLUTO (USGS 2001). This includes soil data collected over two decades, starting in the 1970s. All samples were analyzed at USGS analytical facilities. Results for the PLUTO samples located within the Big River watershed are shown in Table 4-3 and on Figure 4-3. Six of these samples appear to be located on the Big River flood plain (see Table 4-3) and were not used in this report for the evaluation of background soil lead concentrations because they are floodplain materials rather than upland soils. Of the 59 non-floodplain samples, 11 (19 percent) exceeded EPA's residential soil lead standard of 400 mg/kg, with concentrations ranging from 500 to 7,000 mg/kg lead.

This data set was used by Newfields to calculate a "background" lead concentration for soils in St. Francois County (Newfields 2006). For the entire county (not just the unique, mineralized soils in OU1), Newfields calculated a geometric mean of 62 mg/kg lead. However, a geometric mean is not a useful statistic for describing background soil lead concentrations in OU1, for the reasons discussed below.

4.2.2 38th Parallel Data Set

The USGS also performed a study that collected samples along two transects spanning North America; one transect east-west, the second north-south. The east-west transect approximately follows the 38th parallel, which is located just to the north of the BRMTS OU1. The results of the pilot phase of this study have been published (USGS 2005) and contain six results for surface soil samples that fall within the Big River watershed (Table 4-4). However, all of these results appear to have been collected at just two locations (see Figure 4-3). None of these results exceed EPA's residential soil lead standard of 400 mg/kg, which is not surprising given the variability in background soil lead concentrations and the fact that only two locations were sampled.

5 BACKGROUND LEAD STUDY

Within the Big River watershed, background lead occurs in soil due to both the presence of native, mineralized soils and the lead-bearing wastes that have been distributed in soils from surficial mining activities. The background lead study was designed to further evaluate the magnitude and distribution of these background soil lead concentrations.

The goals of the background soil lead study were to:

1. Characterize the range of background soil lead concentrations within OU1
2. Characterize the variability of background soil lead concentrations within OU1
3. Evaluate whether the spatial distribution of background soil lead concentrations is related to site geology (e.g., proximity to the Bonneterre-Davis contact) or the presence of early (pre-1860) surficial mining.

5.1 STUDY DESIGN

The background study used a random stratified design. In this type of design, a larger, heterogeneous population is divided into homogenous subpopulations before sampling. The sampling within each subpopulation is then performed randomly. The purpose of this sampling method is to increase the representativeness of the samples collected from each subpopulation.

The sampling strata were defined based on an understanding of geology, ore mineralization, and anthropogenic activities. The three sampling strata were:

1. Areas where early surficial mining had occurred
2. An area proximate to the Bonneterre-Davis contact (called the “Bonneterre-Davis contact zone”)
3. Native, undisturbed soil within, or close to, OU1 (called “general background soils”).

Early surficial mining areas were defined as all areas with documented lead diggings (see Figure 3-2). The Bonneterre-Davis contact zone was defined as all areas within 600 m of the contact line that did not fall in surficial mining areas. (The 600 m distance was selected based on an evaluation of the existing residential soil lead data and the observation that, on average, soil lead concentrations are elevated within this area and drop off outside of it.) Native, undisturbed soils consisted of all other background sampling locations (i.e., not those in the surficial mining or contact zone areas) within, or close to, OU1.

To constrain the study to only legitimate background sampling locations, all areas that could plausibly have been impacted by activities associated with the hardrock mining era (e.g., all site-related activities) were eliminated from the sampling areas. This included chat piles and tailings ponds, mills, smelters, mine shafts, railways, and all roads that could potentially have served as concentrate haul routes. In addition, soils close to all major roads were excluded from the study to eliminate any contributions from the use of leaded gasoline.

To accomplish this, buffer zones were placed around the following potential lead sources:

- Chat piles and tailings ponds—152 m (500 ft, as per EPA's Halo definition)
- Smelters/calciners—304 m (1,000 ft, as per EPA's Halo definition)
- Mine shafts—30 m (100 ft, as per EPA's Halo definition)
- Mills—200 m
- Historic and active railways—100 m
- Potential concentrate haul routes—50 m
- Major roads—30 m.

Additional areas excluded from consideration as background sampling locations included the 100-year Federal Emergency Management Agency floodplain for the Big River and Flat River Creek, urban/suburban areas where housing is located, industrial areas, and disturbed lands. This resulted in the sampling areas identified on Figure 5-1.

5.2 SOIL SAMPLE COLLECTION AND ANALYSIS

Two rounds of soil sampling were conducted. The first was of the background soils for the formal background study and the second was a set of targeted soil samples collected from surficial mining areas and of barite tailings.

5.2.1 Background Study Soils

Extent of sampling coverage was limited by property access. Ultimately, samples were collected on Doe Run property, in St. Joe and St. Francois state parks, and on private property to which access had been granted.

The background soil sampling was conducted on August 5–9, 2013, and resulted in the collection of 62 background soil samples, including 33 contact zone samples, 12 historical mining samples, and 17 general background samples. These counts include a total of three field duplicates. Soil samples were collected from 0 to 6 inches in depth using a stainless-steel soil auger. Photographs of sampling locations are provided in Appendix A.

All soil samples were shipped to ALS Laboratories (Kelso, Washington) for analysis. Soil samples were air-dried and sieved to less than 2 mm. Following sieving, samples were homogenized by crushing, and multi-increment sampled (ITRC 2012) to obtain a soil subsample for analysis. Samples were digested according to EPA Method 3050B, and analyzed for metals (barium, cadmium, copper, lead, and zinc) by inductively coupled plasma-atomic emission spectroscopy (ICP-AES; EPA Method 6010C).

5.2.2 Collection and Analysis of Targeted Soil Samples

Additional soil samples were collected by Doe Run at three locations during the week of August 12th. These locations included:

1. Mine-a-Joe (10 samples)
2. Firmin-Desloge Park (6 samples)
3. Star Mine tailings discharge point (7 samples).

Mine-a-Joe is a documented area of historical surficial lead mining located to the west of the town of Desloge (Figure 3-2), while Firmin-Desloge Park is another area of surficial lead mining that is located to the south of Potosi. The Star Mine Tailings Pond is located north of the town of Old Mines; barite was mined here from 1944 to 1957, producing more than 75,000 tons of concentrate (Wharton 1972). The Star Mine tailings samples were collected from the drainage into which the tailings pond decant structure discharged during the operational life of the impoundment. As a result, these samples represent barite tailings that have been discharged to streams that ultimately flow into the Big River.

Samples were collected from 0 to 3 inches in depth using a stainless steel trowel and shipped to Integral's laboratory in Louisville, Colorado, for analysis of metals concentrations.

Soil samples were processed by air-drying, disaggregation, and sieving to <2 mm, and were then ground to <0.5 mm. Following processing, samples were homogenized and incrementally sub-sampled to obtain replicate aliquots for energy dispersive x-ray fluorescence (EDXRF) analysis. Concentrations of barium, cadmium, copper, lead, and zinc were measured using a Bruker Tracer III-V+ EDXRF spectrometer using 60-second spectra acquisitions. Element concentrations in site samples were determined by calibration against National Institute of Standards and Technology Standard Reference Material 2710, which was analyzed by EDXRF in parallel with site samples. Reported element concentrations include the mean and standard deviation of triplicate analyses.

5.3 BONNETERRE OUTCROP SAMPLING

Surface outcrops of Bonneterre dolomite were collected to directly investigate the connection between bedrock and soil lead concentrations. At each of these locations, a co-located soil sample was collected.

5.3.1 Bonneterre Outcrop Sampling

Samples were collected from outcrops of Bonneterre dolomite on August 8 and 9, 2013, by Doe Run personnel. Of the 11 locations at which samples were collected, 10 were located on highway right-of-way and one was located on private property to which access had been granted. At each outcrop location, three rock samples were collected within an approximate distance of 2 m along the outcrop. At each location, a rock hammer was used to break off approximately 200 g of rock. Photographs of the sampling locations are provided in Appendix A.

One sample of the overlaying soil was collected at each outcrop location. Because there was very little, if any, soil directly over the outcropping rock, these soils were collected far enough back from the outcrop to obtain a 6-inch soil core. The soil samples were collected in the manner described in Section 5.2.1.

The 33 rock and 11 soil samples were shipped to ALS Laboratories (Kelso, Washington) for analysis. Rock samples were pulverized in a shatter box, a subsample was digested according to EPA Method 3050B, and concentrations of barium, cadmium, copper, lead, and zinc were determined by ICP-AES (EPA Method 6010C). Soil samples were analyzed in the manner described in Section 5.2.1.

5.3.2 Initial Bonneterre Outcrop Sampling

An initial set of five Bonneterre rock samples were collected the week of March 4, 2013, by Doe Run personnel. These samples were collected as described above.

Samples were delivered to Doe Run's Central Laboratory (Viburnum, Missouri) for analysis. The rock samples were pulverized in a shatter box, digested according to EPA Method 3050B, and concentrations of copper, lead, and zinc were determined by ICP-AES (EPA Method 6010C).

5.4 DATA VALIDATION

The soil and rock data produced by ALS Laboratories received Stage 2B validation, per EPA's functional guidelines for inorganic data review (USEPA 2004).

All results were found to be acceptable for their intended use.

A data validation report is provided in Appendix B.

5.5 STUDY RESULTS

Complete results of soil, rock, and co-located soil and rock samples are presented in Tables 5-1 through 5-4. Of the 72 samples collected for the background study, 28 samples (39 percent) exceeded EPA's residential cleanup goal of 400 mg/kg. These results are consistent with those from EPA's BRMTS and WCLD ERAs and the USGS PLUTO data set, in which 30, 36, and 19 percent, respectively, of the samples exceeded 400 mg/kg.

5.5.1 Spatial Data Evaluation

The sampling described above resulted in the collection of soil, rock, and co-located soil and rock samples from the vicinity of OU1. Sampling locations are shown on Figure 5-2. The results, as they relate to surficial mining, contact zone, and general background areas, are shown on Figures 5-3 and 5-4. Note that all results color coded yellow, orange, or red in these figures exceed EPA's residential cleanup standard of 400 mg/kg, and results color coded red exceed the time critical removal action level of 1,200 mg/kg. The distribution and magnitude of the background soil lead concentrations indicate that the surficial mining and Bonneterre-Davis contact zone areas contain the highest lead concentrations.

Results for the Bonneterre outcrop samples show a distinct geographic pattern. The samples collected on the approximate north-south transect, roughly paralleling Highway 67, have lead concentrations less than 25 mg/kg (Figure 5-5). The initial rock samples, collected on an approximate east-west transect, roughly paralleling Highway 8, have much higher lead concentrations, in the range of 600 to 2,000 mg/kg. This pattern is consistent with the background soils, where most samples have low concentrations, with a subset of high concentration samples. Evaluation of the co-located rock and soil samples (Figure 5-5) indicates that the soils invariably contain greater lead concentrations than the underlying rock. This is consistent with the premise that chemical weathering of the dolomite concentrates lead in the overlying soils.

5.5.2 Statistical Data Evaluation

For the statistical analyses, the background soil data developed by EPA, USGS, and Integral were categorized by spatial location (see Tables 4-1 through 5-2). To accomplish this, the location of each sample was categorized as to whether it fell within the surficial mining areas, the Bonneterre-Davis contact zone, or the general background areas. As mentioned previously, Big River floodplain samples from the USGS PLUTO data set were excluded from the background soil data set. In addition, the samples from the Star Mine discharge location were excluded because they represent tailings, rather than soils.

Histograms provide a simple, visual display of data distribution and are particularly important for the Big River data set, given its unique nature. Figure 5-6 presents a histogram for the entire background soil lead data set for the Big River watershed (n = 165). Distributions of this type are described as having a long right-hand tail and, although the majority of samples contain less than 200 mg/kg, there are also a significant number that contain more than 400 mg/kg (46 out of 165 samples, or 28 percent). These samples exceeding 400 mg/kg are distributed relatively evenly up to, and beyond, concentrations of 1,200 mg/kg lead.

When the full data set is broken down into subpopulations (Figure 5-7), the general background and contact zone populations exhibit the same data distribution as the full data set (as do the EPA and USGS background data sets). As expected, based on site geology, the contact zone data set contains the two background samples with the highest lead concentrations (10,900 and 16,300 mg/kg). The occurrence of elevated and highly variable lead concentrations results from a "nugget effect" in which any given soil sample may contain a grain of galena (or its alteration products). This suggests that these particular contact zone samples were collected in the vicinity of a lead-bearing portion of the Bonneterre formation.

In contrast, the histogram for the surficial mining data subset shows a distinctly different profile. In this case, the dominant population ranges from 400 to 1,200 mg/kg lead, with relatively little variability. This situation would have resulted from mixing of soils during historical surface mining, resulting in homogenization of the residual lead in the area of the diggings (Figure 5-7). Thus, where residences have been constructed on top of areas that were surface mined, background soil lead concentrations will generally exceed 400 mg/kg (unless clean fill was placed on top of the existing soils). As indicated on Figure 5-8, approximately half of the current residential areas in OU1 occur on top of surface mined areas (for this analysis, residential areas were defined as urban and suburban residential areas).

5.5.2.1 Summary Statistics

EPA guidance for comparing environmental samples to site-specific background concentrations recommends that background threshold values be calculated and used for this comparison. Background threshold values take the form of 95th upper confidence limits (UCLs) for comparing average site concentrations to a background value or 95th upper prediction limits (UPLs) for comparing individual sample concentrations to a background value (USEPA 2013). Thus, if the lead concentration of a particular sample is less than the 95th UPL, then that sample is representative of background conditions.

Summary statistics and background threshold values were calculated for the full Big River watershed data set, and the historical mining, contact zone, and general background subpopulations, using the EPA software package ProUCL (version 5.0.00) (USEPA 2013). The results of these statistical analyses, including median, average, 95th UCL, and 95th UPL are presented in Table 5-5.

The geometric mean (geomean) is not presented in Table 5-5 because it is not a meaningful statistic for describing the background soil lead data in the Big River watershed. The geomean is designed to reduce the influence of particularly high or low values in a data set. While this may be appropriate in some situations, it obscures the distribution of the data, which is particularly important to understanding background lead concentrations in the soils of the Big River watershed. Elevated lead concentrations occur in these soils due to natural mineralization and the surface mining and associated ore processing and smelting that occurred over a 150-year period. Thus, excluding or reducing the importance of high concentration samples simply because they have high concentrations is not justified. The exclusion of samples as not valid background samples would require knowledge of a sample having been impacted by site-related releases or activities.

Table 5-5 presents the 95th UCL and 95th UPL values for the entire Big River watershed background data set, and for the three sampling strata utilized in the Integral background study: surficial mining areas, the Davis-Bonneterre contact zone, and general background soils. Applying these background threshold values to the Big River watershed data set indicates that if a set of samples were collected anywhere in the watershed, and the average lead concentration was less than 1,143 mg/kg lead (the 95th UCL for the entire watershed) then that set of samples would be representative of background. In addition, if any individual sample from that set of samples had a lead concentration less than 1,777 mg/kg lead (the 95th UPL for the entire watershed) then the lead in that individual sample could be from background. Applying the background threshold values to the surficially mined soils indicates that if a set of samples had an average lead concentration less than 910 mg/kg lead (the 95th UCL for surface mined areas), or any one of those samples had a lead concentration less than 1,481 mg/kg lead (the 95th UPL for surface mined areas) then those samples would be representative of background. Thus, background soil lead concentrations in most of OU1 exceed EPA's residential soil standard of 400 mg/kg.

6 CONCLUSIONS

Background soil lead concentrations in the Big River watershed are characterized by values that are generally less than 200 mg/kg, with a significant population that contain more than 400 mg/kg (46 out of 165 samples, or 28 percent). The data exhibit high variability, with individual samples having concentrations greater than 10,000 mg/kg. This pattern is consistent with observations of soil overlaying lead ore veins, where soils in close proximity to the lead ore have high concentrations, and concentrations decrease with distance from the lead source. Spatially, this pattern leads to "islands" of high concentrations surrounded by areas of low concentrations. Random sampling of this pattern would lead to the majority of the data set having low concentrations, with a subset having high concentrations—depending on where the samples are located relative to the "islands". This distribution of the data is consistent with that observed in the EPA and USGS background data sets and also in the Integral background study.

The exception to this observation is the historical mining areas. In these areas, samples are consistently in the range of 400 to 1,200 mg/kg, with few exceptions. Surface mining is expected to have resulted in the homogenization of lead in the disturbed soils and, thus, relatively consistent lead concentrations across the surficially mined areas. Thus, where residences have been constructed on top of areas that were surface mined, background soil lead concentrations will generally exceed 400 mg/kg (unless clean fill was placed on top of the existing soils). As a result, background soil lead concentrations in the surficial mining areas generally exceed EPA's residential standard of 400 mg/kg.

The large variability of background lead concentrations results in elevated background reference values (95^{th} UCLs and 95^{th} UPLs). Because of these large background reference values, OU1 residential soils are generally indistinguishable from background.

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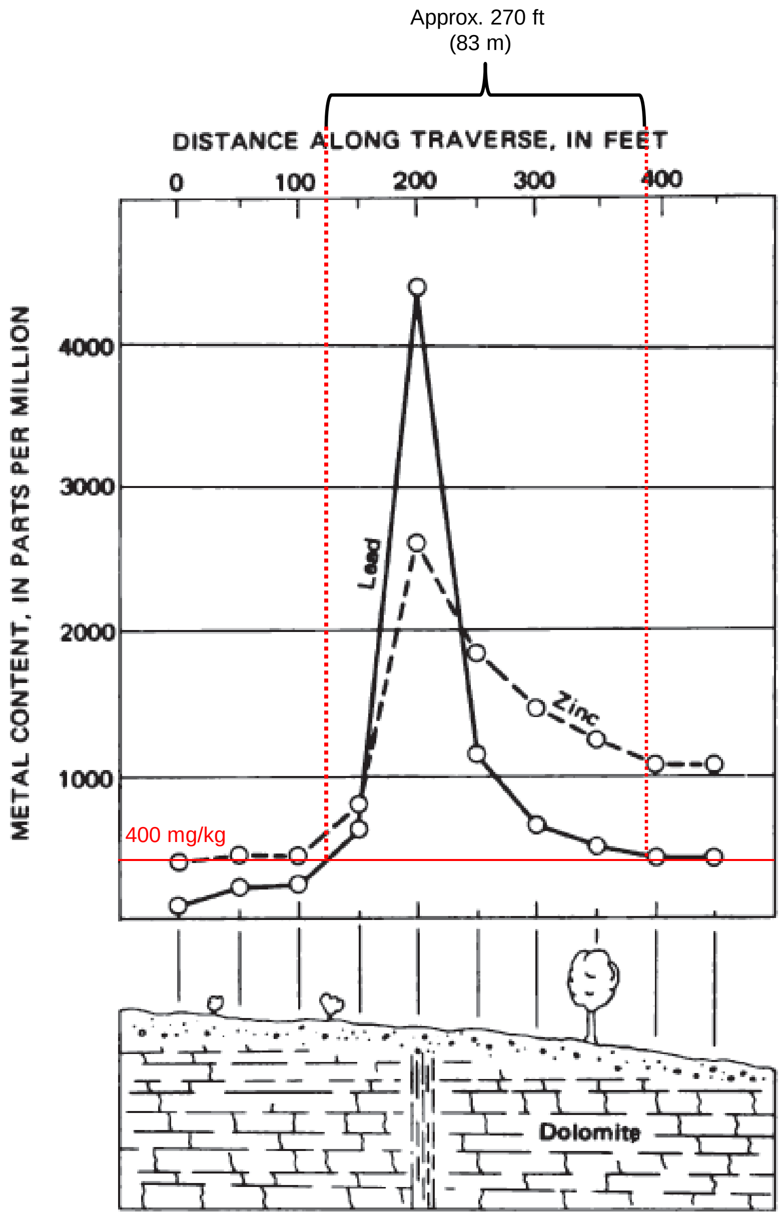
FIGURES



Note: Modified from Huff (1952)

Figure 2-1.
Soil Lead Concentrations Overlaying Lead Ore Vein

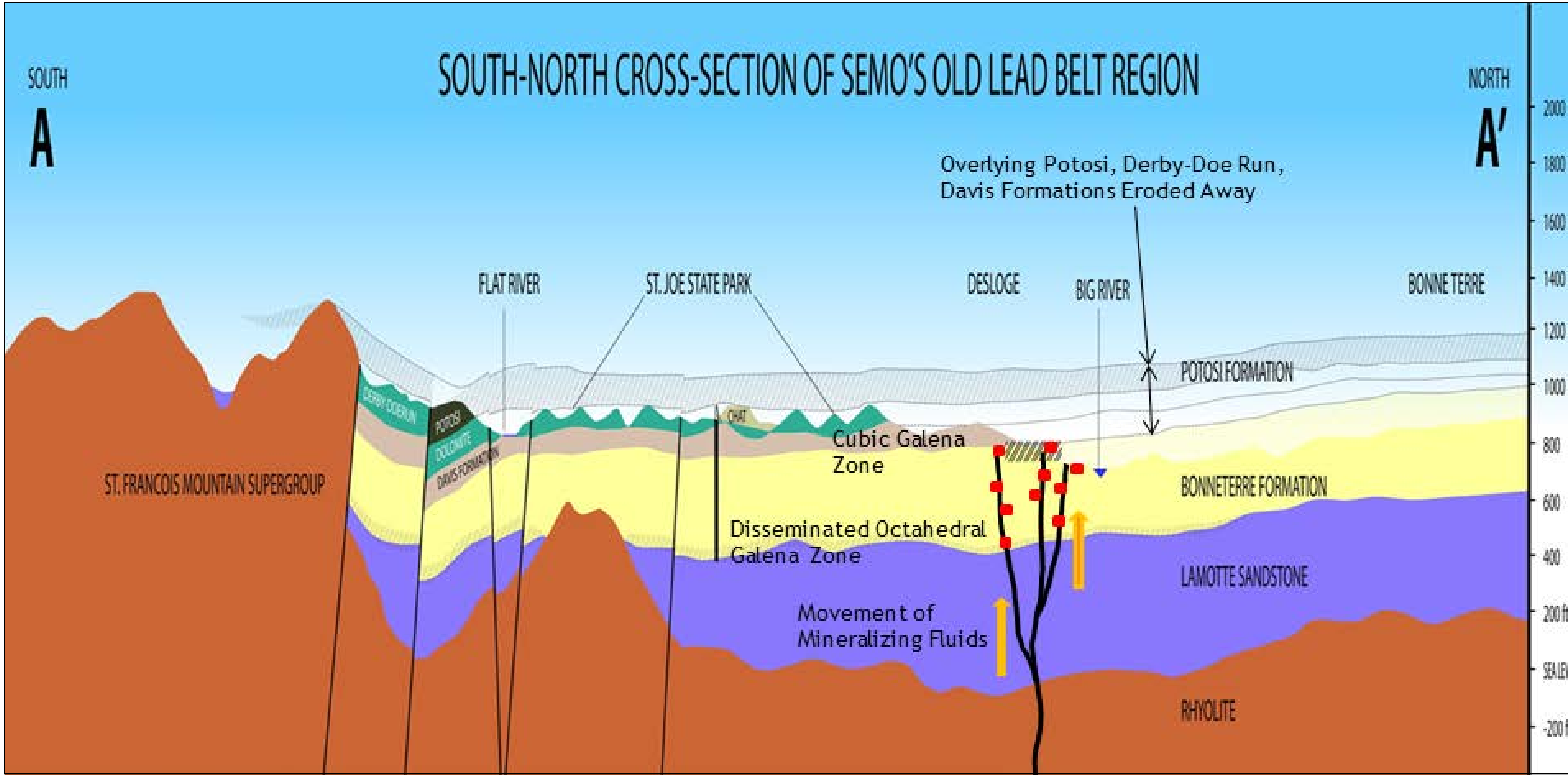


Figure 2-2.
Geologic Cross Section of South East Missouri and Lead Ore Formation Processes

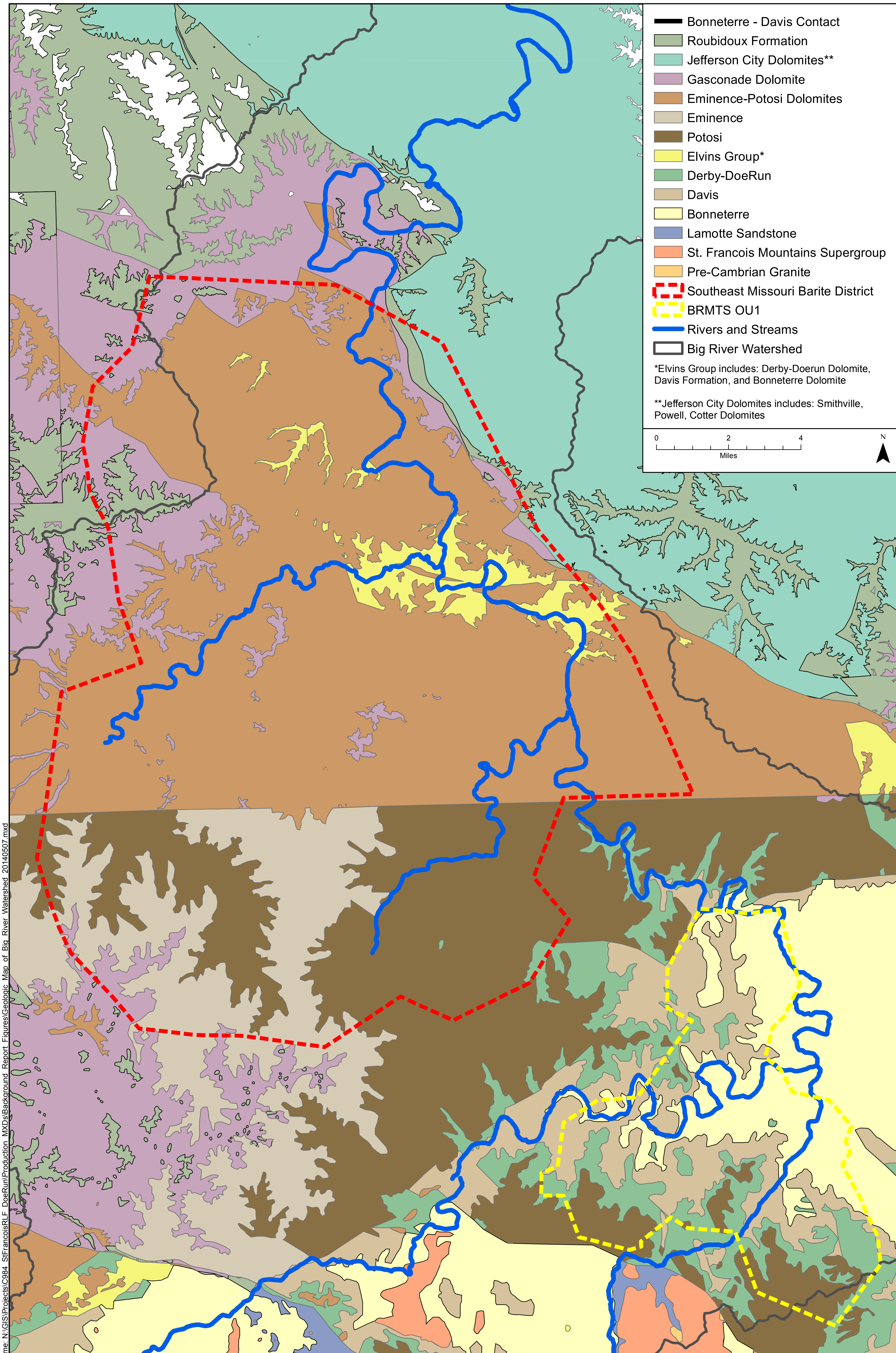


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Figure 2-3.
Geologic Map of Big River Watershed

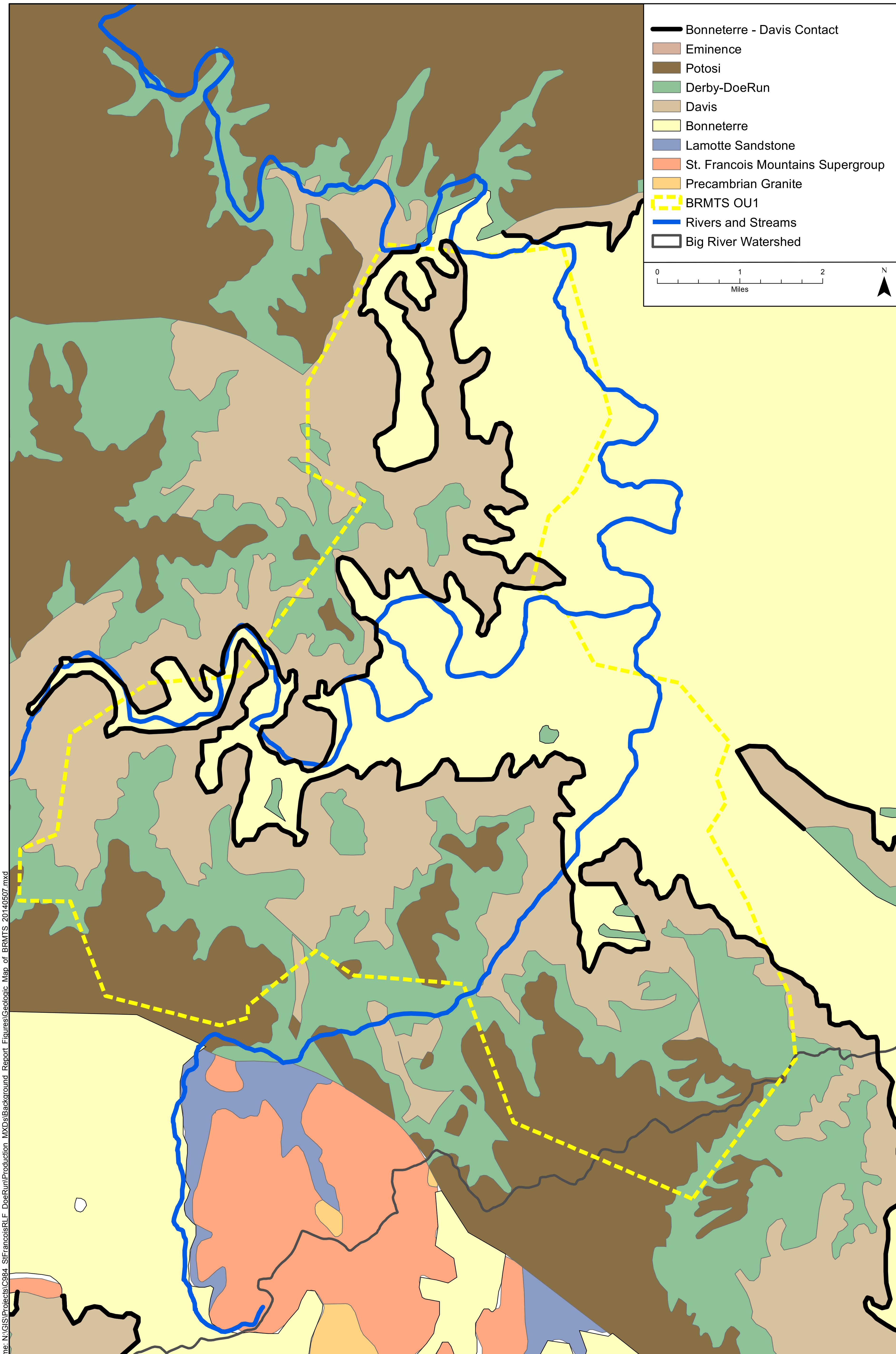

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Figure 2-4.
Geologic Map of the BRMTS OU1

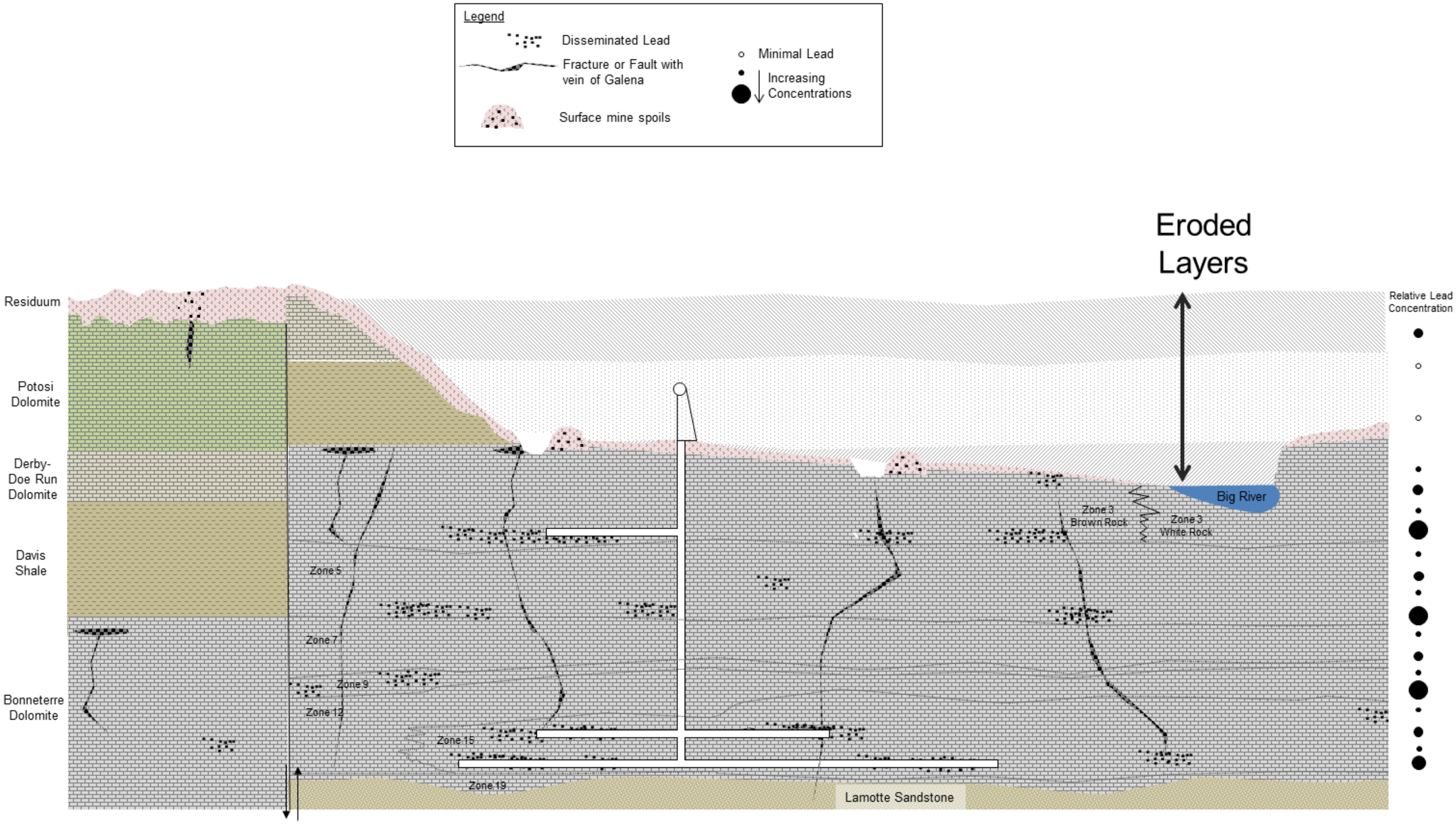

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Figure 2-5.
Schematic of BRMTS Ore Distribution and Results of Weathering, Erosion and Surficial Mining

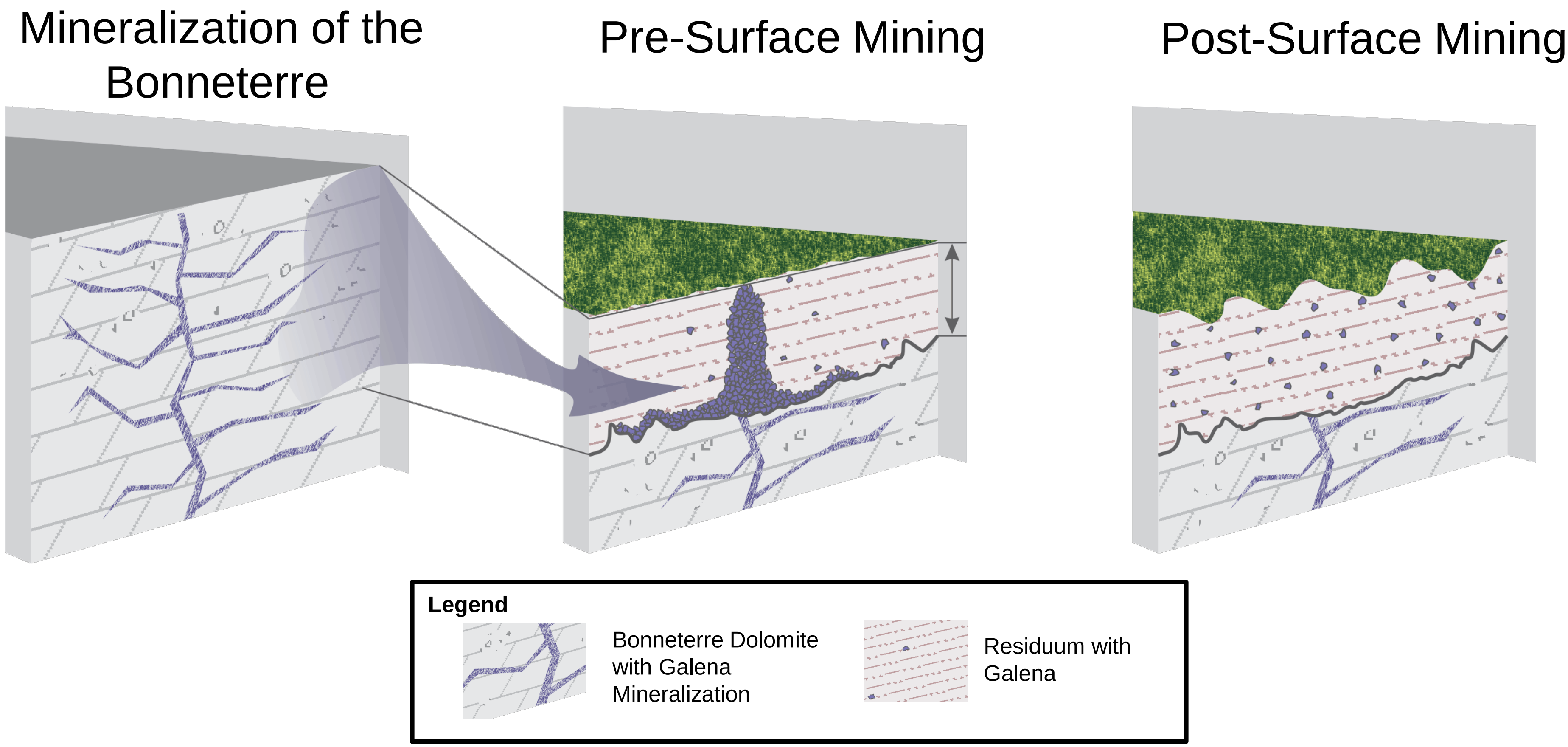

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Figure 2-6.
Schematic of Weathering Processes, Formation of Surficial Lead Ores, and Results of Surface Mining in the BRMTS OU1

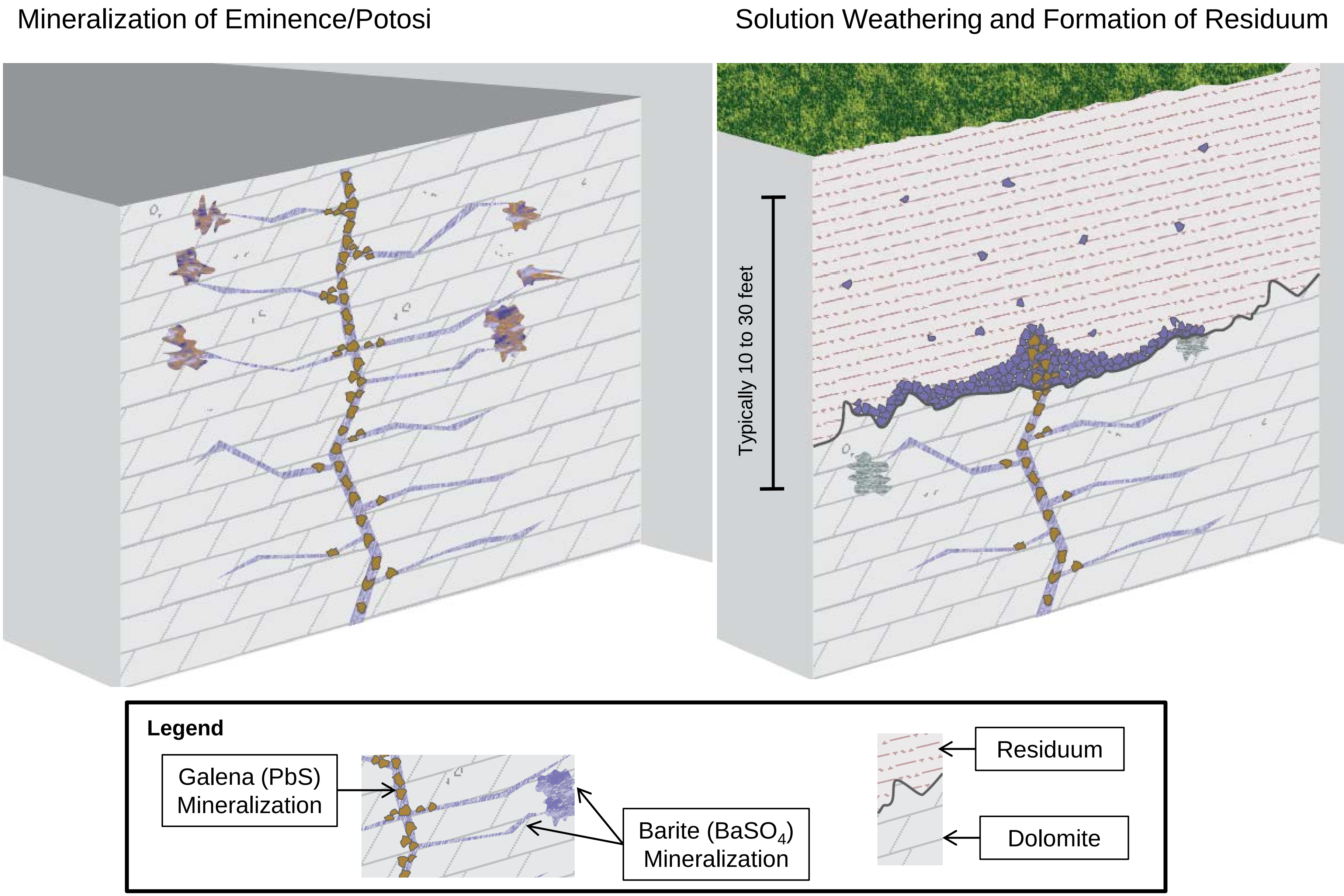

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Figure 2-7.
Schematic of Ore Distribution and Weathering Processes in the SE Missouri Barite District

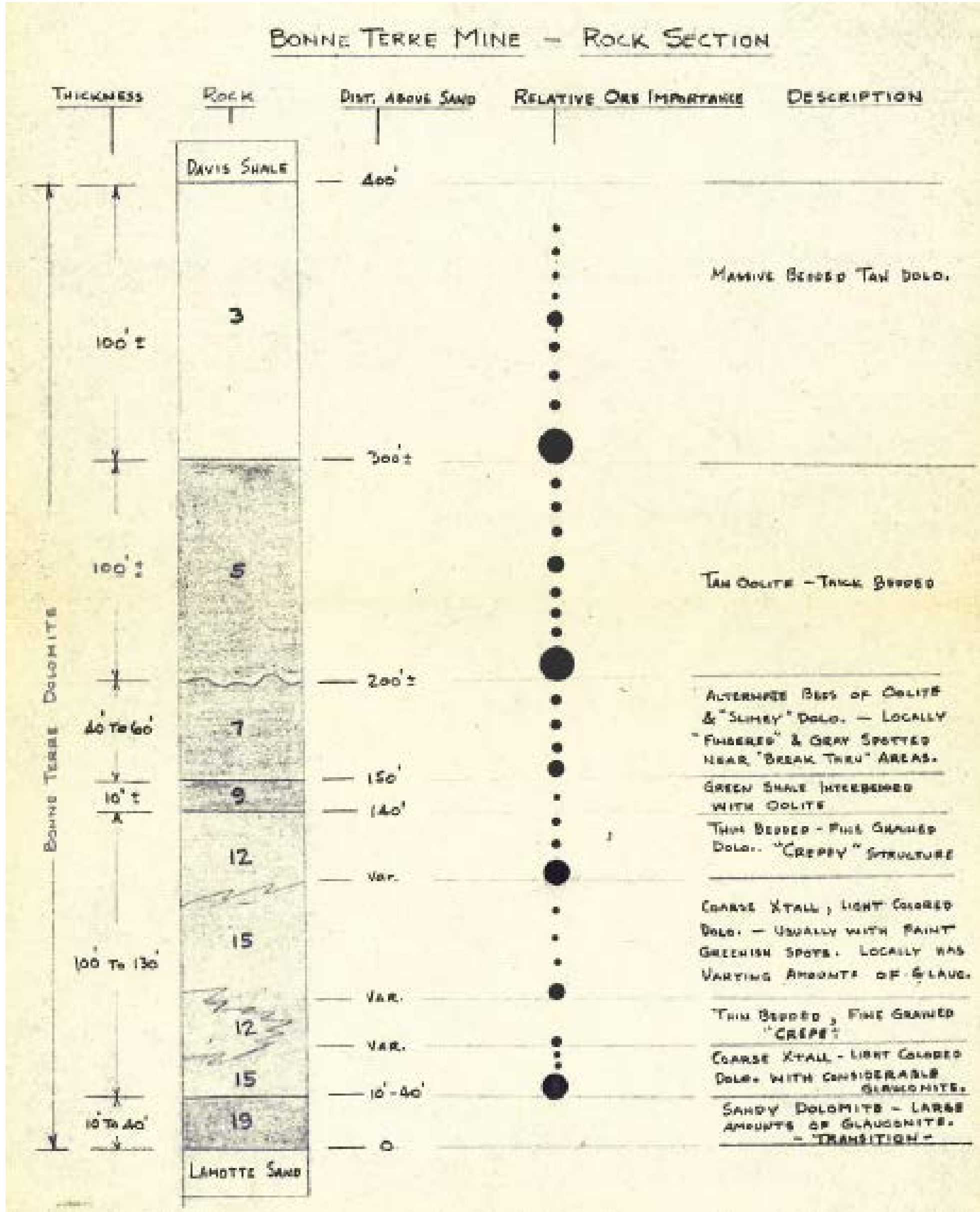

Figure 2-8.
Schematic of Bonne Terre Mine Rock Section

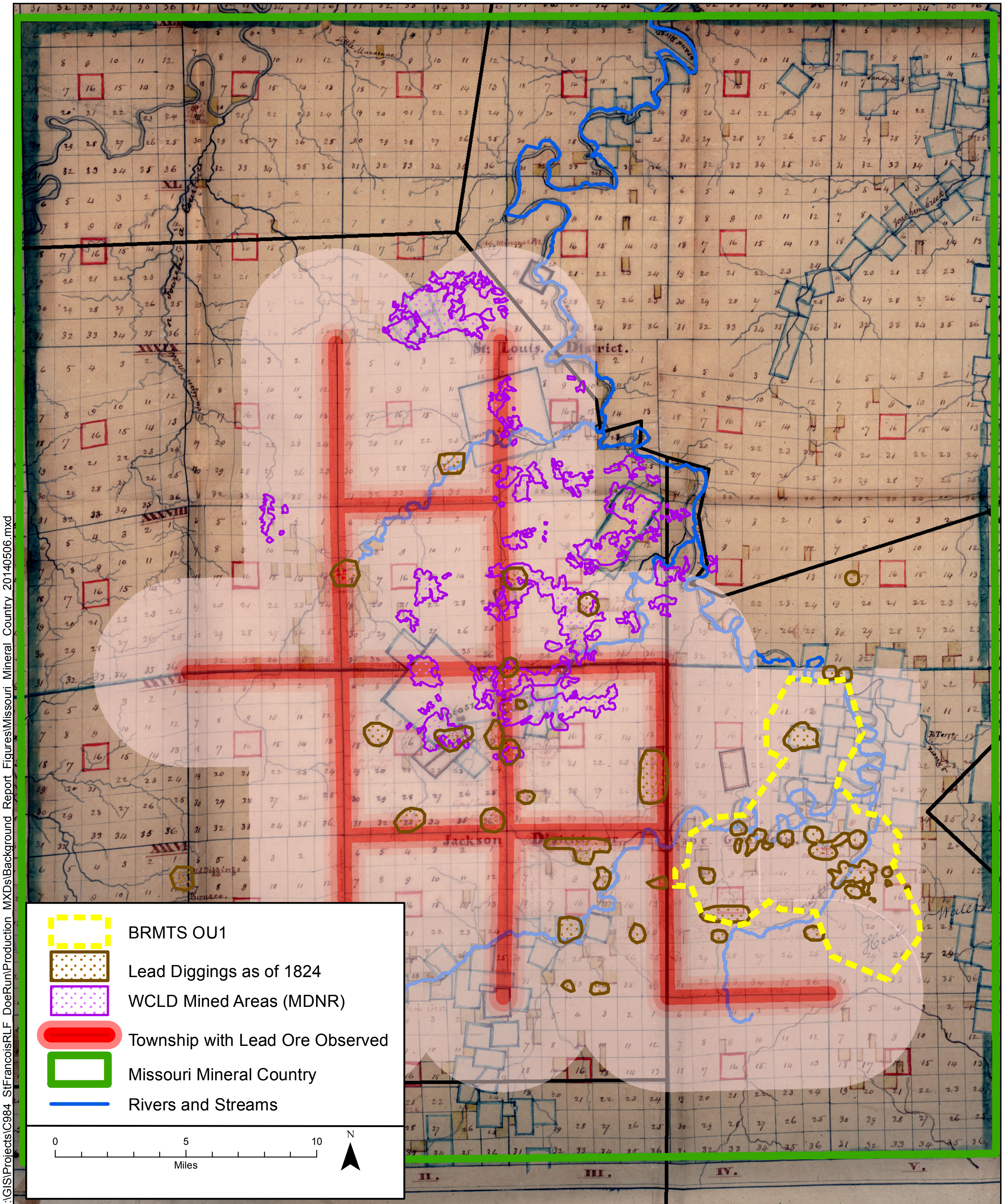

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Figure 3-1.
Surface Lead Ore Occurrence and Surficial Diggings in the Missouri Mineral Country

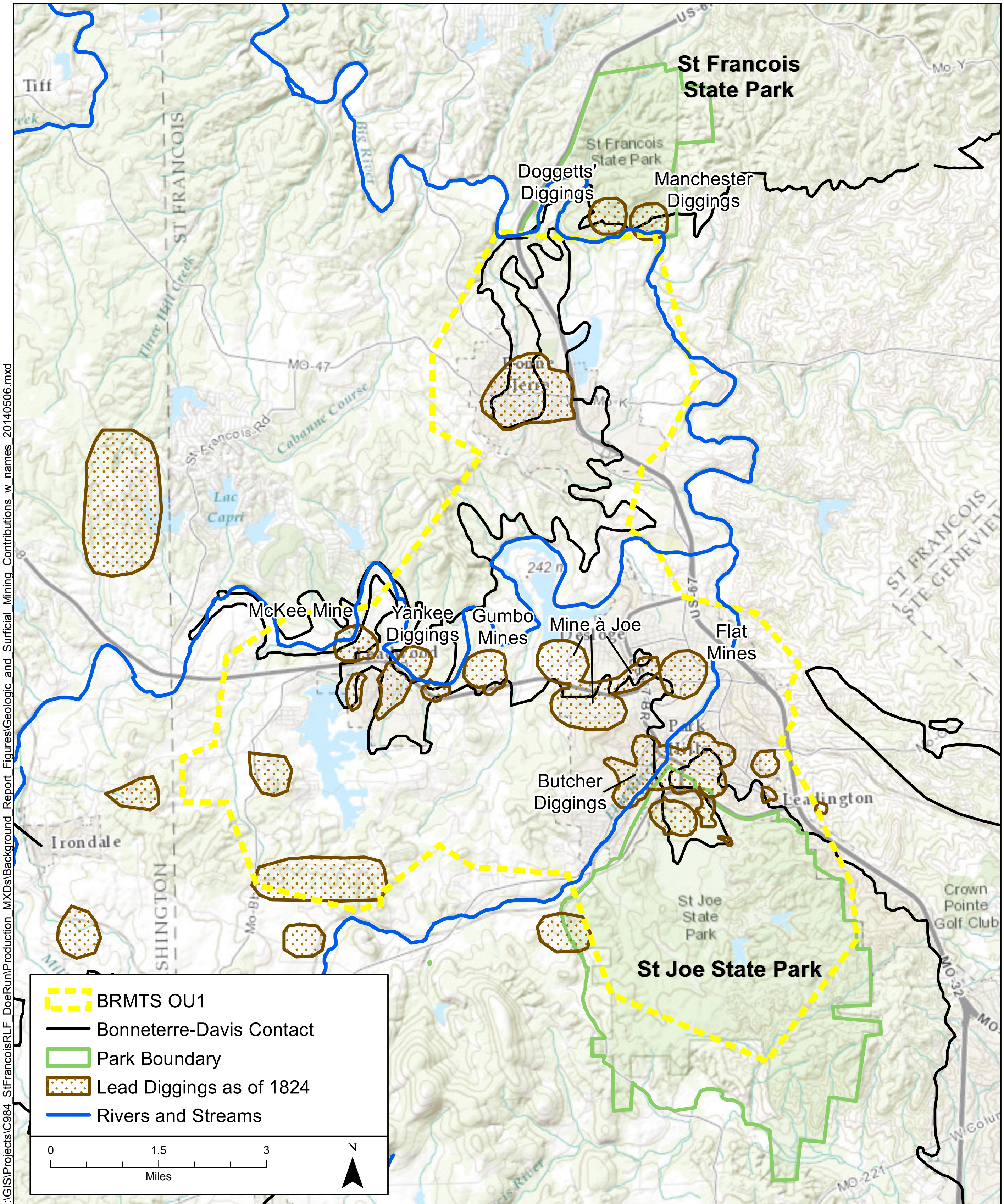

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Figure 3-2.
Lead Diggings in the BRMTS OU1

Doggett's diggings in St. Francois State Park

Surficial diggings near Potosi

Source:http://www.itrcweb.org/miningwaste-guidance/cs28_potosi.htm

Figure 3-3.
Historical Lead Diggings in St. Francois State Park and near Potosi

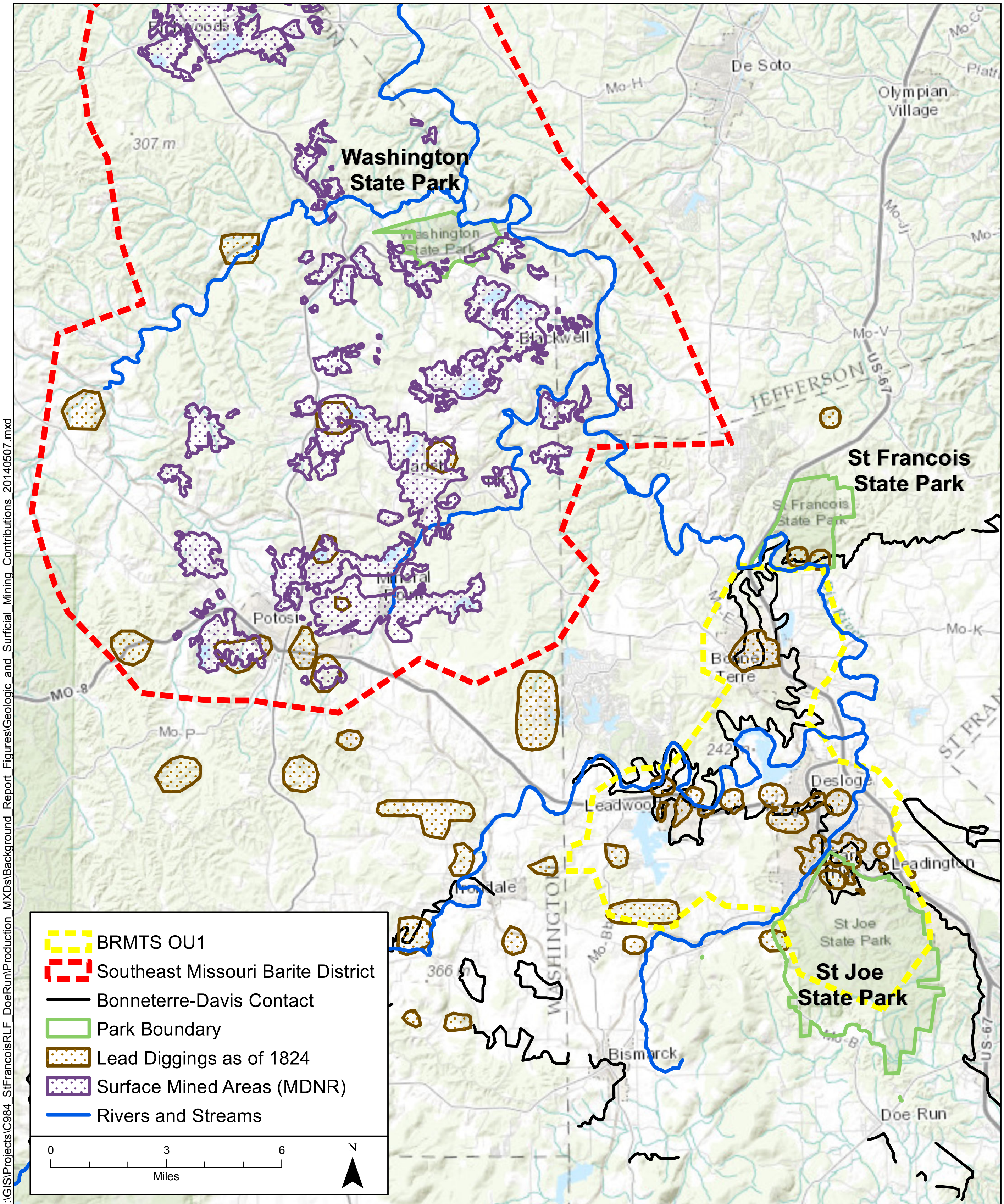

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Figure 3-4.
Surface Mined Areas and the Bonneterre-Davis Contact

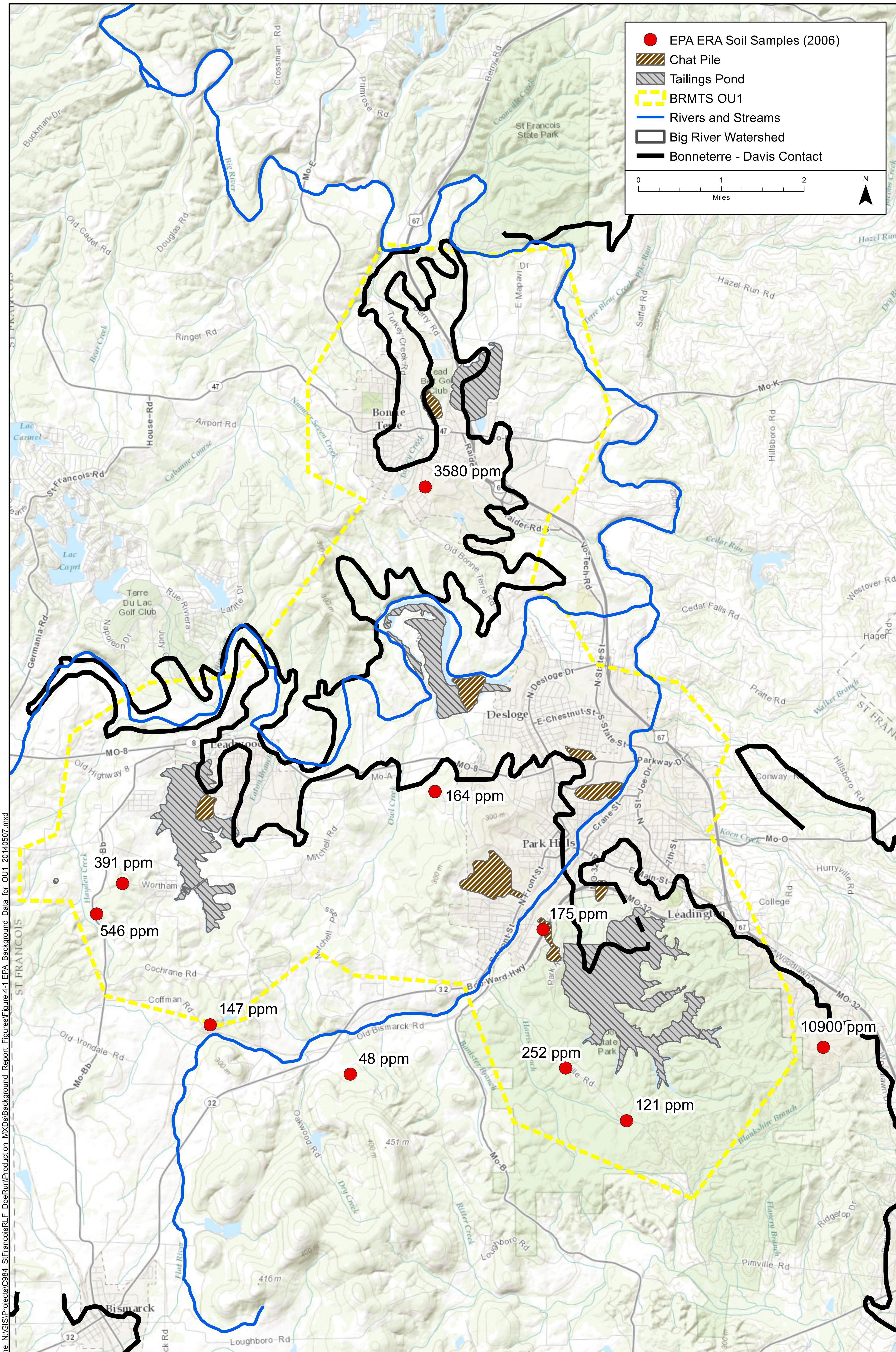

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Figure 4-1.
EPA Background Soil Lead Samples in Vicinity of BRMTS OU1

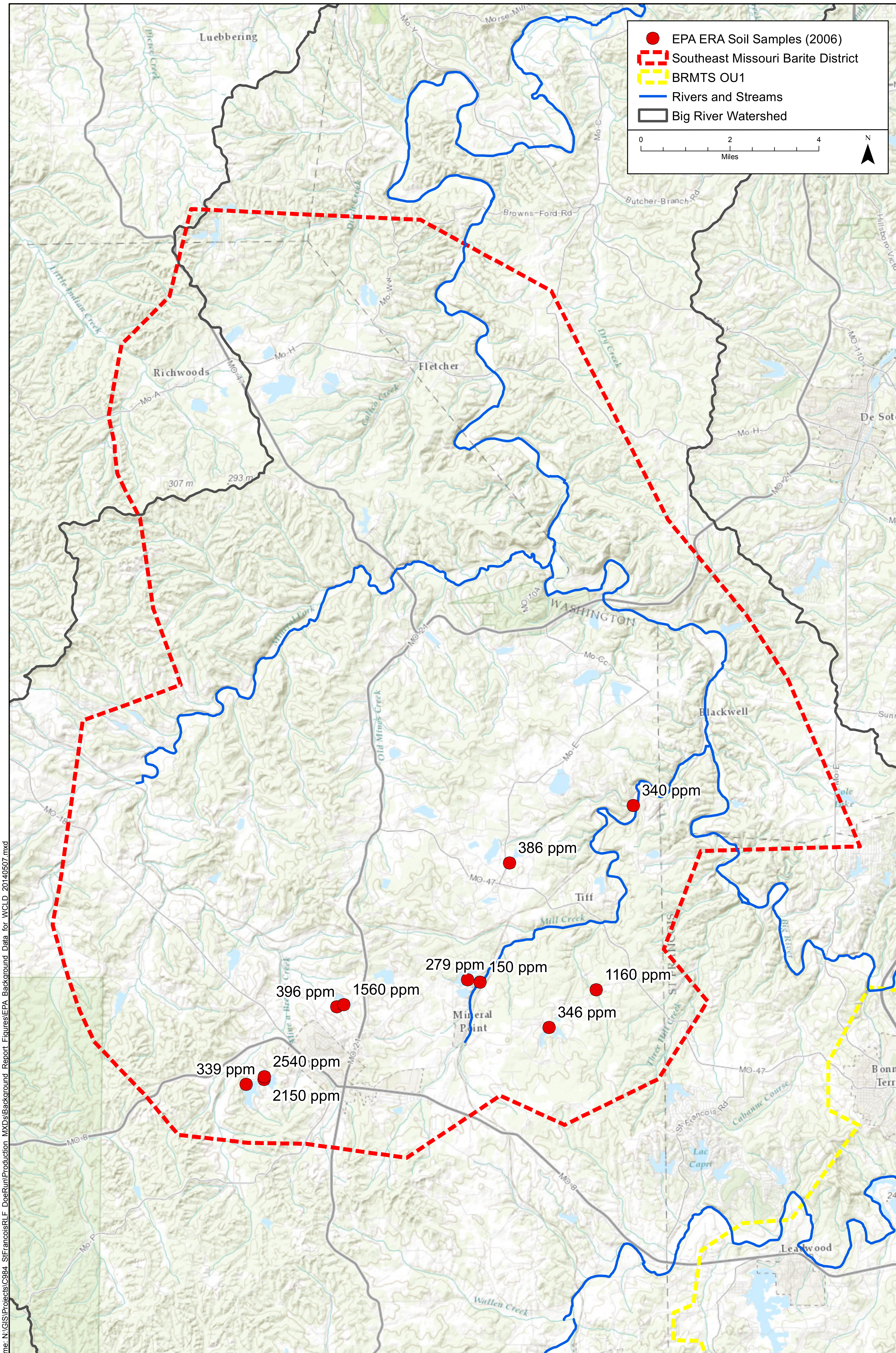

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Figure 4-2.
EPA Soil Lead Data for the Washington County Lead District

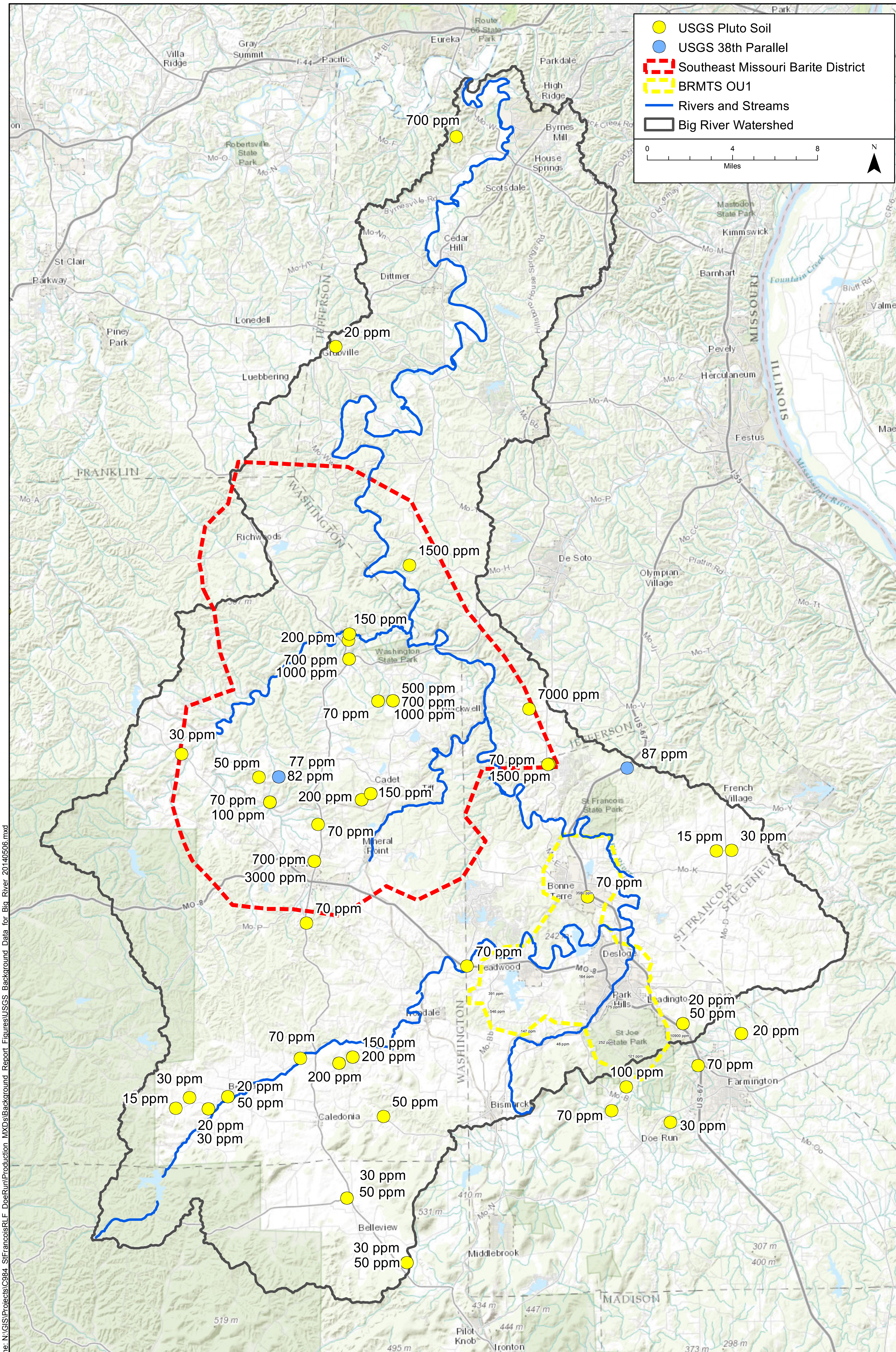

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Figure 4-3.
USGS Background Soil Lead Data in the Big River Watershed

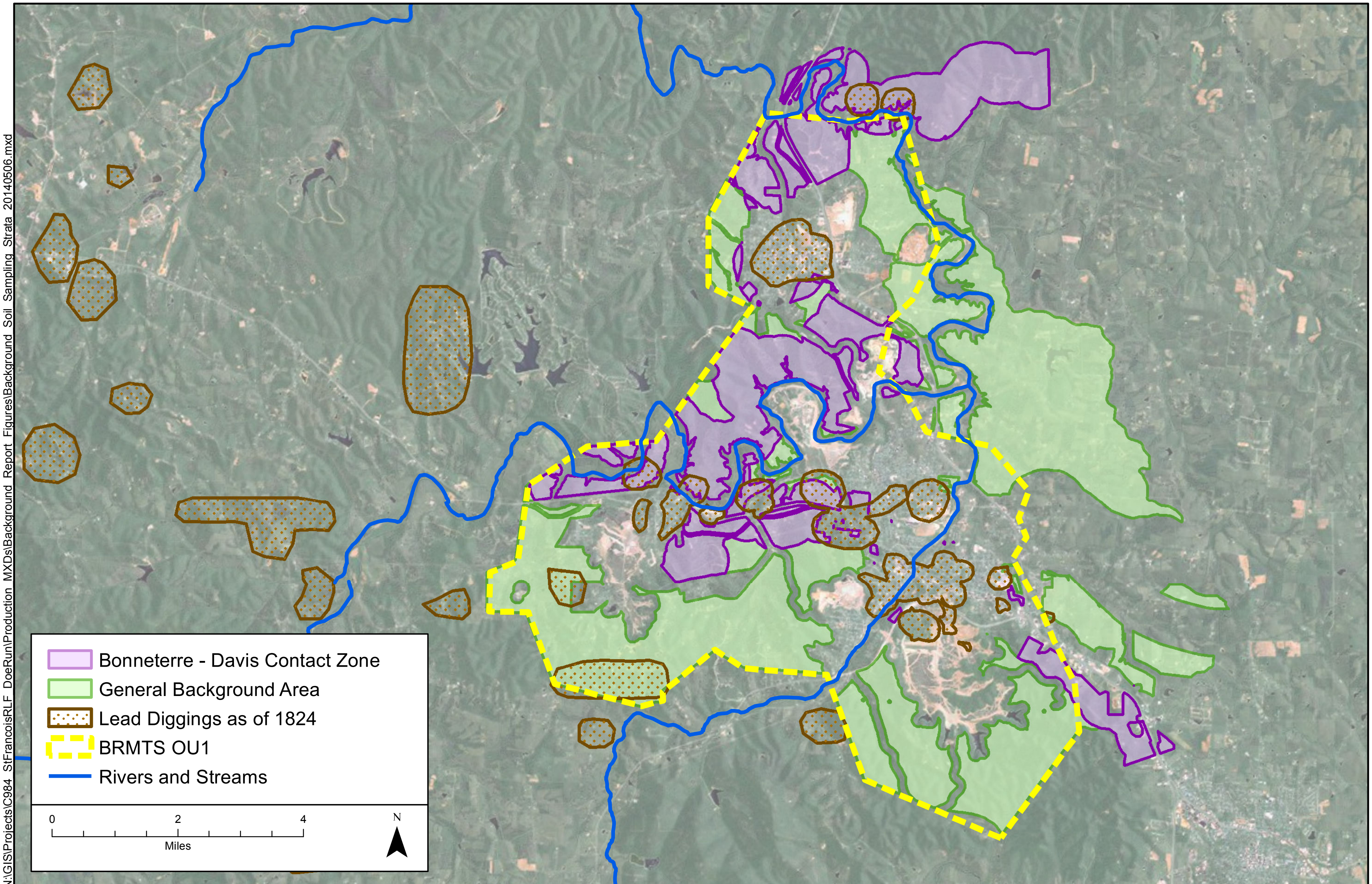

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Figure 5-1.
Background Soil Sampling Strata

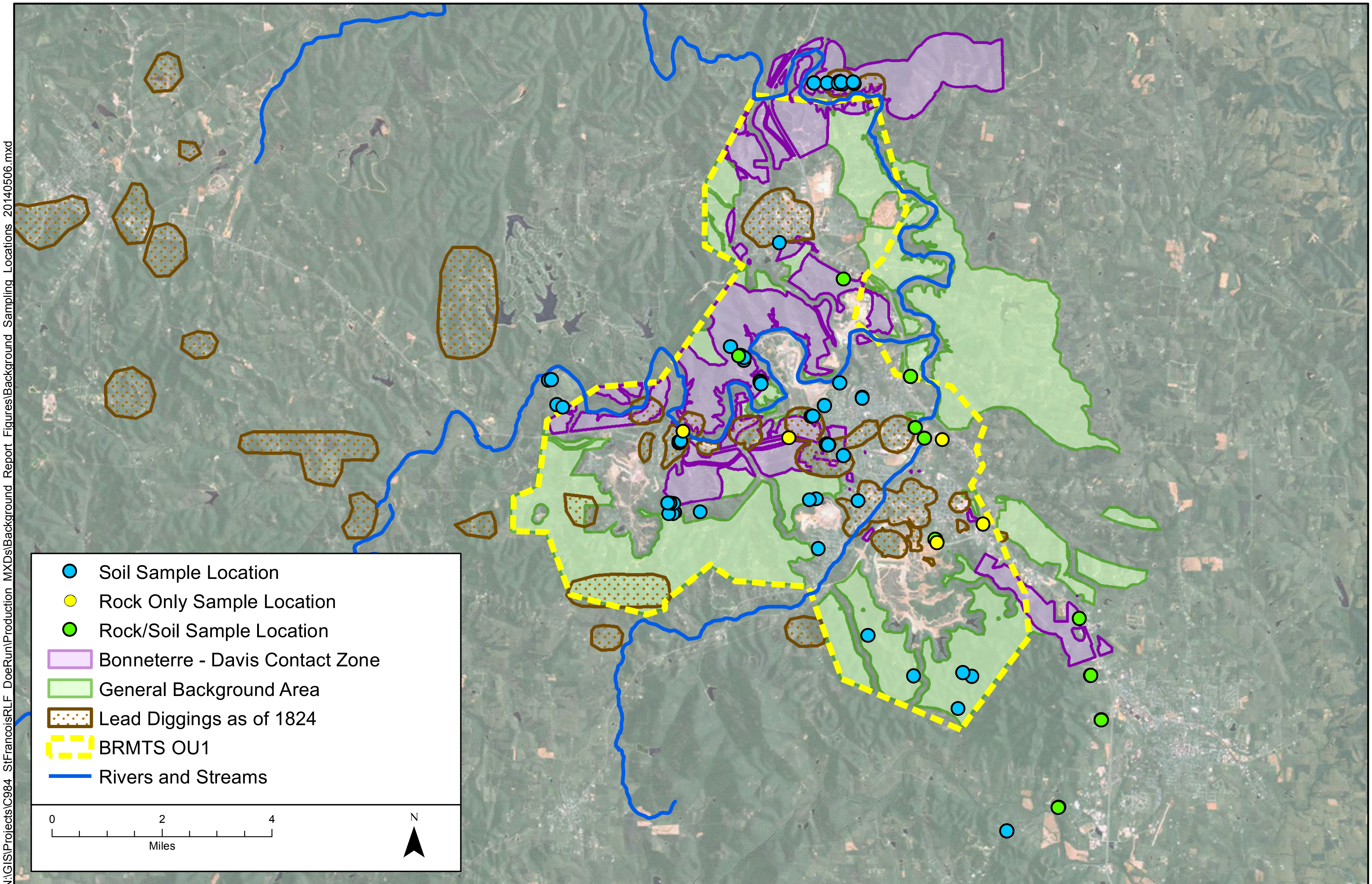

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Figure 5-2.
Background Soil and Rock Sampling Locations

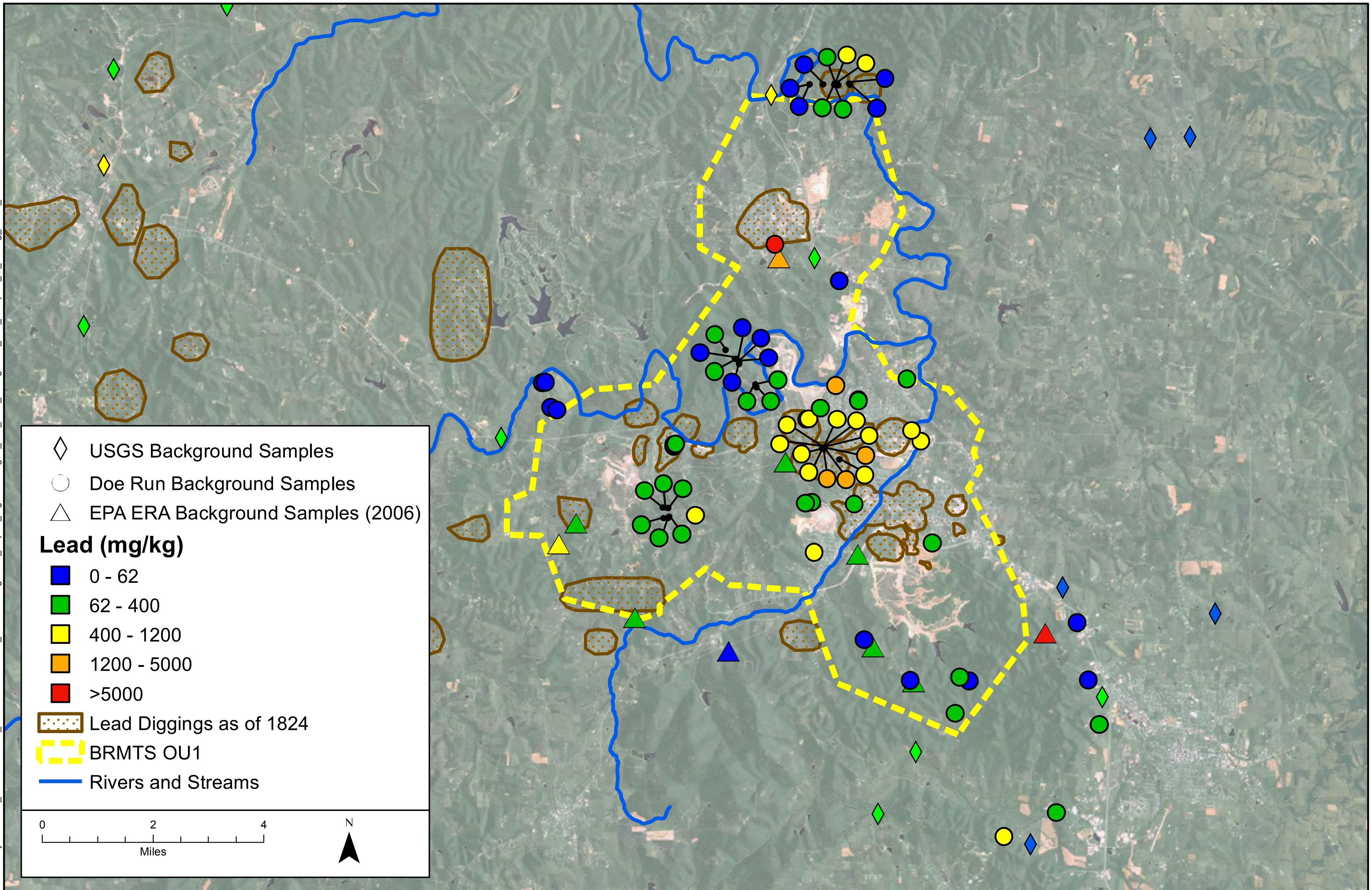

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Figure 5-3.
Influence of Lead Diggings on Soil Lead Concentrations in Vicinity of OU1

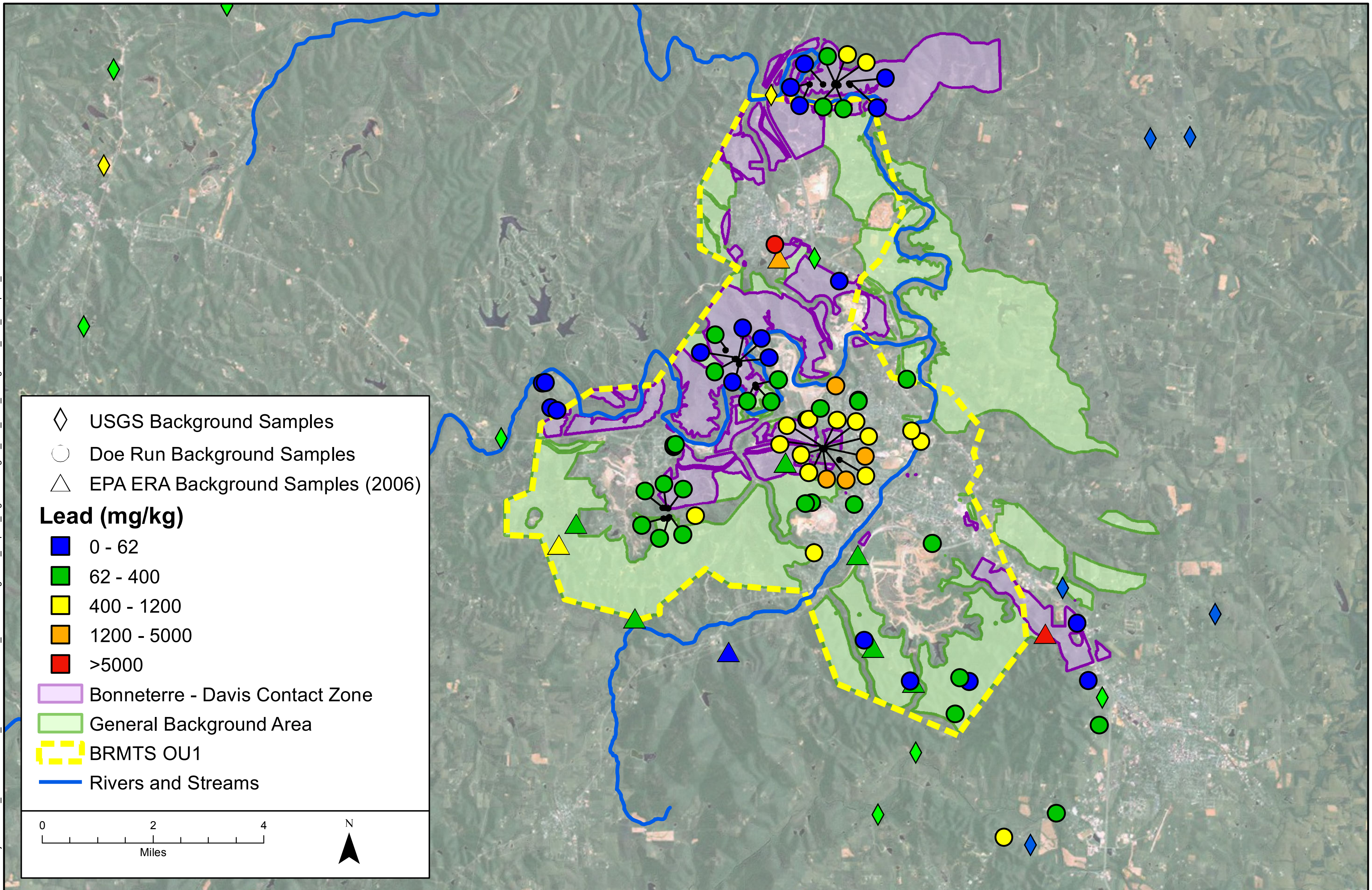

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Figure 5-4.
Background Lead Concentrations in Contact Zone and General Background Areas

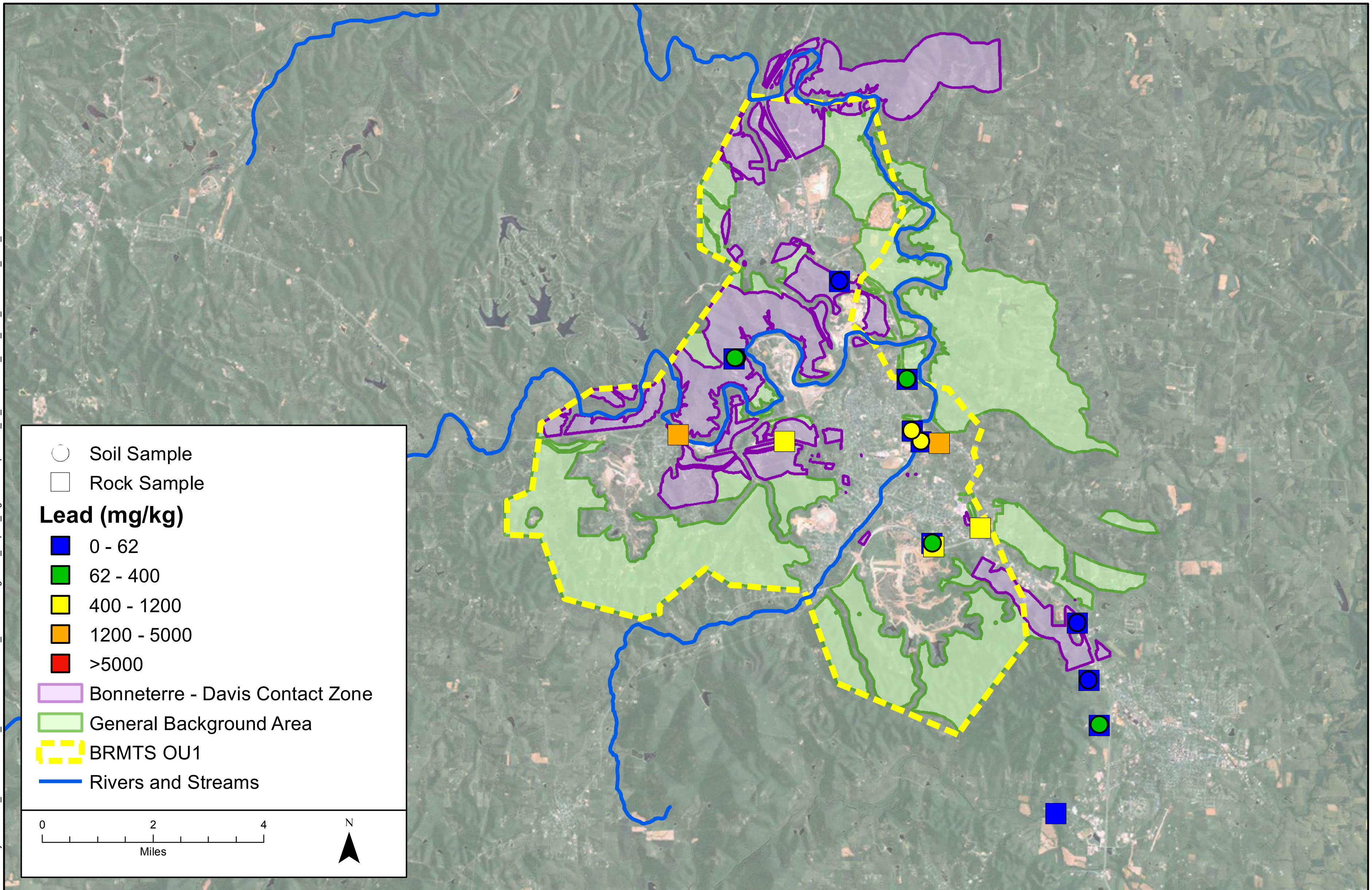

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Figure 5-5.
Comparison of Bonneterre Rock and
Co-located Soil Results

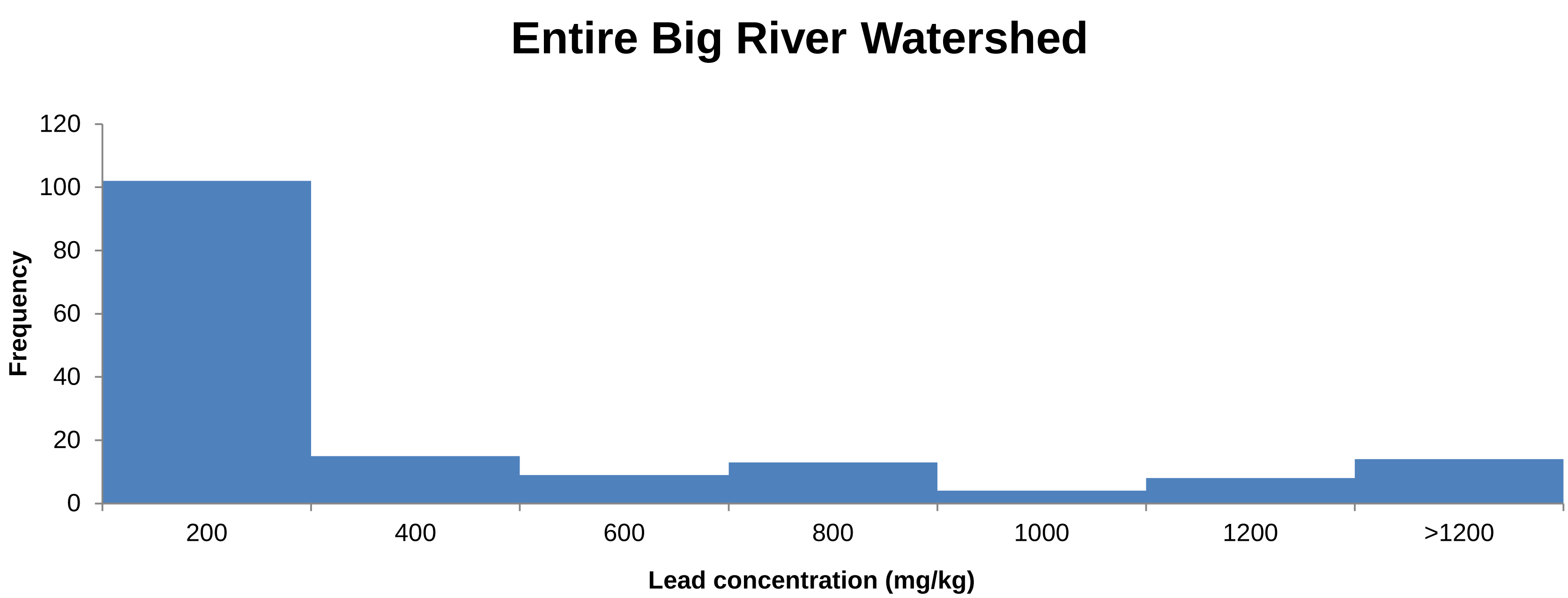

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Figure 5-6.
Histogram of Background Soil Lead Concentrations in the Big River Watershed

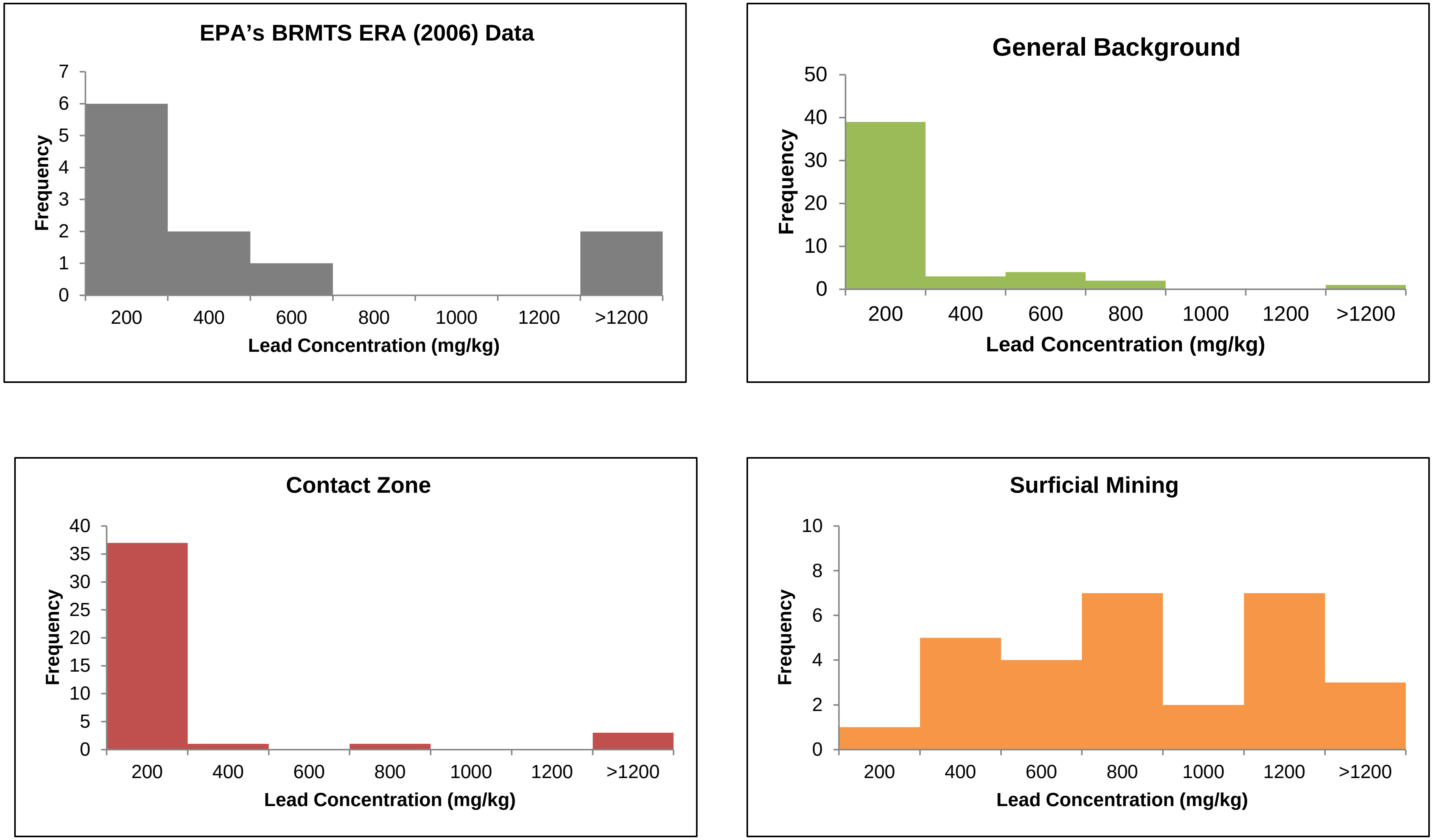

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Figure 5-7.
Histograms of Background Soil Lead Concentrations in Sub-Populations of the Big River Watershed Data Set

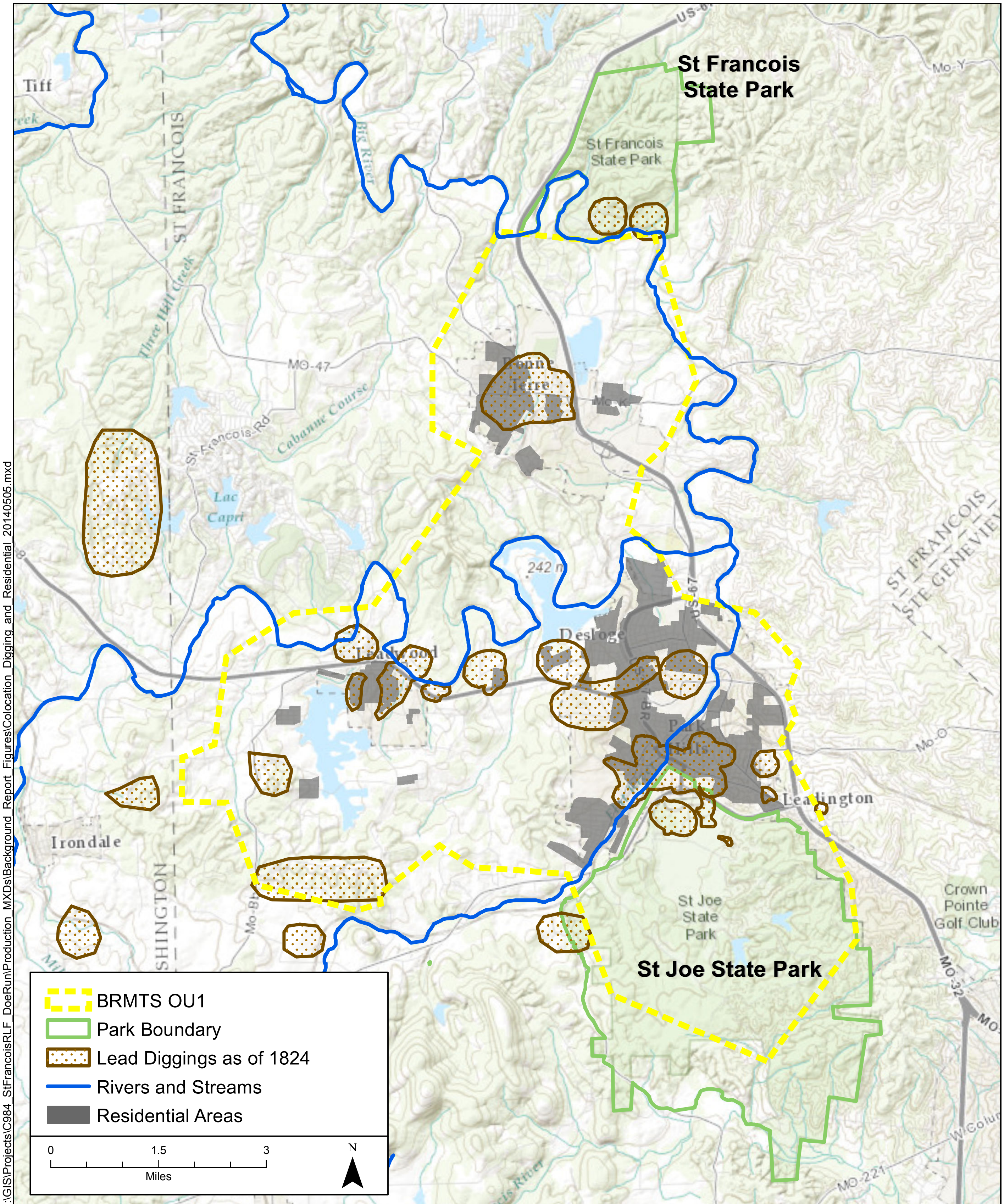

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Figure 5-8.
Co-location of Lead Diggings and Residential Areas in the BRMTS OU1

TABLES

Table 3-1. Early Production of Lead in Saint Francois and Washington Counties

Date Range		Lead Production (Tons of Metal)		
		Saint Francois County	Washington County	Jefferson County
1740[a]	1799	500	9,500	--
1800	1819	3,000	17,100	200
1820	1829	4,500	10,000	1,500
1830	1849	18,000	25,000	4,680
1850	1859	8,000	13,000	3,150
1860	1869	5,000	3,000	1,400
	Total	39,000	77,600	10,930
	Extraction Losses[b]	59,091	117,576	16,561
	Smelting Losses[c]	20,091	39,976	5,631
	Total Losses	**79,182**	**157,552**	**22,191**

Notes:
Data from Winslow (1894)

[a] Lead production in Washington County began in 1725
[b]Assumes 50% ore extraction efficiency (Weigel 1953)
[c]Assumes 66% smelting efficiency (see Section 3.3)

Table 4-1. EPA Background Soil Lead Data in Vicinity of BRMTS OU1

	Database Coordinates		FSP Coordinates[a]		Location Information				Concentration (mg/kg)				
Sample ID	Latitude	Longitude	Latitude	Longitude	General Background	Contact Zone	Surficial Mining	SEMO Barite District	Barium	Cadmium	Copper	Lead	Zinc
BKG-SS01	37.9132	-90.5489	37.9132	-90.5489	N	Y	N	N	--	3	--	3,580	231
BKG-SS02	n/a	n/a	37.8598	-90.5485	N	Y	N	N	--	1	--	165	70
BKG-SS02-FD	n/a	n/a	37.8598	-90.5485	N	Y	N	N	--	1	--	162	66
BKG-SS03	37.8451	-90.6181	37.8451	-90.6181	N	N	Y	N	--	1	--	391	109
BKG-SS04	n/a	n/a	37.8399	-90.6240	Y	N	N	N	--	0	--	546	532
BKG-SS05	n/a	n/a	37.8200	-90.5995	Y	N	N	N	--	0	--	147	63
BKG-SS06	37.8351	-90.5255	37.8351	-90.5255	N	Y	N	N	--	1	--	175	48
BKG-SS07	37.8092	-90.5790	37.8106	-90.5689	Y	N	N	N	--	1	--	48	36
BKG-SS08	37.8107	-90.5213	37.8107	-90.5213	Y	N	N	N	--	0	--	252	63
BKG-SS09	37.8012	-90.5081	37.8012	-90.5081	Y	N	N	N	--	0	--	121	47
BKG-SS10	37.8101	-90.4595	37.8131	-90.4643	N	Y	N	N	--	23	--	10,900	886

Notes:
-- =no data
EPA = U.S. Environmental Protection Agency
FSP = field sampling plan
n/a = not available
SEMO = Southeast Missouri

[a] Black & Veatch (2005)

Table 4-2. EPA Soil Lead Data for the Washington County Lead District

	Coordinates[a]		Location Information				Concentration (mg/kg)				
Sample ID	Latitude	Longitude	General Background	Contact Zone	Surficial Mining	SEMO Barite District	Barium	Cadmium	Copper	Lead	Zinc
SS01	37.9309	-90.8067	N	N	N	Y	5,030	7.3	56.6	2,150	293
SS02	37.9294	-90.8140	N	N	N	Y	2,810	2.9	10.2	339	209
SS03	37.9540	-90.7760	N	N	N	Y	4,550	12.7	58.2	396	1,850
SS04	37.9546	-90.7731	N	N	N	Y	4,230	7.5	57.8	1,560	1,530
SS05	37.9609	-90.7168	N	N	N	Y	2,750	3.1	14.8	150	402
SS06	37.9618	-90.7220	N	N	N	Y	3,900	4	19.3	279	481
SS07	37.9575	-90.6691	N	N	N	Y	3,760	8.3	38.4	1,160	1,290
SS08	38.0173	-90.6518	N	N	N	Y	3,560	4.2	25.5	340	534
SS09	37.9995	-90.7035	N	N	N	Y	3,910	2	11	386	216
SS10	37.9318	-90.8064	N	N	N	Y	2,310	2.5	31.9	2,540	201
SS11	37.9456	-90.6888	N	N	N	Y	2,730	5.2	37.6	346	663

Notes:
EPA = U.S. Environmental Protection Agency
SEMO = Southeast Missouri

[a] Coordinates digitized from maps in USEPA (2008b)

Table 4-3. USGS Background Soil Lead Data, PLUTO Database

Sample Information			Location Information					Concentration (mg/kg)				
ID	Latitude	Longitude	General Background	Contact Zone	Surficial Mining	SEMO Barite District	Floodplain Sample	Barium	Cadmium	Copper	Lead	Zinc
4854	37.7760	-90.8950	Y	N	N	N	N	1,000	1 <	20	15	44
4921	37.7580	-90.9460	Y	N	N	N	N	500	1 <	10	20	27
5222	37.7670	-90.7170	Y	N	N	N	N	700	1 <	15	50	52
5249	37.9130	-90.5370	N	Y	N	N	N	700	1 <	15	70	48
5319	37.9420	-90.4250	Y	N	N	N	N	1,000	1 <	15	15	45
5339	37.7120	-90.7500	Y	N	N	N	N	700	1 <	15	30	43
5420	37.7830	-90.5080	Y	N	N	N	N	300	1 <	15	100	49
5494	38.0170	-90.8830	N	N	N	Y	N	700	1 <	10	30	75
5505	37.8170	-90.4080	Y	N	N	N	N	500	1 <	10	20	46
5567	37.7670	-90.5210	Y	N	N	N	N	500	1 <	15	70	66
5692	37.7580	-90.4710	Y	N	N	N	N	700	1 <	15	30	42
5737	37.9420	-90.4120	Y	N	N	N	N	700	1 <	15	30	49
5748	38.0420	-90.5830	N	N	N	Y	N	1,000	11	150	7,000	640
5755	39.6080	-94.5170	Y	N	N	N	N	700	1 <	15	20	68
5764	38.0000	-90.8170	N	N	N	Y	N	700	1 <	20	50	87
5804	38.4330	-90.6330	Y	N	N	N	N	700	1 <	20	700	173
5975	38.1420	-90.6830	N	N	N	Y	N	1,500	1 <	30	1,500	215
6042	37.7120	-90.7500	Y	N	N	N	N	1,000	1 <	20	50	45
6174	38.0040	-90.5670	N	N	N	Y	N	300	5	70	1,500	590
6289	37.9670	-90.7670	N	N	N	Y	N	500	1 <	7	70	54
6342	37.7830	-90.8830	Y	N	N	N	N	700	1 <	15	30	33
6371	37.9000	-90.7790	Y	N	N	N	N	200	1 <	50	70	450
6375	38.0790	-90.7370	N	N	N	Y	N	15,000	1 <	150	700	2,660
6377	37.7960	-90.4460	N	Y	N	N	N	300	1 <	70	70	98
6383	37.9420	-90.7710	N	N	N	Y	N	5,000	1 <	70	3,000	660
6389	37.9420	-90.7710	N	N	N	Y	N	3,000	1 <	70	700	250
6392	38.0920	-90.7370	N	N	N	Y	N	2,000	2	50	200	640
6396	37.8250	-90.4580	Y	N	N	N	N	700	1 <	30	50	35
6397	38.0790	-90.7370	N	N	N	Y	N	100,000	1 <	150	1,000	1,780
6402	37.8250	-90.4580	Y	N	N	N	N	1,000	1 <	15	20	39
7036	37.9560	-90.5500	N	Y	N	N	Y	500	6	70	1,000	350
7037	37.8080	-90.7870	Y	N	N	N	N	500	1 <	30	70	63
7038	38.1650	-90.7080	N	N	N	Y	Y	1,000	6	70	3,000	385
7039	38.0040	-90.5680	N	N	N	Y	N	700	1 <	15	70	54
7040	37.8680	-90.6420	Y	N	N	N	N	700	1 <	20	70	68
7041	38.2330	-90.6690	Y	N	N	N	Y	2,000	5	70	2,000	390
7043	38.4180	-90.5990	Y	N	N	N	Y	1,000	3	50	1,500	275
7044	38.0750	-90.6210	N	N	N	Y	Y	1,500	6	100	3,000	500
7045	38.0960	-90.7360	N	N	N	Y	N	2,000	1 <	15	150	196
7046	38.3470	-90.6330	Y	N	N	N	Y	1,000	3	30	1,500	235
7404	37.9870	-90.7210	N	N	N	Y	N	1,000	2	70	150	3,880
7435	38.0500	-90.7130	N	N	N	Y	N	200	1 <	70	70	217

Table 4-3. USGS Background Soil Lead Data, PLUTO Database

Sample Information			Location Information					Concentration (mg/kg)					
ID	Latitude	Longitude	General Background	Contact Zone	Surficial Mining	SEMO Barite District	Floodplain Sample	Barium	Cadmium		Copper	Lead	Zinc
7439	37.7750	-90.8670	Y	N	N	N	N	300	1	<	20	20	55
7440	37.7830	-90.8500	Y	N	N	N	N	200	1	<	70	20	84
7444	37.7830	-90.8500	Y	N	N	N	N	500	1		70	50	93
7447	37.9830	-90.8080	N	N	N	Y	N	200	1	<	50	100	425
7450	37.9870	-90.7210	N	N	N	Y	N	700	1		50	150	3,900
7462	37.8040	-90.7540	Y	N	N	N	N	100	1	<	100	200	255
7471	37.8040	-90.7540	Y	N	N	N	N	100	1	<	100	200	247
7474	37.7750	-90.8670	Y	N	N	N	N	300	1	<	20	30	45
7485	37.9830	-90.8080	N	N	N	Y	N	150	1		100	70	480
7492	37.9830	-90.8080	N	N	N	Y	N	150	1	<	70	70	485
7495	37.9830	-90.8080	N	N	N	Y	N	150	1	<	50	100	420
7504	37.9830	-90.7290	N	N	N	Y	N	10,000	2		70	200	2,900
7507	38.0500	-90.7000	N	N	N	Y	N	15,000	3.5		100	700	4,750
7525	37.9830	-90.8080	N	N	N	Y	N	150	1	<	50	100	435
7536	37.9830	-90.8080	N	N	N	Y	N	150	1		70	70	450
7542	37.9830	-90.7290	N	N	N	Y	N	7,000	1.5		70	150	2,840
7553	38.0500	-90.7130	N	N	N	Y	N	200	1	<	30	70	145
7558	38.0500	-90.7000	N	N	N	Y	N	10,000	2.5		70	1,000	2,760
7565	37.9830	-90.7290	N	N	N	Y	N	10,000	2		70	150	2,900
7572	37.8080	-90.7420	N	Y	N	N	N	100	1.5		100	200	870
7582	37.8080	-90.7420	N	Y	N	N	N	70	2		50	150	730
7584	37.9870	-90.7210	N	N	N	Y	N	700	1		50	150	3,900
7585	38.0500	-90.7000	N	N	N	Y	N	10,000	3.5		70	500	5,000

Notes:
< = non-detect value
SEMO = Southeast Missouri
USGS = U.S. Geological Survey

Table 4-4. USGS Background Soil Data in the Big River Watershed, 38th Parallel Study

	Coordinates			Location Information				Concentration (mg/kg)				
Field No.	Latitude	Longitude	Depth	General Background	Contact Zone	Surficial Mining	SEMO Barite District	Barium	Cadmium	Copper	Lead	Zinc
52-1d-2-PH	38	-90.8	0-5 cm	N	N	N	Y	675	0.2	17.5	81.7	60
51-4-PH	38	-90.5	0-5 cm	N	N	N	N	507	0.8	13.7	87.4	433
52-1d-1-PH	38	-90.8	0-5 cm	N	N	N	Y	768	0.2	14.2	76.6	70
52-1d-1-A	38	-90.8	0-8 in	N	N	N	Y	677	0.2	15.3	77.3	56
52-1d-2-A	38	-90.8	0-7.5 in	N	N	N	Y	694	0.2	10.2	82.4	51
51-4-A	38	-90.5	0-5 in	N	N	N	N	453	0.7	15.3	79.1	377

Notes:
OU1 = Operating Unit 1
SEMO = Southeast Missouri
USGS = U.S. Geological Survey

Table 5-1. Background Soil Sampling Results

	Coordinates		Location Information				Concentration (mg/kg)				
Sample ID	Latitude	Longitude	General Background	Contact Zone	Surficial Mining	SEMO Barite District	Barium	Cadmium	Copper	Lead	Zinc
SS-SP-01-001	37.8647	-90.5850	N	N	Y	N	175	3.66	33.8	914	347
SS-SP-01-001 FD	37.8647	-90.5850	N	N	Y	N	180	5.38	32	1,090	424
SS-SP-01-002	37.8650	-90.5850	N	N	Y	N	152	1.66	21.8	388	108
SS-SP-01-003	37.8652	-90.5843	N	N	Y	N	107	1.04	16.5	223	66.6
SS-SP-01-004	37.8463	-90.5785	N	Y	N	N	167	2.28	26.4	631	165
SS-SP-01-005	37.8463	-90.5872	Y	N	N	N	110	0.59	7.7	67.2	52.7
SS-SP-01-006	37.8460	-90.5877	Y	N	N	N	127	1.7	20.3	303	126
SS-SP-01-007	37.8461	-90.5890	Y	N	N	N	123	0.61	10.9	92	67.7
SS-SP-01-008	37.8488	-90.5874	N	Y	N	N	42.6	0.73	13.1	72.2	37.4
SS-SP-01-009	37.8488	-90.5884	N	Y	N	N	107	1.27	21.6	104	81.1
SS-SP-01-010	37.8488	-90.5892	N	Y	N	N	121	0.58	74	69.7	65.7
SS-SP-01-011	37.8490	-90.5399	Y	N	N	N	102	1.35	8.9	141	85.1
SS-SP-01-012	37.8487	-90.5422	Y	N	N	N	111	0.53	51.5	97.4	60.9
SS-SP-01-013	37.8482	-90.5260	N	Y	N	N	130	1.05	43.2	268	69.2
SS-SP-01-014	37.8359	-90.5397	Y	N	N	N	366	2.61	43.3	703	529
SS-SP-01-015	37.8794	-90.5311	Y	N	N	N	127	11.7	57.7	1,810	727
SS-SP-01-016	37.8707	-90.5409	N	N	Y	N	228	2.97	33.6	1,080	334
SS-SP-01-017	37.8708	-90.5403	N	N	Y	N	366	70	38.9	1,080	1,280
SS-SP-01-018	37.8736	-90.5363	Y	N	N	N	233	4.27	25.8	340	314
SS-SP-01-019	37.8755	-90.5237	N	Y	N	N	146	0.6	27	141	63.3
SS-SP-01-020	37.8752	-90.5236	N	Y	N	N	199	0.93	22.5	131	68.5
SS-SP-01-021	37.8602	-90.5305	N	N	Y	N	130	4.18	97	1,060	246
SS-SP-01-022	37.9168	-90.5498	N	Y	N	N	177	35.2	1,050	16,300	1,680
SS-SP-01-023	37.8897	-90.5671	N	Y	N	N	238	0.45	7.8	66.8	46.5
SS-SP-01-024	37.8872	-90.5637	N	Y	N	N	45.4	0.55	39.6	43.5	30.4
SS-SP-01-025	37.8872	-90.5636	N	Y	N	N	45.6	0.45	47.1	40.5	29
SS-SP-01-026	37.8873	-90.5641	N	Y	N	N	73.9	0.97	16.6	72.6	68.7
SS-SP-01-027	37.8805	-90.5576	N	Y	N	N	141	0.29	8.4	81.6	35.7
SS-SP-01-028	37.8802	-90.5576	N	Y	N	N	139	0.45	7.9	82.8	41
SS-SP-01-029	37.8797	-90.5572	N	Y	N	N	174	0.44	10.6	75.8	80.5
SS-SP-01-030	37.8859	-90.5627	N	Y	N	N	82.7	0.06	12.4	25.6	31.4
SS-SP-01-031	37.8867	-90.5627	N	Y	N	N	69.8	0.14	28	33.4	25.3
SS-SP-01-031 FD	37.8867	-90.5627	N	Y	N	N	66.9	0.16	32.1	32.8	25
SS-SP-01-032	37.7659	-90.4621	N	Y	N	N	60.2	0.18	18.6	108	32.5
SS-SP-01-033	37.7602	-90.4795	Y	N	N	N	92.2	0.3	78.8	426	186
SS-SP-01-034	37.7887	-90.4472	N	Y	N	N	900	0.33	39.4	101	45.1
SS-SP-01-035	37.8005	-90.4502	N	Y	N	N	137	0.08	23.1	25	25.6
SS-SP-01-036	37.8156	-90.4535	N	Y	N	N	169	0.32	27.4	20.1	28.5
SS-SP-01-037	37.8375	-90.5006	N	Y	N	N	379	0.41	55.8	137	93.6
SS-SP-01-038	37.8642	-90.5033	Y	N	N	N	315	2.23	30.9	421	183
SS-SP-01-039	37.8670	-90.5063	Y	N	N	N	512	2.93	48	515	174
SS-SP-01-040	37.8806	-90.5074	Y	N	N	N	206	0.47	30.2	77.4	57.5
SS-SP-01-041	37.9068	-90.5289	N	Y	N	N	292	0.58	24.7	30.2	70.2
SS-SP-01-042	37.9586	-90.5326	N	Y	N	N	164	0.45	45	56.8	42.9
SS-SP-01-043	37.9588	-90.5284	N	N	Y	N	130	0.3	13.5	418	41.7

Table 5-1. Background Soil Sampling Results

	Coordinates		Location Information				Concentration (mg/kg)				
Sample ID	Latitude	Longitude	General Background	Contact Zone	Surficial Mining	SEMO Barite District	Barium	Cadmium	Copper	Lead	Zinc
SS-SP-01-044	37.9587	-90.5287	N	N	Y	N	80.5	0.25	29.7	72.2	22.2
SS-SP-01-045	37.9584	-90.5289	N	N	Y	N	89.7	0.45	33.7	317	51.6
SS-SP-01-046	37.9583	-90.5275	N	N	Y	N	164	0.43	19.1	299	58.8
SS-SP-01-047	37.9587	-90.5279	N	N	Y	N	160	0.68	24	1,020	65
SS-SP-01-048	37.9583	-90.5236	N	Y	N	N	88.5	0.18	14	29.6	21.9
SS-SP-01-049	37.9587	-90.5240	N	Y	N	N	90.6	0.26	25	51.2	31.5
SS-SP-01-050	37.9586	-90.5370	N	Y	N	N	164	0.16	12	37.1	35
SS-SP-01-050 FD	37.9586	-90.5370	N	Y	N	N	151	0.16	12.2	37.1	36.4
SS-SP-01-051	37.8011	-90.4896	Y	N	N	N	87.8	0.16	8	32.9	30.2
SS-SP-01-052	37.8021	-90.4928	Y	N	N	N	122	0.48	30.3	91.6	53.4
SS-SP-01-053	37.7927	-90.4945	Y	N	N	N	61.7	0.08	7.7	141	20.7
SS-SP-01-054	37.8125	-90.5240	Y	N	N	N	71	0.1	6.6	23.6	20.2
SS-SP-01-055	37.8017	-90.5091	Y	N	N	N	35.7	0.08	3.9	42	17.2
SS-SP-01-056	37.8821	-90.6279	N	Y	N	N	101	0.3	14.8	51.4	44.9
SS-SP-01-057	37.8822	-90.6270	N	Y	N	N	69.2	0.18	7.8	36.2	26.6
SS-SP-01-058	37.8756	-90.6254	N	Y	N	N	29.5	0.06	23.5	9.1	16.6
SS-SP-01-059	37.8748	-90.6234	N	Y	N	N	52.6	0.06	16.8	6.5	15.4

Notes:
OU1 = Operating Unit 1
SEMO = Southeast Missouri

Table 5-2. Targeted Soil Sampling Results

Location	Sample ID	Coordinates: Latitude	Coordinates: Longitude	Location Information: General Background	Location Information: Contact Zone	Location Information: Surficial Mining	Location Information: SEMO Barite District	Concentration (mg/kg): Barium	Concentration (mg/kg): Cadmium	Concentration (mg/kg): Copper	Concentration (mg/kg): Lead	Concentration (mg/kg): Zinc
Mine a Joe	MAJ SS-01	37.8633	-90.5357	N	N	Y	N	140 ± 25%	-- -- --	210 ± 10%	470 ± 7%	250 ± 3%
	MAJ SS-02	37.8633	-90.5358	N	N	Y	N	610 ± 13%	-- -- --	300 ± 3%	1,500 ± 5%	360 ± 6%
	MAJ SS-03	37.8633	-90.5358	N	N	Y	N	960 ± 10%	-- -- --	180 ± 9%	1,200 ± 7%	410 ± 2%
	MAJ SS-04	37.8634	-90.5359	N	N	Y	N	1,100 ± 14%	-- -- --	190 ± 11%	510 ± 3%	290 ± 6%
	MAJ SS-05	37.8634	-90.5359	N	N	Y	N	100 ± 132%	-- -- --	210 ± 1%	1,700 ± 5%	600 ± 8%
	MAJ SS-06	37.8632	-90.5360	N	N	Y	N	1,200 ± 10%	-- -- --	160 ± 5%	1,500 ± 5%	240 ± 13%
	MAJ SS-07	37.8632	-90.5358	N	N	Y	N	1,500 ± 1%	-- -- --	160 ± 4%	780 ± 7%	230 ± 3%
	MAJ SS-08	37.8631	-90.5357	N	N	Y	N	560 ± 9%	-- -- --	190 ± 12%	660 ± 19%	230 ± 7%
	MAJ SS-09	37.8632	-90.5353	N	N	Y	N	1,000 ± 18%	-- -- --	180 ± 10%	520 ± 4%	350 ± 3%
	MAJ SS-10	37.8631	-90.5355	N	N	Y	N	870 ± 14%	-- -- --	180 ± 8%	690 ± 5%	390 ± 1%
Firmin Desloge Park	WCLD SS-01	37.9279	-90.7986	N	N	Y	N	2,500 ± 3%	-- -- --	160 ± 3%	700 ± 3%	220 ± 6%
	WCLD SS-02	37.9280	-90.7986	N	N	Y	N	2,300 ± 4%	-- -- --	190 ± 4%	770 ± 1%	360 ± 6%
	WCLD SS-03	37.9279	-90.7987	N	N	Y	N	4,000 ± 4%	-- -- --	160 ± 7%	670 ± 2%	270 ± 6%
	WCLD SS-04	37.9280	-90.7988	N	N	Y	N	2,600 ± 9%	-- -- --	210 ± 11%	1,100 ± 3%	500 ± 3%
	WCLD SS-05	37.9279	-90.7988	N	N	Y	N	1,300 ± 8%	-- -- --	210 ± 15%	820 ± 3%	570 ± 4%
	WCLD SS-06	37.9279	-90.7987	N	N	Y	N	1,300 ± 13%	-- -- --	240 ± 12%	760 ± 1%	600 ± 4%
Star Mine Barite Tailings Dam	WCLD SS-07	38.0672	-90.7497	N	N	N	Y	1,200 ± 11%	-- -- --	220 ± 17%	960 ± 1%	1,300 ± 2%
	WCLD SS-08	38.0671	-90.7498	N	N	N	Y	7,700 ± 2%	-- -- --	190 ± 2%	570 ± 1%	900 ± 2%
	WCLD SS-09	38.0671	-90.7500	N	N	N	Y	2,400 ± 8%	-- -- --	230 ± 9%	930 ± 5%	910 ± 1%
	WCLD SS-10	38.0671	-90.7501	N	N	N	Y	3,600 ± 3%	-- -- --	230 ± 3%	880 ± 4%	730 ± 5%
	WCLD SS-11	38.0671	-90.7502	N	N	N	Y	3,600 ± 11%	-- -- --	180 ± 11%	970 ± 2%	400 ± 7%
	WCLD SS-12	38.0671	-90.7503	N	N	N	Y	2,100 ± 9%	-- -- --	230 ± 9%	1,000 ± 1%	780 ± 4%
	WCLD SS-13	38.0672	-90.7504	N	N	N	Y	3,000 ± 4%	-- -- --	170 ± 10%	1,000 ± 2%	370 ± 4%
			Reporting Level					97		19	7	9

Notes:
-- = not analyzed
SEMO = Southeast Missouri

Table 5-3. Outcrop Sampling Results

	Coordinates		Concentration (mg/kg)				
Sample ID	Latitude	Longitude	Barium	Cadmium	Copper	Lead	Zinc
OR-001	37.8871	-90.5644	4.32	0.04	7.76	0.4	1.6
OR-002			3.31	0.04	2.89	0.5	2.4
OR-003			3.06	0.04	4.25	0.4	1.7
OR-004	37.7659	-90.4623	4.7	0.04	4.97	5	2
OR-005			8.9	0.04	5.85	7.9	2.7
OR-006			4.58	0.04	3.01	2.2	2
OR-007	37.7602	-90.4795	15.3	0.04	6.43	12.1	6.7
OR-008			9.04	0.04	2.04	0.4	3.2
OR-009			14.4	0.04	4.41	2.2	5.9
OR-010	37.7886	-90.4472	7.92	0.04	1.91	1	2.8
OR-011			7.28	0.04	0.62	0.4	1.6
OR-012			4.95	0.04	5.66	1.8	2
OR-013	37.8005	-90.4501	5.54	0.04	6.03	0.9	6.6
OR-014			7.36	0.04	5.81	0.4	2.2
OR-015			5.01	0.04	6.02	1.1	1.7
OR-016	37.8156	-90.4534	4.95	0.04	3.07	1.5	6.5
OR-017			6.75	0.04	3.2	1.3	3.3
OR-018			8.4	0.04	5.26	1.5	3.3
OR-019	37.8375	-90.5007	4.66	0.04	10.7	1.2	1.8
OR-020			5.4	0.04	6.42	2.5	2.5
OR-021			13.8	0.04	13	2	10
OR-022	37.8642	-90.5034	6.37	0.04	2.75	3.7	5.2
OR-023			10.2	0.04	4.61	24.4	13.8
OR-024			5.79	0.04	2.9	2.8	5.5
OR-025	37.8670	-90.5063	14.5	0.87	1.32	7.9	27.9
OR-026			6.5	0.4	1.41	6.1	25.4
OR-027			8.06	0.61	1.69	6.8	22.6
OR-028	37.8806	-90.5074	4.74	1.01	2.42	3.6	31.1
OR-029			2.96	2.13	1	5.4	52.9
OR-030			3.56	0.1	1.13	2	8.8
OR-031	37.9067	-90.5289	4.46	0.1	4.1	13.8	77.4
OR-032			5.02	0.04	3.44	6.5	17.3
OR-033			2.69	0.04	5.06	6.8	30.7

Table 5-4. Initial Outcrop Sampling Results.

		Coordinates		Concentration (mg/kg)				
Sample #	Location Description	Latitude	Longitude	Barium	Cadmium	Copper	Lead	Zinc
1	Hwy 8 West	37.8653	-90.5485	--	--	100	600	nd
2	Truck Stop	37.8636	-90.4975	--	--	--	2,000	--
3	Dollar General Leadwood	37.8677	-90.5835	--	--	nd	1,500	200
4	Hwy 32 St. Joe Park	37.8366	-90.5001	--	--	nd	700	100
5	On ramp MAC Hwy 67	37.8412	-90.4846	--	--	nd	800	500

Notes:
-- = no data available
nd = not detected

Table 5-5. Background Summary Statistics (values in mg/kg)

Data Set	N	Minimum	Median	Average	Maximum	95th UCL[a]	95th UPL
Big River Watershed	165	7	141	579	16,300	1,143	1,777
Surficial Mining	29	72	760	783	1,700	910	1,481
Contact Zone	42	7	71	821	16,300	2,841	9,802
General Background	49	15	70	175	1,810	360	702

Notes:
N = number of samples in data set
UCL = upper confidence limit
UPL = upper prediction limit

[a] All 95th UCLs are 95% Chebysehv values, with the exception of the surficial mining value for which ProUCL reported a 95% Students-t value.

APPENDIX A

OU1 BACKGROUND STUDY
PHOTO LOG

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Appendix A Photo Log
Site Photographs from 2013

Photograph 1. Area Surrounding Sample SS-SP-01-001 (August 6, 2013)

Photograph 2. Area Surrounding Sample SS-SP-01-002 (August, 2013)

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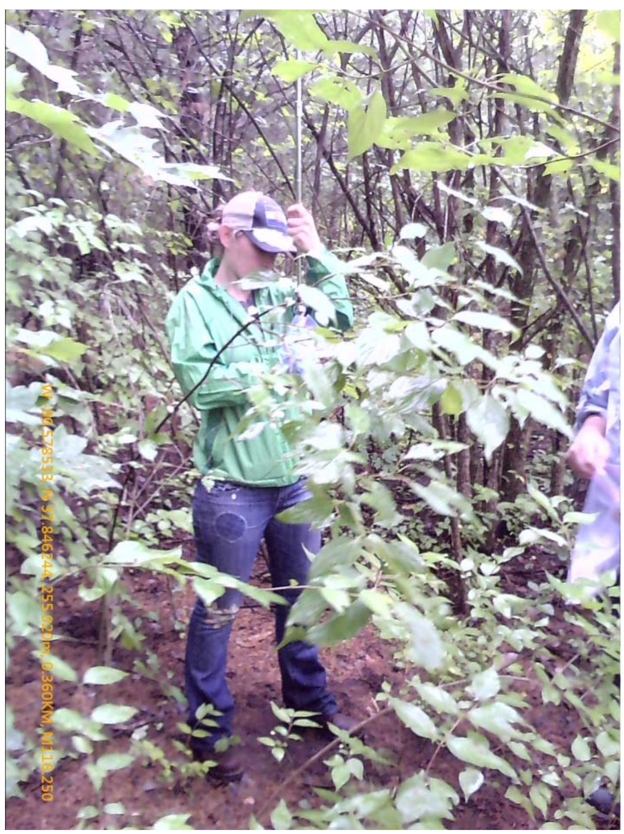
Photograph 3. Area Surrounding Sample SS-SP-01-003 (August 6, 2013)



Photograph 4. No Landscape Photograph Available. Location for Sample SS-SP-01-004 (August, 2013)

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Photograph 5. No Landscape Photograph Available. Location of Sample SS-SP-01-005 (August, 2013)

Photograph 6. Area Surrounding Sample SS-SP-01-006 (August, 2013)

Photograph 7. Area Surrounding Sample SS-SP-01-007 (August, 2013)

Photograph 8. Area Surrounding Sample SS-SP-01-008 (August, 2013)

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Photograph 9. Area Surrounding Sample SS-SP-01-009 (August, 2013)

Photograph 10. Area Surrounding Sample SS-SP-01-010 (August, 2013)

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Photograph 11. Area Surrounding Sample SS-SP-01-011 (August, 2013)

Photograph 12. No Landscape Photograph Available. Location of Sample SS-SP-01-012 (August, 2013)

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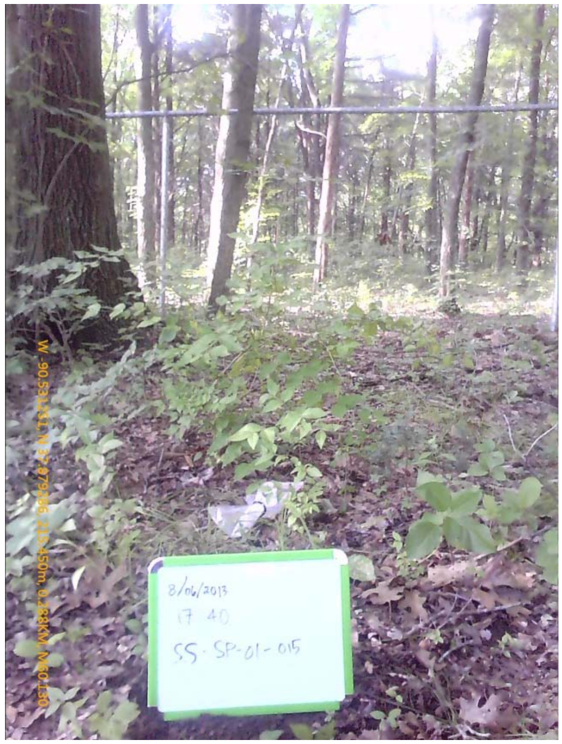

Photograph 13. Area Surrounding Sample SS-SP-01-015 (August, 2013)

Photograph 14. No Landscape Photograph Available. Location of Sample SS-SP-01-016 (August, 2013)

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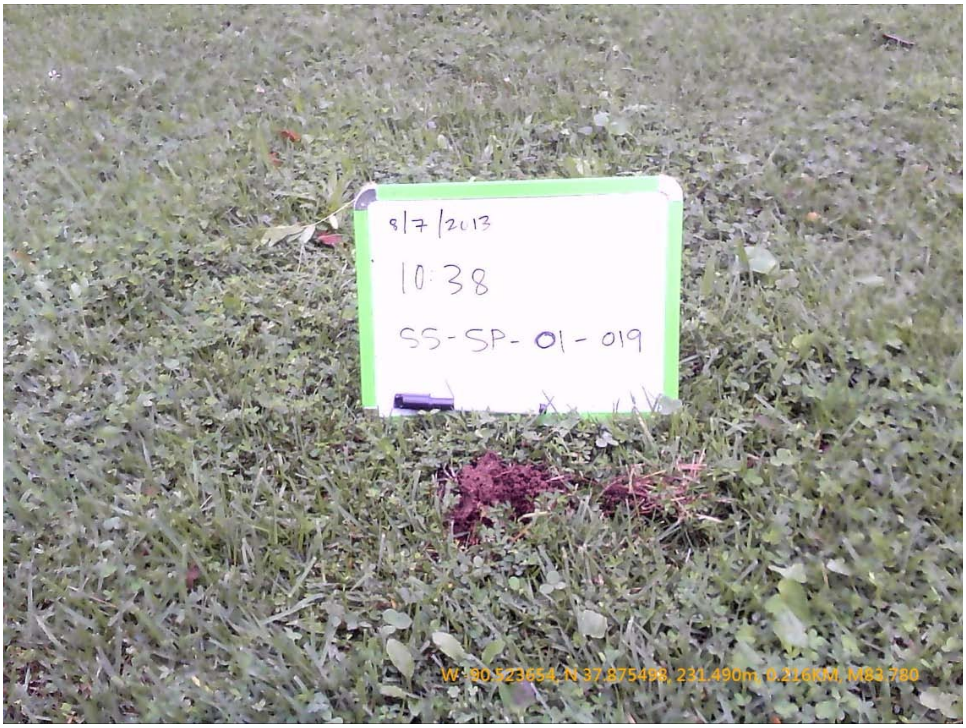
Photograph 15. No Landscape Photograph Available. Location of Sample SS-SP-01-017 (August, 2013)

Photograph 16. Area Surrounding Sample SS-SP-01-018 (August, 2013)



Photograph 17. No Landscape Photograph Available. Location of Sample SS-SP-01-019 (August, 2013)

Photograph 18. Area Surrounding Sample SS-SP-01-020 (August, 2013)

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Photograph 19. Area Surrounding Sample SS-SP-01-021 (August, 2013)

Photograph 20. No Landscape Photograph Available. Location of Sample SS-SP-01-022 (August, 2013)

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Photograph 21. Area Surrounding Sample SS-SP-01-023 (August, 2013)

Photograph 22. No Landscape Photograph Available. Location of Sample SS-SP-01-024 (August, 2013)

Photograph 23. Area Surrounding Sample SS-SP-01-025 (August, 2013)

Photograph 24. Area Surrounding Sample SS-SP-01-026 (August, 2013)

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Photograph 25. No Landscape Photograph Available. Location of Sample OR-SP-01-001 (August, 2013)

Photograph 26. Area Surrounding Sample SS-SP-01-027 (August, 2013)

Photograph 27. No Landscape Photograph Available. Location of Sample SS-SP-01-028 (August, 2013)

Photograph 28. Area Surrounding Sample SS-SP-01-029 (August, 2013)

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Photograph 29. Area Surrounding Sample SS-SP-01-030 (August, 2013)

Photograph 30. Area Surrounding Sample SS-SP-01-031 (August, 2013)

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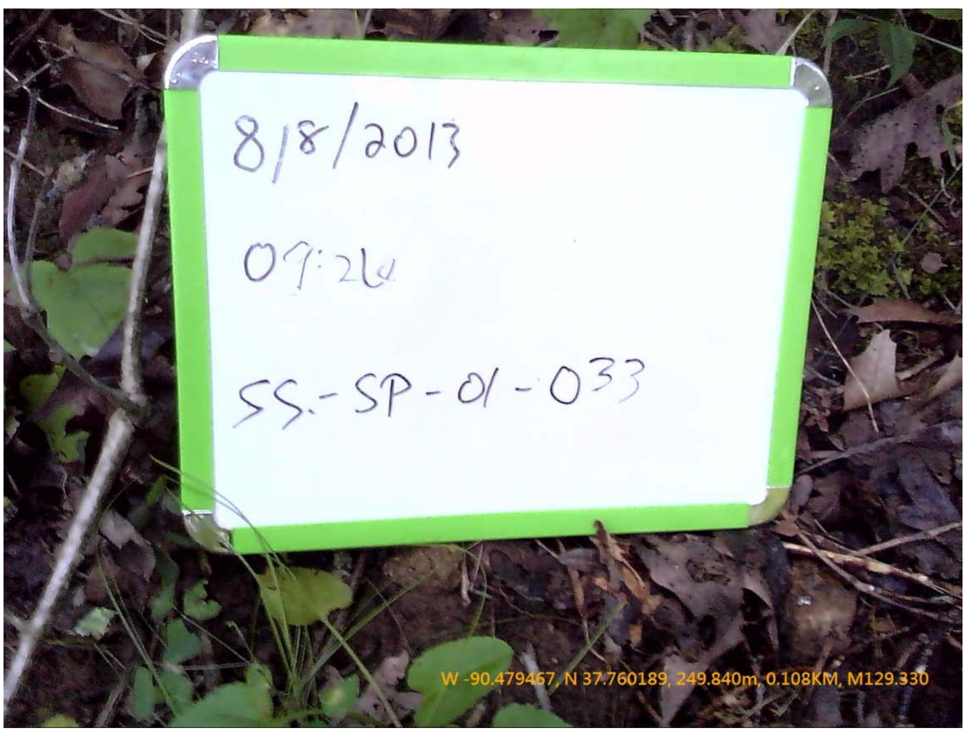
Photograph 31. No Landscape Photograph Available. Location of Sample OR-SP-01-005 (August, 2013)

Photograph 32. No Landscape Photograph Available. Location of Sample SS-SP-01-032 (August, 2013)

Photograph 33. No Landscape Photograph Available. Location of OR-SP-01-008 (August, 2013)



Photograph 34. No Landscape Photograph Available. Location of Sample SS-SP-01-033 (August, 2013)

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Photograph 35. No Landscape Photograph Available. Location of Sample OR-SP-01-012 (August, 2013)

Photograph 36. Area Surrounding Sample SS-SP-01-034 (August, 2013)

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Photograph 37. Area Surrounding Samples OR-SP-01-013 through OR-SP-01--015 (August, 2013)

Photograph 38. Area Surrounding Sample SS-SP-01-035 (August, 2013)

Photograph 39. Area Surrounding Sample OR-SP-01-016 through OR-SP-01-018 (August, 2013)

Photograph 40. Area Surrounding Sample SS-SP-01-036 (August, 2013)

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Photograph 41. Area Surrounding Sample OR-SP-01-019 through OR-SP-01-021 (August, 2013)

Photograph 42. Area Surrounding Sample SS-SP-01-037 (August, 2013)

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Photograph 43. No Landscape Photograph Available. Location of Sample OR-SP-01-24 (August, 2013)

Photograph 44. Area Surrounding Sample SS-SP-01-038 (August, 2013)

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Photograph 45. No Landscape Photograph Available. Location of Sample OR-SP-01-26 (August, 2013)

Photograph 46. No Landscape Photograph. Location of Sample SS-SP-01-039 (August, 2013)

Photograph 47. No Landscape Photograph. Location of Sample SS-SP-01-040 (August, 2013)

Photograph 48. No Landscape Photograph Available. Location of Sample OR-SP-01-029 (August, 2013)

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Photograph 49. Area Surrounding Samples OR-SP-01-031 through OR-01-033 (August, 2013)

Photograph 50. No Landscape Photograph Available. Area Surrounding Sample SS-SP-01-041 (August, 2013)

Photograph 51. Area Surrounding Sample SS-SP-01-042 (August, 2013)

Photograph 52. Area Surrounding Sample SS-SP-01-043 (August, 2013)

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Photograph 53. Area Surrounding Sample SS-SP-01-044 (August, 2013)

Photograph 54. Area Surrounding Sample SS-SP-01-045 (August, 2013)

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Photograph 55. Area Surrounding Sample SS-SP-01-046 (August, 2013)

Photograph 56. No Landscape Photograph. Location of Sample SS-SP-01-047 (August, 2013)

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Photograph 57. No Landscape Photograph. Location of Sample SS-SP-01-048 (August, 2013)

Photograph 58. Area Surrounding Sample SS-SP-01-049 (August, 2013)

Photograph 59. Area Surrounding Sample SS-SP-01-050 (August, 2013)

Photograph 60. Area Surrounding Sample SS-SP-01-051 (August, 2013)

Photograph 61. Area Surrounding Sample SS-SP-01-052 (August, 2013)

Photograph 62. Area Surrounding Sample SS-SP-01-053 (August, 2013)

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Photograph 63.   Area Surrounding Sample SS-SP-01-054 (August, 2013)

Photograph 64.   Area Surrounding Sample SS-SP-01-055 (August, 2013)

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Photograph 65. Area Surrounding Sample SS-SP-01-056 (August, 2013)

Photograph 66. Area Surrounding Sample SS-SP-01-057 (August, 2013)

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Photograph 67. Area Surrounding Sample SS-SP-01-058 (August, 2013)

Photograph 68. Area Surrounding Sample SS-SP-01-059 (August, 2013)

Note:

No photographs are available for area surrounding samples SS-SP-01-013 and SS-SP-01-014

APPENDIX B

DATA VALIDATION REPORT

DATA VALIDATION REPORT

St. Francois County Residential Lead Forensics – Background Soil Lead Study

Prepared for
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September 2013

CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ICSA	interference check sample A
RL	reporting limit
MDL	method detection limit
QA/QC	quality assurance and quality control
RPD	relative percent difference
SDG	sample delivery group

1 INTRODUCTION

This report presents the findings of the data validation of soil and rock samples and associated quality control samples analyzed by ALS Environmental of Kelso, Washington. The sample delivery groups (SDGs) reviewed and numbers of samples are summarized in Table 1-1; analytical methods are summarized in Table 1-2.

The samples received Stage 2B validation, which included a review of all laboratory summary forms of quality control and instrument performance data. The data validation was based upon criteria described in the U.S. Environmental Protection Agency's (EPA) functional guidelines for inorganic data review (USEPA 2004) and the referenced analytical method.

The quality assurance and quality control (QA/QC) parameters reviewed are discussed in Section 2. All electronic data deliverables (EDD) were compared to the hardcopy data packages, and 10% of the field sample results and laboratory quality control sample results were verified. Qualifiers resulting from the validation process were entered into the EDD for inclusion in the project database. A reason code indicating the reason for qualification was also entered into the database. The definitions of the data qualifiers used are provided in Table 1-3 and a description of the reason codes used are provided in Table 1-4. For example, if a data point was estimated due to a serial dilution result, the qualifier "J" and the reason code "ICPSD" would be entered into the database, indicated as J – ICPSD on the printout of the EDD. Reason codes are also used in the discussion of findings in Section 2.

2 FINDINGS

2.1 PARAMETERS REVIEWED

The QA/QC parameters reviewed for each analytical parameter are discussed below and are listed in Table 2-1.

2.2 SAMPLE RECEIPT AND HOLDING TIMES

All samples were received in good condition and with complete chain-of-custody forms and all analyses were conducted within the holding times specified in the analytical methods, with the exceptions noted below.

All SDGs: The sample coolers were received at ambient temperatures (21.5°C, 21.6°C, and 19.4°C, respectively). According to SW-846 (Chapter 3), temperature preservation is not required for solid and water samples for metals analysis; no qualifiers were assigned based on the sample temperatures.

2.3 BLANKS

Results from the laboratory method blanks, instrument blanks, and equipment blanks analyzed were evaluated to the method detection limit (MDL). If a metal was detected in the laboratory method blank or instrument blank, associated sample results less than the method reporting limit were qualified as not detected (U - LB). If a laboratory method blank or instrument blank indicated a negative bias, associated sample results were estimated (UJ/J – LB).

The following qualifiers were assigned based on the evaluation of the method and instrument blanks:

SDG K1308084: Cobalt, 22 results (U-LB); lead, 4 results (U-LB); and potassium, 2 results (U-LB).

SDG K1308085: Sodium, 1 result (U-LB).

SDG K1308180: Aluminum, 2 results (U-LB); barium, 2 results (U-LB); cadmium, 6 results (U-LB); calcium, 1 result (U-LB); copper, 2 results (UJ-LB); magnesium, 1 result (U-LB); manganese, 2 results (U-LB); and sodium 2 results (J/UJ-LB).

Two equipment blanks (EB-01 and EB-02) were collected in association with the soil samples in SDGs K1308085 and K1308180. No qualifiers were assigned based on the evaluation of the equipment blanks.

2.4 MATRIX SPIKES

Matrix spikes were reported with all SDGs. The percent recoveries of the matrix spikes were evaluated against the laboratory control limits of 75 to 125%. Detected results were estimated (J–MS) for percent recoveries below the lower control limit. The percent recovery control limits are not applicable when the concentration of an analyte in the parent sample is greater than 4 times the amount spiked, and qualifiers were not assigned for percent recoveries outside the control limits in these cases.

The following qualifiers were assigned based on the evaluation of the matrix spike percent recoveries:

SDG K1308180: Manganese (J-MS), 10 results.

2.5 LABORATORY CONTROL SAMPLES

A laboratory control sample was analyzed with all analytical batches, where applicable, and the percent recoveries were within the laboratory control limits. Laboratory control sample duplicates were not analyzed.

2.6 LABORATORY REPLICATES

Laboratory replicates were reported with all SDGs.

Laboratory replicate relative percent differences (RPDs) were evaluated against the laboratory control limit of 20% for values greater than 5 times the reporting limit (RL). For values less than 5 times the RL, the absolute difference should be less than the RL. Detected results were estimated (J-Rep) when these control limits were not met. The following qualifiers were assigned based on the evaluation of the laboratory replicates:

SDG K1308084: Zinc (J-REP), 14 results.

2.7 FIELD REPLICATES

Three field replicate pairs were reported as listed in Table 2-2. The EPA has not established control limits for field replicates. For this project the target control limit for field replicates is an RPD less than 30% for values greater than 5 times the RL. For values less than 5 times the RL, the absolute difference should be less than the RL. Results that did not meet these control limits are discussed below.

SDG K1308085: The RPD for cadmium between replicates SS-001 and SS-002 was above the control limit at 38%. Results for cadmium in the parent and duplicate samples were qualified as estimated (J-REP).

The RPD for nickel between replicates SS-052 and SS-053 was above the control limit at 33%. Results for nickel in the parent and duplicate samples were qualified as estimated (J-REP).

2.8 SERIAL DILUTIONS

Serial dilutions were reported in all SDGs. The percent differences for serial dilutions were evaluated against the control limit of 10%, when the initial concentration is greater than 50 times the MDL.

The following qualifiers were assigned based on the evaluation of the serial dilutions:

SDG K1308084: Cobalt and zinc, 14 results each (J-ICPSD); copper, lead, and nickel, 21 results each (J-ICPSD); and potassium and vanadium, 35 results each (J-ICPSD).

SDG K1308085: Arsenic, cobalt, iron, nickel, and zinc, 21 results each (J-ICPSD); barium, potassium, and vanadium, 14 results each (J-ICPSD); lead, 42 results (J-ICPSD); and magnesium and manganese, 35 results each (J-ICPSD).

2.9 METHOD REPORTING LIMITS AND METHODOLOGY

SDGs K1308084 and K1308085: Several samples required dilution for select analytes due to high analyte concentrations. MDLs and RLs were elevated as appropriate; qualifiers were not applied to the data.

2.10 INITIAL CALIBRATION VERIFICATION

Initial calibration verifications were analyzed on all instruments and met the acceptance criteria stated in the EPA's functional guidelines for inorganic data review (USEPA 2004).

2.11 CONTINUING CALIBRATION VERIFICATION

Continuing calibration verifications were analyzed at the appropriate frequency and met the acceptance criteria stated in EPA's functional guidelines for inorganic data review (USEPA 2004).

2.12 INTERFERENCE CHECK

The interference check sample was analyzed at the beginning of each analytical sequence and met the acceptance criteria stated in the EPA's functional guidelines for inorganic data review (USEPA 2004), except for those noted below. When interference levels were detected at absolute concentrations above the MDL in the Interference Check Sample A (ICSA), samples with interferent element concentrations greater than or equal to ICSA/ICSAB levels were qualified as estimated (J/UJ-ICS).

The following qualifiers were assigned based on the evaluation of the interference check samples:

SDG K1308084: Cadmium, 35 results (J/UJ-ICS); copper, 8 results (J-ICS); lead, 32 results (J/UJ-ICS).

SDG K1308085: Cadmium, 1 result (J-ICS); cobalt, 2 results (J-ICS).

3 OVERALL ASSESSMENT

3.1 DATA QUALIFICATION

A total of 1,960 data points were reported. Of these, 525 (27%) were qualified; the number of results qualified are summarized by reason in Table 3-1. A total of 493 results were estimated (J/UJ), and 43 detected results were qualified as non-detected (U) because of calibration or method blank contamination. Some data points were qualified for multiple reasons and, therefore, the sum of the qualifiers assigned is greater than the total number of data points qualified. Completeness was 100%. A summary of all qualified results is presented in Table 3-2.

3.2 DATA USABILITY

The data meet the criteria set forth in the referenced quality assurance documents, with the exceptions noted above. All results are acceptable for their intended use.

4 REFERENCES

USEPA. 1971. Residue, Total (Gravimetric, Dried at 103-105°C). Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020). March 1983.

USEPA. 2004. USEPA contract laboratory program national functional guidelines for inorganic data review. USEPA-540-R-04-004. U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation, Washington, DC. October 2004.

USEPA. 2007. SW-846: Test method for evaluating solid wastes physical/chemical methods, Method 6010C, inductively coupled plasma - atomic emission spectroscopy (ICP-AES). Revision 3.0. U.S. Environmental Protection Agency, Washington, DC. November 2007.

TABLES

Table 1-1. SDGs Reviewed and Number of Samples

SDG	Number of Samples	Validation Level	Analyses Requested
K1308084	33 Soils	Stage 2B	Metals[a], Percent Solids
K1308085	50 Soils, 3 Field Duplicates	Stage 2B	Metals[a], Percent Solids
K1308180	9 Soils, 2 Equipment Blanks	Stage 2B	Metals[a], Percent Solids

Notes:
SDG = sample delivery group

[a] Al, As, Ba, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Ag, Na,V, Zn

Table 1-2. Analytical Parameter, Method, and Laboratory

Analytical Parameter	Analytical Method	Reference	Laboratory
Soils			
Metals	SW846 6010C	USEPA 2007	
Percent Solids	EPA 160.3	USEPA 1971	ALS Kelso
Water			
Metals	SW846 6010C	USEPA 2007	

Notes:
USEPA = U.S. Environmental Protection Agency

Table 1-3. Definition of Data Qualifiers

Data Qualifier	Definition
J	The associated numerical value is an estimated quantity.
U	The material was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.
UJ	The material was analyzed for, but was not detected. The sample quantitation limit is an estimated quantity.

Table 1-4. Definition of Data Validation Reason Codes

Reason Code	Definition
ICPSD	ICP serial dilution % difference
ICS	Interference check sample
LB	Laboratory blank contamination
MS	Matrix spike recovery
REP	Replication (MS/MSD, lab replicate RPD and/or field duplicate RPD)

Notes:
ICP = inductively-coupled plasma
MS/MSD = matrix spike/matrix spike duplicate
RPD = relative percent difference

Table 2-1. QA/QC Parameters Reviewed

QA/QC Parameter	Analytical Parameter	
	Metals	Percent Solids
Sample Receipt & Holding Times	D	D
Blanks	Q	NA
MS	Q	NA
LCS	+	NA
Laboratory Replicates	Q	+
Field Replicates	Q	+
Serial Dilution	Q	D
MRL & Methodology	+	+
Initial Calibration Verification	+	NA
Continuing Calibration Verification	+	NA
Interference Check	Q	NA

Notes:
Parameter Codes:
+ = All QA/QC criteria met
D = Data are discussed in the report. QA/QC criteria were not met; however no data were qualified.
Q = Data were qualified and are discussed in the report.
NA = not applicable

LCS = laboratory control sample
MRL = method reporting limit
MS = matrix spike
QA/QC = quality assurance and quality control

Table 2-2. Field Replicates

SDG	Sample	Field Replicate
K1308085	SS-001	SS-002
K1308085	SS-032	SS-033
K1308085	SS-052	SS-053

Notes:
SDG = sample delivery group

Table 3-1. Summary of Qualified Data Points by Reason

Data Qualification Reason	Number of Data Points Estimated	Number of Data Qualified Non-detected	Number of Data Points Rejected
Blank Outlier	4	43	-
Interference Check Outlier	78	-	-
Matrix Spike Outlier	10	-	-
Replication Outlier	18	-	-
Serial Dilution Outlier	420	-	-

Table 3-2. Summary of Qualified Data

SDG	Sample	Analyte	Result	Units	MDL	MRL	Lab Qualifier	DV Qualifier	DV Qualifier Reason
K1308084	K1308084-001	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-001	Cobalt	0.61	mg/kg	0.1	0.79	J	U	LB
K1308084	K1308084-021	Cobalt	1	mg/kg	0.1	0.77		J	ICPSD
K1308084	K1308084-021DUP	Cobalt	0.9	mg/kg	0.1	0.8		J	ICPSD
K1308084	K1308084-022	Cobalt	0.69	mg/kg	0.1	0.77	J	J	ICPSD
K1308084	K1308084-023	Cobalt	0.26	mg/kg	0.1	0.78	J	J	ICPSD
K1308084	K1308084-024	Cobalt	0.86	mg/kg	0.1	0.76		J	ICPSD
K1308084	K1308084-001DUP	Cadmium	0	mg/kg	0	0.2	U	UJ	ICS
K1308084	K1308084-001DUP	Cobalt	0.5	mg/kg	0.1	0.8	J	U	LB
K1308084	K1308084-002	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-025	Cobalt	0.19	mg/kg	0.1	0.78	J	UJ	LB,ICPSD
K1308084	K1308084-026	Cobalt	0.65	mg/kg	0.1	0.76	J	UJ	LB,ICPSD
K1308084	K1308084-027	Cobalt	0.37	mg/kg	0.1	0.78	J	UJ	LB,ICPSD
K1308084	K1308084-028	Cobalt	0.81	mg/kg	0.1	0.79		J	ICPSD
K1308084	K1308084-003	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-002	Cobalt	0.63	mg/kg	0.1	0.79	J	U	LB
K1308084	K1308084-004	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-029	Cobalt	0.42	mg/kg	0.1	0.77	J	UJ	LB,ICPSD
K1308084	K1308084-030	Cobalt	0.52	mg/kg	0.1	0.77	J	UJ	LB,ICPSD
K1308084	K1308084-031	Cobalt	4.46	mg/kg	0.1	0.77		J	ICPSD
K1308084	K1308084-032	Cobalt	2.13	mg/kg	0.1	0.77		J	ICPSD
K1308084	K1308084-005	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-003	Cobalt	0.43	mg/kg	0.1	0.78	J	U	LB
K1308084	K1308084-006	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-033	Cobalt	2.8	mg/kg	0.1	0.78		J	ICPSD
K1308084	K1308084-007	Cadmium	0.04	mg/kg	0.04	0.19	J	J	ICS
K1308084	K1308084-008	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-009	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-010	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-011	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-002	Copper	2.89	mg/kg	0.2	0.79		J	ICPSD
K1308084	K1308084-006	Copper	3.01	mg/kg	0.2	0.79		J	ICPSD
K1308084	K1308084-016	Copper	3.07	mg/kg	0.19	0.78		J	ICPSD
K1308084	K1308084-017	Copper	3.2	mg/kg	0.2	0.78		J	ICPSD
K1308084	K1308084-012	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-013	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-003	Copper	4.25	mg/kg	0.2	0.78		J	ICPSD
K1308084	K1308084-009	Copper	4.41	mg/kg	0.19	0.76		J	ICPSD
K1308084	K1308084-004	Copper	4.97	mg/kg	0.19	0.77		J	ICPSD
K1308084	K1308084-018	Copper	5.26	mg/kg	0.2	0.79		J	ICPSD
K1308084	K1308084-014	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-012	Copper	5.66	mg/kg	0.2	0.79		J	ICPSD
K1308084	K1308084-014	Copper	5.81	mg/kg	0.19	0.78		J	ICPSD
K1308084	K1308084-005	Copper	5.85	mg/kg	0.19	0.76		J	ICPSD
K1308084	K1308084-015	Copper	6.02	mg/kg	0.19	0.76		J	ICPSD
K1308084	K1308084-013	Copper	6.03	mg/kg	0.19	0.78		J	ICPSD
K1308084	K1308084-015	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-007	Cobalt	0.31	mg/kg	0.1	0.78	J	U	LB
K1308084	K1308084-020	Copper	6.42	mg/kg	0.2	0.79		J	ICPSD
K1308084	K1308084-007	Copper	6.43	mg/kg	0.19	0.78		J	ICPSD
K1308084	K1308084-001DUP	Copper	7.5	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-001	Copper	7.76	mg/kg	0.2	0.79		J	ICPSD
K1308084	K1308084-019	Copper	10.7	mg/kg	0.19	0.78		J	ICPSD
K1308084	K1308084-016	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-008	Cobalt	0.37	mg/kg	0.1	0.79	J	U	LB
K1308084	K1308084-017	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-018	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-019	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-020	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-021	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-009	Cobalt	0.48	mg/kg	0.1	0.76	J	U	LB
K1308084	K1308084-021DUP	Cadmium	0	mg/kg	0	0.2	U	UJ	ICS

Table 3-2. Summary of Qualified Data

SDG	Sample	Analyte	Result	Units	MDL	MRL	Lab Qualifier	DV Qualifier	DV Qualifier Reason
K1308084	K1308084-022	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-023	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-007	Lead	12.1	mg/kg	0.4	1.9		J	ICPSD
K1308084	K1308084-024	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-010	Cobalt	0.62	mg/kg	0.1	0.78	J	U	LB
K1308084	K1308084-025	Cadmium	0.87	mg/kg	0.04	0.19		J	ICS
K1308084	K1308084-026	Cadmium	0.4	mg/kg	0.04	0.19		J	ICS
K1308084	K1308084-027	Cadmium	0.61	mg/kg	0.04	0.2		J	ICS
K1308084	K1308084-028	Cadmium	1.01	mg/kg	0.04	0.2		J	ICS
K1308084	K1308084-029	Cadmium	2.13	mg/kg	0.04	0.19		J	ICS
K1308084	K1308084-030	Cadmium	0.1	mg/kg	0.04	0.19	J	J	ICS
K1308084	K1308084-011	Cobalt	0.14	mg/kg	0.1	0.77	J	U	LB
K1308084	K1308084-031	Cadmium	0.1	mg/kg	0.04	0.19	J	J	ICS
K1308084	K1308084-032	Cadmium	0.04	mg/kg	0.04	0.19	U	UJ	ICS
K1308084	K1308084-033	Cadmium	0.04	mg/kg	0.04	0.2	U	UJ	ICS
K1308084	K1308084-029	Copper	1	mg/kg	0.19	0.77		J	ICS
K1308084	K1308084-030	Copper	1.13	mg/kg	0.19	0.77		J	ICS
K1308084	K1308084-025	Copper	1.32	mg/kg	0.19	0.78		J	ICS
K1308084	K1308084-011	Copper	0.62	mg/kg	0.19	0.77	J	J	ICPSD,ICS
K1308084	K1308084-010	Copper	1.91	mg/kg	0.2	0.78		J	ICPSD,ICS
K1308084	K1308084-008	Copper	2.04	mg/kg	0.2	0.79		J	ICPSD,ICS
K1308084	K1308084-001	Nickel	1.94	mg/kg	0.1	0.79		J	ICPSD
K1308084	K1308084-026	Copper	1.41	mg/kg	0.19	0.76		J	ICS
K1308084	K1308084-013	Cobalt	0.33	mg/kg	0.1	0.78	J	U	LB
K1308084	K1308084-001DUP	Nickel	1.8	mg/kg	0.1	0.8		J	ICPSD
K1308084	K1308084-002	Nickel	1.68	mg/kg	0.1	0.79		J	ICPSD
K1308084	K1308084-003	Nickel	1.65	mg/kg	0.1	0.78		J	ICPSD
K1308084	K1308084-004	Nickel	7.51	mg/kg	0.1	0.77		J	ICPSD
K1308084	K1308084-005	Nickel	12.2	mg/kg	0.1	0.76		J	ICPSD
K1308084	K1308084-027	Copper	1.69	mg/kg	0.2	0.78		J	ICS
K1308084	K1308084-014	Cobalt	0.25	mg/kg	0.1	0.78	J	U	LB
K1308084	K1308084-006	Nickel	3.03	mg/kg	0.1	0.79		J	ICPSD
K1308084	K1308084-007	Nickel	1.09	mg/kg	0.1	0.78		J	ICPSD
K1308084	K1308084-008	Nickel	0.83	mg/kg	0.1	0.79		J	ICPSD
K1308084	K1308084-009	Nickel	0.95	mg/kg	0.1	0.76		J	ICPSD
K1308084	K1308084-010	Nickel	1.07	mg/kg	0.1	0.78		J	ICPSD
K1308084	K1308084-011	Nickel	0.6	mg/kg	0.1	0.77	J	J	ICPSD
K1308084	K1308084-001	Lead	0.4	mg/kg	0.4	2	U	UJ	ICPSD,ICS
K1308084	K1308084-015	Cobalt	0.74	mg/kg	0.1	0.76	J	U	LB
K1308084	K1308084-012	Nickel	7.6	mg/kg	0.1	0.79		J	ICPSD
K1308084	K1308084-013	Nickel	1.26	mg/kg	0.1	0.78		J	ICPSD
K1308084	K1308084-014	Nickel	1.75	mg/kg	0.1	0.78		J	ICPSD
K1308084	K1308084-015	Nickel	1.66	mg/kg	0.1	0.76		J	ICPSD
K1308084	K1308084-001DUP	Lead	0.4	mg/kg	0.4	2	U	UJ	ICPSD,ICS
K1308084	K1308084-016	Cobalt	0.47	mg/kg	0.1	0.78	J	U	LB
K1308084	K1308084-016	Nickel	0.91	mg/kg	0.1	0.78		J	ICPSD
K1308084	K1308084-017	Nickel	1.1	mg/kg	0.1	0.78		J	ICPSD
K1308084	K1308084-018	Nickel	1.33	mg/kg	0.1	0.79		J	ICPSD
K1308084	K1308084-019	Nickel	1.52	mg/kg	0.1	0.78		J	ICPSD
K1308084	K1308084-002	Lead	0.5	mg/kg	0.4	2	J	UJ	LB,ICPSD,ICS
K1308084	K1308084-017	Cobalt	0.45	mg/kg	0.1	0.78	J	U	LB
K1308084	K1308084-020	Nickel	1.41	mg/kg	0.1	0.79		J	ICPSD
K1308084	K1308084-001	Potassium	310	mg/kg	8.9	79.2		J	ICPSD
K1308084	K1308084-001DUP	Potassium	320	mg/kg	9	80		J	ICPSD
K1308084	K1308084-002	Potassium	244	mg/kg	8.9	79.2		J	ICPSD
K1308084	K1308084-003	Potassium	165	mg/kg	8.8	78.4		J	ICPSD
K1308084	K1308084-003	Lead	0.4	mg/kg	0.4	2	U	UJ	ICPSD,ICS
K1308084	K1308084-018	Cobalt	0.65	mg/kg	0.1	0.79	J	U	LB
K1308084	K1308084-004	Potassium	438	mg/kg	8.7	77		J	ICPSD
K1308084	K1308084-005	Potassium	378	mg/kg	8.6	76.3		J	ICPSD
K1308084	K1308084-006	Potassium	159	mg/kg	8.9	79.3		J	ICPSD
K1308084	K1308084-007	Potassium	215	mg/kg	8.8	77.7		J	ICPSD

Table 3-2. Summary of Qualified Data

SDG	Sample	Analyte	Result	Units	MDL	MRL	Lab Qualifier	DV Qualifier	DV Qualifier Reason
K1308084	K1308084-008	Potassium	224	mg/kg	8.8	78.6		J	ICPSD
K1308084	K1308084-009	Potassium	221	mg/kg	8.6	76.3		J	ICPSD
K1308084	K1308084-004	Lead	5	mg/kg	0.4	1.9		J	ICPSD,ICS
K1308084	K1308084-019	Cobalt	0.7	mg/kg	0.1	0.78	J	U	LB
K1308084	K1308084-010	Potassium	103	mg/kg	8.8	77.8		J	ICPSD
K1308084	K1308084-011	Potassium	91	mg/kg	8.7	77.1		J	ICPSD
K1308084	K1308084-012	Potassium	86.5	mg/kg	8.9	79.2		J	ICPSD
K1308084	K1308084-013	Potassium	114	mg/kg	8.8	77.7		J	ICPSD
K1308084	K1308084-014	Potassium	119	mg/kg	8.7	77.7		J	ICPSD
K1308084	K1308084-005	Lead	7.9	mg/kg	0.4	1.9		J	ICPSD,ICS
K1308084	K1308084-020	Cobalt	0.47	mg/kg	0.1	0.79	J	U	LB
K1308084	K1308084-015	Potassium	173	mg/kg	8.6	76.2		J	ICPSD
K1308084	K1308084-016	Potassium	74.2	mg/kg	8.7	77.7	J	UJ	LB,ICPSD
K1308084	K1308084-017	Potassium	77.5	mg/kg	8.8	78.4	J	UJ	LB,ICPSD
K1308084	K1308084-018	Potassium	100	mg/kg	8.8	78.5		J	ICPSD
K1308084	K1308084-019	Potassium	254	mg/kg	8.8	77.7		J	ICPSD
K1308084	K1308084-006	Lead	2.2	mg/kg	0.4	2		J	ICPSD,ICS
K1308084	K1308084-020	Potassium	337	mg/kg	8.8	78.5		J	ICPSD
K1308084	K1308084-008	Lead	0.4	mg/kg	0.4	2	U	UJ	ICPSD,ICS
K1308084	K1308084-021	Potassium	513	mg/kg	8.7	77.1		J	ICPSD
K1308084	K1308084-021DUP	Potassium	554	mg/kg	9	78.6		J	ICPSD
K1308084	K1308084-009	Lead	2.2	mg/kg	0.4	1.9		J	ICPSD,ICS
K1308084	K1308084-022	Potassium	425	mg/kg	8.7	76.9		J	ICPSD
K1308084	K1308084-023	Potassium	205	mg/kg	8.8	78.4		J	ICPSD
K1308084	K1308084-010	Lead	1	mg/kg	0.4	2	J	UJ	LB,ICPSD,ICS
K1308084	K1308084-024	Potassium	454	mg/kg	8.6	76.2		J	ICPSD
K1308084	K1308084-025	Potassium	324	mg/kg	8.7	77.7		J	ICPSD
K1308084	K1308084-011	Lead	0.4	mg/kg	0.4	1.9	U	UJ	ICPSD,ICS
K1308084	K1308084-026	Potassium	234	mg/kg	8.6	76.3		J	ICPSD
K1308084	K1308084-027	Potassium	405	mg/kg	8.8	78.4		J	ICPSD
K1308084	K1308084-012	Lead	1.8	mg/kg	0.4	2	J	UJ	LB,ICPSD,ICS
K1308084	K1308084-028	Potassium	208	mg/kg	8.9	79.3		J	ICPSD
K1308084	K1308084-029	Potassium	136	mg/kg	8.7	76.9		J	ICPSD
K1308084	K1308084-013	Lead	0.9	mg/kg	0.4	1.9	J	UJ	LB,ICPSD,ICS
K1308084	K1308084-030	Potassium	225	mg/kg	8.7	76.9		J	ICPSD
K1308084	K1308084-031	Potassium	133	mg/kg	8.7	76.9		J	ICPSD
K1308084	K1308084-032	Potassium	186	mg/kg	8.7	76.9		J	ICPSD
K1308084	K1308084-033	Potassium	136	mg/kg	8.8	78.4		J	ICPSD
K1308084	K1308084-001	Vanadium	3.6	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-014	Lead	0.4	mg/kg	0.4	1.9	U	UJ	ICPSD,ICS
K1308084	K1308084-001DUP	Vanadium	3.5	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-002	Vanadium	3.5	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-015	Lead	1.1	mg/kg	0.4	1.9	J	J	ICPSD,ICS
K1308084	K1308084-003	Vanadium	2.5	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-004	Vanadium	6.4	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-005	Vanadium	4.3	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-016	Lead	1.5	mg/kg	0.4	1.9	J	J	ICPSD,ICS
K1308084	K1308084-006	Vanadium	2.5	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-007	Vanadium	4.3	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-017	Lead	1.3	mg/kg	0.4	2	J	J	ICPSD,ICS
K1308084	K1308084-008	Vanadium	4.2	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-009	Vanadium	4.3	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-010	Vanadium	7.1	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-018	Lead	1.5	mg/kg	0.4	2	J	J	ICPSD,ICS
K1308084	K1308084-011	Vanadium	6.7	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-012	Vanadium	6.1	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-019	Lead	1.2	mg/kg	0.4	1.9	J	J	ICPSD,ICS
K1308084	K1308084-013	Vanadium	4.2	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-014	Vanadium	5.3	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-015	Vanadium	6.1	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-020	Lead	2.5	mg/kg	0.4	2		J	ICPSD,ICS
K1308084	K1308084-016	Vanadium	6.7	mg/kg	0.2	0.8		J	ICPSD

Table 3-2. Summary of Qualified Data

SDG	Sample	Analyte	Result	Units	MDL	MRL	Lab Qualifier	DV Qualifier	DV Qualifier Reason
K1308084	K1308084-017	Vanadium	6	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-021	Lead	2	mg/kg	0.4	1.9		J	ICS
K1308084	K1308084-018	Vanadium	5.2	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-019	Vanadium	3.7	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-020	Vanadium	4.5	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-021DUP	Lead	1.4	mg/kg	0.4	2	J	J	ICS
K1308084	K1308084-021	Vanadium	3.8	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-021DUP	Vanadium	4	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-022	Lead	3.7	mg/kg	0.4	1.9		J	ICS
K1308084	K1308084-022	Vanadium	4.3	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-023	Vanadium	2.9	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-024	Vanadium	4.3	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-024	Lead	2.8	mg/kg	0.4	1.9		J	ICS
K1308084	K1308084-025	Vanadium	4	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-026	Vanadium	3.5	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-025	Lead	7.9	mg/kg	0.4	1.9		J	ICS
K1308084	K1308084-027	Vanadium	4.9	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-028	Vanadium	5.7	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-029	Vanadium	3.9	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-026	Lead	6.1	mg/kg	0.4	1.9		J	ICS
K1308084	K1308084-030	Vanadium	3.6	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-031	Vanadium	6.1	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-027	Lead	6.8	mg/kg	0.4	2		J	ICS
K1308084	K1308084-032	Vanadium	9.7	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-033	Vanadium	6	mg/kg	0.2	0.8		J	ICPSD
K1308084	K1308084-021DUP	Zinc	3.1	mg/kg	0.2	0.98		J	REP,ICPSD
K1308084	K1308084-028	Lead	3.6	mg/kg	0.4	2		J	ICS
K1308084	K1308084-022	Zinc	5.2	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-024	Zinc	5.5	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-030	Zinc	8.8	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-021	Zinc	10	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-023	Zinc	13.8	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-029	Lead	5.4	mg/kg	0.4	1.9		J	ICS
K1308084	K1308084-032	Zinc	17.3	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-030	Lead	2	mg/kg	0.4	1.9		J	ICS
K1308084	K1308084-027	Zinc	22.6	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-026	Zinc	25.4	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-025	Zinc	27.9	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-032	Lead	6.5	mg/kg	0.4	1.9		J	ICS
K1308084	K1308084-033	Zinc	30.7	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-033	Lead	6.8	mg/kg	0.4	2		J	ICS
K1308084	K1308084-028	Zinc	31.1	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-029	Zinc	52.9	mg/kg	0.2	1		J	REP,ICPSD
K1308084	K1308084-031	Zinc	77.4	mg/kg	0.2	1		J	REP,ICPSD
K1308085	K1308085-001	Cadmium	3.66	mg/kg	0.04	0.21		J	REP
K1308085	K1308085-038	Cobalt	5.6	mg/kg	0.11	0.85		J	ICS
K1308085	K1308085-021	Arsenic	10	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-002	Cadmium	5.38	mg/kg	0.04	0.21		J	REP
K1308085	K1308085-049	Cobalt	5.86	mg/kg	0.1	0.82		J	ICS
K1308085	K1308085-021DUP	Arsenic	10.1	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-022	Arsenic	11.9	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-023	Arsenic	22	mg/kg	0.8	4		J	ICPSD
K1308085	K1308085-024	Arsenic	5	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-025	Arsenic	10.7	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-026	Arsenic	8.9	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-027	Arsenic	11.8	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-028	Arsenic	8.6	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-029	Arsenic	7.2	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-030	Arsenic	8.5	mg/kg	0.8	4		J	ICPSD
K1308085	K1308085-031	Arsenic	8.9	mg/kg	0.8	4		J	ICPSD
K1308085	K1308085-032	Arsenic	6.8	mg/kg	0.8	4		J	ICPSD
K1308085	K1308085-033	Arsenic	6	mg/kg	0.8	4		J	ICPSD

Table 3-2. Summary of Qualified Data

SDG	Sample	Analyte	Result	Units	MDL	MRL	Lab Qualifier	DV Qualifier	DV Qualifier Reason
K1308085	K1308085-034	Arsenic	11.6	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-040	Arsenic	14.6	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-041	Arsenic	11.3	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-042	Arsenic	12.7	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-043	Arsenic	16.6	mg/kg	0.8	4.1		J	ICPSD
K1308085	K1308085-044	Arsenic	11.9	mg/kg	0.8	3.9		J	ICPSD
K1308085	K1308085-045	Arsenic	8.2	mg/kg	0.8	3.8		J	ICPSD
K1308085	K1308085-035	Barium	92.2	mg/kg	1.51	4.02		J	ICPSD
K1308085	K1308085-014	Sodium	39.5	mg/kg	4.1	41.3	J	U	LB
K1308085	K1308085-036	Barium	900	mg/kg	1.62	4.33		J	ICPSD
K1308085	K1308085-037	Barium	137	mg/kg	0.31	0.83		J	ICPSD
K1308085	K1308085-038	Barium	169	mg/kg	0.32	0.85		J	ICPSD
K1308085	K1308085-039	Barium	379	mg/kg	1.55	4.12		J	ICPSD
K1308085	K1308085-046	Barium	80.5	mg/kg	0.31	0.82		J	ICPSD
K1308085	K1308085-047	Barium	89.7	mg/kg	0.31	0.82		J	ICPSD
K1308085	K1308085-048	Barium	164	mg/kg	0.31	0.82		J	ICPSD
K1308085	K1308085-049	Barium	160	mg/kg	0.31	0.82		J	ICPSD
K1308085	K1308085-050	Barium	88.5	mg/kg	0.3	0.8		J	ICPSD
K1308085	K1308085-050DUP	Barium	90.7	mg/kg	0.3	0.8		J	ICPSD
K1308085	K1308085-051	Barium	90.6	mg/kg	0.3	0.81		J	ICPSD
K1308085	K1308085-052	Barium	164	mg/kg	0.31	0.82		J	ICPSD
K1308085	K1308085-053	Barium	151	mg/kg	0.31	0.82		J	ICPSD
K1308085	K1308085-021	Cobalt	12.4	mg/kg	0.1	0.82		J	ICPSD
K1308085	K1308085-021DUP	Cobalt	12.8	mg/kg	0.1	0.82		J	ICPSD
K1308085	K1308085-022	Cobalt	22.1	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-024	Cobalt	6.95	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-025	Cobalt	11.2	mg/kg	0.1	0.82		J	ICPSD
K1308085	K1308085-026	Cobalt	11.2	mg/kg	0.1	0.82		J	ICPSD
K1308085	K1308085-027	Cobalt	6.53	mg/kg	0.1	0.82		J	ICPSD
K1308085	K1308085-028	Cobalt	14.1	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-029	Cobalt	10.5	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-030	Cobalt	13.4	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-031	Cobalt	11.9	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-032	Cobalt	7.97	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-033	Cobalt	7.83	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-034	Cobalt	10.8	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-041	Cobalt	17.9	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-042	Cobalt	14.3	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-043	Cobalt	13.2	mg/kg	0.1	0.83		J	ICPSD
K1308085	K1308085-044	Cobalt	11.3	mg/kg	0.1	0.78		J	ICPSD
K1308085	K1308085-045	Cobalt	14.7	mg/kg	0.09	0.75		J	ICPSD
K1308085	K1308085-040	Cobalt	17.2	mg/kg	0.1	0.83		J	ICPSD
K1308085	K1308085-023	Cobalt	151	mg/kg	0.1	0.8		J	ICPSD
K1308085	K1308085-021	Iron	21800	mg/kg	2.1	8.2		J	ICPSD
K1308085	K1308085-021DUP	Iron	22700	mg/kg	2.1	8.2		J	ICPSD
K1308085	K1308085-022	Iron	22500	mg/kg	2	8.1		J	ICPSD
K1308085	K1308085-023	Iron	48200	mg/kg	2	8		J	ICPSD
K1308085	K1308085-024	Iron	7390	mg/kg	2	8.1		J	ICPSD
K1308085	K1308085-025	Iron	18300	mg/kg	2	8.2		J	ICPSD
K1308085	K1308085-026	Iron	15500	mg/kg	2.1	8.2		J	ICPSD
K1308085	K1308085-027	Iron	21400	mg/kg	2.1	8.2		J	ICPSD
K1308085	K1308085-028	Iron	13200	mg/kg	2	8.1		J	ICPSD
K1308085	K1308085-029	Iron	11400	mg/kg	2	8.1		J	ICPSD
K1308085	K1308085-030	Iron	12100	mg/kg	2	8.1		J	ICPSD
K1308085	K1308085-031	Iron	17000	mg/kg	2	8.1		J	ICPSD
K1308085	K1308085-032	Iron	14300	mg/kg	2	8.1		J	ICPSD
K1308085	K1308085-033	Iron	13700	mg/kg	2	8.1		J	ICPSD
K1308085	K1308085-034	Iron	23800	mg/kg	2	8.1		J	ICPSD
K1308085	K1308085-040	Iron	46800	mg/kg	2.1	8.3		J	ICPSD
K1308085	K1308085-041	Iron	28700	mg/kg	2	8.1		J	ICPSD
K1308085	K1308085-042	Iron	28000	mg/kg	2	8.1		J	ICPSD
K1308085	K1308085-043	Iron	49600	mg/kg	2.1	8.3		J	ICPSD

Table 3-2. Summary of Qualified Data

SDG	Sample	Analyte	Result	Units	MDL	MRL	Lab Qualifier	DV Qualifier	DV Qualifier Reason
K1308085	K1308085-044	Iron	26600	mg/kg	2	7.8		J	ICPSD
K1308085	K1308085-045	Iron	16500	mg/kg	1.9	7.5		J	ICPSD
K1308085	K1308085-001	Lead	914	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-002	Lead	1090	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-003	Lead	388	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-004	Lead	223	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-005	Lead	631	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-006	Lead	67.2	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-006DUP	Lead	70.5	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-007	Lead	303	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-008	Lead	92	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-009	Lead	72.2	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-010	Lead	104	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-011	Lead	69.7	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-012	Lead	141	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-013	Lead	97.4	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-014	Lead	268	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-015	Lead	703	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-016	Lead	1810	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-017	Lead	1080	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-018	Lead	1080	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-019	Lead	340	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-020	Lead	141	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-021	Lead	131	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-021DUP	Lead	140	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-022	Lead	1060	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-023	Lead	16300	mg/kg	2	9.9		J	ICPSD
K1308085	K1308085-024	Lead	66.8	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-025	Lead	43.5	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-026	Lead	40.5	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-027	Lead	72.6	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-028	Lead	81.6	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-029	Lead	82.8	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-030	Lead	75.8	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-031	Lead	25.6	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-032	Lead	33.4	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-033	Lead	32.8	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-034	Lead	108	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-040	Lead	421	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-041	Lead	515	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-042	Lead	77.4	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-043	Lead	30.2	mg/kg	0.4	2.1		J	ICPSD
K1308085	K1308085-044	Lead	56.8	mg/kg	0.4	2		J	ICPSD
K1308085	K1308085-045	Lead	418	mg/kg	0.4	1.9		J	ICPSD
K1308085	K1308085-021	Magnesium	1900	mg/kg	0.2	8.2		J	ICPSD
K1308085	K1308085-021DUP	Magnesium	1910	mg/kg	0.2	8.2		J	ICPSD
K1308085	K1308085-022	Magnesium	16300	mg/kg	0.2	8.1		J	ICPSD
K1308085	K1308085-023	Magnesium	79500	mg/kg	0.2	8		J	ICPSD
K1308085	K1308085-024	Magnesium	573	mg/kg	0.2	8.1		J	ICPSD
K1308085	K1308085-025	Magnesium	46600	mg/kg	0.2	8.2		J	ICPSD
K1308085	K1308085-026	Magnesium	37700	mg/kg	0.2	8.2		J	ICPSD
K1308085	K1308085-027	Magnesium	39000	mg/kg	0.2	8.2		J	ICPSD
K1308085	K1308085-028	Magnesium	1100	mg/kg	0.2	8.13		J	ICPSD
K1308085	K1308085-029	Magnesium	1210	mg/kg	0.2	8.14		J	ICPSD
K1308085	K1308085-030	Magnesium	958	mg/kg	0.2	8.08		J	ICPSD
K1308085	K1308085-031	Magnesium	1740	mg/kg	0.2	8.1		J	ICPSD
K1308085	K1308085-032	Magnesium	1090	mg/kg	0.2	8.07		J	ICPSD
K1308085	K1308085-033	Magnesium	1010	mg/kg	0.2	8.05		J	ICPSD
K1308085	K1308085-034	Magnesium	1240	mg/kg	0.2	8.11		J	ICPSD
K1308085	K1308085-035	Magnesium	748	mg/kg	1.01	40.2		J	ICPSD
K1308085	K1308085-036	Magnesium	3720	mg/kg	1.08	43.3		J	ICPSD
K1308085	K1308085-037	Magnesium	3680	mg/kg	0.2	8.3		J	ICPSD

Table 3-2. Summary of Qualified Data

SDG	Sample	Analyte	Result	Units	MDL	MRL	Lab Qualifier	DV Qualifier	DV Qualifier Reason
K1308085	K1308085-038	Magnesium	59700	mg/kg	0.2	8.5		J	ICPSD
K1308085	K1308085-039	Magnesium	6530	mg/kg	1.03	41.2		J	ICPSD
K1308085	K1308085-040	Magnesium	6510	mg/kg	0.2	8.3		J	ICPSD
K1308085	K1308085-041	Magnesium	18000	mg/kg	0.2	8.1		J	ICPSD
K1308085	K1308085-042	Magnesium	1870	mg/kg	0.2	8.1		J	ICPSD
K1308085	K1308085-043	Magnesium	3360	mg/kg	0.2	8.3		J	ICPSD
K1308085	K1308085-044	Magnesium	3030	mg/kg	0.2	7.8		J	ICPSD
K1308085	K1308085-045	Magnesium	1680	mg/kg	0.2	7.5		J	ICPSD
K1308085	K1308085-046	Magnesium	2120	mg/kg	0.2	8.2		J	ICPSD
K1308085	K1308085-047	Magnesium	1710	mg/kg	0.2	8.2		J	ICPSD
K1308085	K1308085-036	Cadmium	0.33	mg/kg	0.22	1.08	J	J	ICS
K1308085	K1308085-048	Magnesium	2090	mg/kg	0.2	8.2		J	ICPSD
K1308085	K1308085-049	Magnesium	42800	mg/kg	0.2	8.2		J	ICPSD
K1308085	K1308085-050	Magnesium	915	mg/kg	0.2	8.01		J	ICPSD
K1308085	K1308085-050DUP	Magnesium	935	mg/kg	0.2	8.01		J	ICPSD
K1308085	K1308085-051	Magnesium	1290	mg/kg	0.2	8.06		J	ICPSD
K1308085	K1308085-052	Magnesium	1710	mg/kg	0.2	8.2		J	ICPSD
K1308085	K1308085-053	Magnesium	1740	mg/kg	0.2	8.2		J	ICPSD
K1308085	K1308085-021	Manganese	1840	mg/kg	0.02	0.82		J	ICPSD
K1308085	K1308085-021DUP	Manganese	1900	mg/kg	0.02	0.82		J	ICPSD
K1308085	K1308085-022	Manganese	1630	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-023	Manganese	4170	mg/kg	0.02	0.8		J	ICPSD
K1308085	K1308085-024	Manganese	1530	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-025	Manganese	412	mg/kg	0.02	0.82		J	ICPSD
K1308085	K1308085-026	Manganese	444	mg/kg	0.02	0.82		J	ICPSD
K1308085	K1308085-027	Manganese	739	mg/kg	0.02	0.82		J	ICPSD
K1308085	K1308085-028	Manganese	1700	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-029	Manganese	1310	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-030	Manganese	2190	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-031	Manganese	693	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-032	Manganese	294	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-033	Manganese	294	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-034	Manganese	349	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-035	Manganese	1430	mg/kg	0.1	4.02		J	ICPSD
K1308085	K1308085-036	Manganese	8720	mg/kg	0.11	4.33		J	ICPSD
K1308085	K1308085-037	Manganese	850	mg/kg	0.02	0.83		J	ICPSD
K1308085	K1308085-038	Manganese	1350	mg/kg	0.02	0.85		J	ICPSD
K1308085	K1308085-039	Manganese	1160	mg/kg	0.1	4.12		J	ICPSD
K1308085	K1308085-040	Manganese	6130	mg/kg	0.02	0.83		J	ICPSD
K1308085	K1308085-041	Manganese	7030	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-042	Manganese	3070	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-043	Manganese	5010	mg/kg	0.02	0.83		J	ICPSD
K1308085	K1308085-044	Manganese	1390	mg/kg	0.02	0.78		J	ICPSD
K1308085	K1308085-045	Manganese	929	mg/kg	0.02	0.75		J	ICPSD
K1308085	K1308085-046	Manganese	497	mg/kg	0.02	0.82		J	ICPSD
K1308085	K1308085-047	Manganese	1100	mg/kg	0.02	0.82		J	ICPSD
K1308085	K1308085-048	Manganese	2370	mg/kg	0.02	0.82		J	ICPSD
K1308085	K1308085-049	Manganese	3290	mg/kg	0.02	0.82		J	ICPSD
K1308085	K1308085-050	Manganese	1180	mg/kg	0.02	0.8		J	ICPSD
K1308085	K1308085-050DUP	Manganese	1190	mg/kg	0.02	0.8		J	ICPSD
K1308085	K1308085-051	Manganese	873	mg/kg	0.02	0.81		J	ICPSD
K1308085	K1308085-052	Manganese	916	mg/kg	0.02	0.82		J	ICPSD
K1308085	K1308085-053	Manganese	887	mg/kg	0.02	0.82		J	ICPSD
K1308085	K1308085-021	Nickel	18.8	mg/kg	0.1	0.82		J	ICPSD
K1308085	K1308085-021DUP	Nickel	19.4	mg/kg	0.1	0.82		J	ICPSD
K1308085	K1308085-022	Nickel	24.7	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-023	Nickel	149	mg/kg	0.1	0.8		J	ICPSD
K1308085	K1308085-024	Nickel	107	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-025	Nickel	47	mg/kg	0.1	0.82		J	ICPSD
K1308085	K1308085-026	Nickel	24.2	mg/kg	0.1	0.82		J	ICPSD
K1308085	K1308085-027	Nickel	19.8	mg/kg	0.1	0.82		J	ICPSD
K1308085	K1308085-028	Nickel	9.84	mg/kg	0.1	0.81		J	ICPSD

Table 3-2. Summary of Qualified Data

SDG	Sample	Analyte	Result	Units	MDL	MRL	Lab Qualifier	DV Qualifier	DV Qualifier Reason
K1308085	K1308085-029	Nickel	8.75	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-030	Nickel	10.1	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-031	Nickel	13.8	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-032	Nickel	11.9	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-033	Nickel	11.8	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-034	Nickel	66.2	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-040	Nickel	32.9	mg/kg	0.1	0.83		J	ICPSD
K1308085	K1308085-041	Nickel	27.1	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-042	Nickel	21.6	mg/kg	0.1	0.81		J	ICPSD
K1308085	K1308085-043	Nickel	25.9	mg/kg	0.1	0.83		J	ICPSD
K1308085	K1308085-044	Nickel	29	mg/kg	0.1	0.78		J	ICPSD
K1308085	K1308085-045	Nickel	16.5	mg/kg	0.09	0.75		J	ICPSD
K1308085	K1308085-035	Potassium	611	mg/kg	45.2	201		J	ICPSD
K1308085	K1308085-036	Potassium	871	mg/kg	48.7	216		J	ICPSD
K1308085	K1308085-037	Potassium	1170	mg/kg	9.3	41.5		J	ICPSD
K1308085	K1308085-038	Potassium	757	mg/kg	9.5	42.3		J	ICPSD
K1308085	K1308085-039	Potassium	1010	mg/kg	46.4	206		J	ICPSD
K1308085	K1308085-046	Potassium	3430	mg/kg	9.2	40.9		J	ICPSD
K1308085	K1308085-047	Potassium	1780	mg/kg	9.2	40.8		J	ICPSD
K1308085	K1308085-048	Potassium	1540	mg/kg	9.2	41.1		J	ICPSD
K1308085	K1308085-049	Potassium	1660	mg/kg	9.2	41		J	ICPSD
K1308085	K1308085-050	Potassium	1210	mg/kg	9	40		J	ICPSD
K1308085	K1308085-050DUP	Potassium	1340	mg/kg	9	40.1		J	ICPSD
K1308085	K1308085-051	Potassium	1130	mg/kg	9.1	40.3		J	ICPSD
K1308085	K1308085-052	Potassium	860	mg/kg	9.2	40.9		J	ICPSD
K1308085	K1308085-053	Potassium	860	mg/kg	9.2	41.1		J	ICPSD
K1308085	K1308085-035	Vanadium	36	mg/kg	1	4		J	ICPSD
K1308085	K1308085-036	Vanadium	131	mg/kg	1.1	4.3		J	ICPSD
K1308085	K1308085-037	Vanadium	30.2	mg/kg	0.2	0.8		J	ICPSD
K1308085	K1308085-038	Vanadium	49.1	mg/kg	0.2	0.8		J	ICPSD
K1308085	K1308085-039	Vanadium	45.9	mg/kg	1	4.1		J	ICPSD
K1308085	K1308085-046	Vanadium	18	mg/kg	0.2	0.8		J	ICPSD
K1308085	K1308085-047	Vanadium	26.1	mg/kg	0.2	0.8		J	ICPSD
K1308085	K1308085-048	Vanadium	41.4	mg/kg	0.2	0.8		J	ICPSD
K1308085	K1308085-049	Vanadium	35.7	mg/kg	0.2	0.8		J	ICPSD
K1308085	K1308085-050	Vanadium	20.3	mg/kg	0.2	0.8		J	ICPSD
K1308085	K1308085-050DUP	Vanadium	20.8	mg/kg	0.2	0.8		J	ICPSD
K1308085	K1308085-051	Vanadium	21.7	mg/kg	0.2	0.8		J	ICPSD
K1308085	K1308085-052	Vanadium	28.4	mg/kg	0.2	0.8		J	ICPSD
K1308085	K1308085-053	Vanadium	28.4	mg/kg	0.2	0.8		J	ICPSD
K1308085	K1308085-033	Zinc	25	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-032	Zinc	25.3	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-026	Zinc	29	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-025	Zinc	30.4	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-031	Zinc	31.4	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-034	Zinc	32.5	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-028	Zinc	35.7	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-029	Zinc	41	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-045	Zinc	41.7	mg/kg	0.2	0.9		J	ICPSD
K1308085	K1308085-044	Zinc	42.9	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-024	Zinc	46.5	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-042	Zinc	57.5	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-021	Zinc	68.5	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-052	Nickel	23.2	mg/kg	0.1	0.82		J	REP
K1308085	K1308085-027	Zinc	68.7	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-043	Zinc	70.2	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-021DUP	Zinc	70.7	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-030	Zinc	80.5	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-041	Zinc	174	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-053	Nickel	32.4	mg/kg	0.1	0.82		J	REP
K1308085	K1308085-040	Zinc	183	mg/kg	0.2	1		J	ICPSD
K1308085	K1308085-022	Zinc	246	mg/kg	0.2	1		J	ICPSD

Table 3-2. Summary of Qualified Data

SDG	Sample	Analyte	Result	Units	MDL	MRL	Lab Qualifier	DV Qualifier	DV Qualifier Reason
K1308085	K1308085-023	Zinc	1680	mg/kg	0.2	1		J	ICPSD
K1308180	K1308180-001	Manganese	508	mg/kg	0.02	0.4	N	J	MS
K1308180	K1308180-002	Manganese	1030	mg/kg	0.02	0.4	N	J	MS
K1308180	K1308180-003	Manganese	411	mg/kg	0.02	0.4	N	J	MS
K1308180	K1308180-004	Manganese	368	mg/kg	0.02	0.4	N	J	MS
K1308180	K1308180-004DUP	Manganese	382	mg/kg	0.02	0.4		J	MS
K1308180	K1308180-005	Manganese	173	mg/kg	0.02	0.4	N	J	MS
K1308180	K1308180-006	Manganese	688	mg/kg	0.02	0.41	N	J	MS
K1308180	K1308180-007	Manganese	369	mg/kg	0.02	0.41	N	J	MS
K1308180	K1308180-008	Manganese	174	mg/kg	0.02	0.4	N	J	MS
K1308180	K1308180-009	Manganese	296	mg/kg	0.02	0.4	N	J	MS
K1308180	K1308180-010	Aluminum	12	µg/L	4	10		U	LB
K1308180	K1308180-011	Aluminum	12.4	µg/L	4	10		U	LB
K1308180	K1308180-010	Barium	0.7	µg/L	0.6	4	J	U	LB
K1308180	K1308180-011	Barium	0.7	µg/L	0.6	4	J	U	LB
K1308180	K1308180-001	Cadmium	0.16	mg/kg	0.04	0.2	J	U	LB
K1308180	K1308180-003	Cadmium	0.08	mg/kg	0.04	0.2	J	U	LB
K1308180	K1308180-005	Cadmium	0.08	mg/kg	0.04	0.2	J	U	LB
K1308180	K1308180-007	Cadmium	0.18	mg/kg	0.04	0.2	J	U	LB
K1308180	K1308180-008	Cadmium	0.06	mg/kg	0.04	0.2	J	U	LB
K1308180	K1308180-009	Cadmium	0.06	mg/kg	0.04	0.2	J	U	LB
K1308180	K1308180-010	Calcium	24.1	µg/L	0.9	20		U	LB
K1308180	K1308180-010	Copper	0.9	µg/L	0.9	4	U	UJ	LB
K1308180	K1308180-011	Copper	0.9	µg/L	0.9	4	U	UJ	LB
K1308180	K1308180-010	Magnesium	13.9	µg/L	0.3	10		U	LB
K1308180	K1308180-010	Manganese	0.4	µg/L	0.07	2	J	U	LB
K1308180	K1308180-011	Manganese	1.9	µg/L	0.07	2	J	U	LB
K1308180	K1308180-011	Sodium	86.1	µg/L	20	200	J	J	LB
K1308180	K1308180-010	Sodium	20	µg/L	20	200	U	UJ	LB

Notes:
MDL = method detection limit
MRL = method reporting limit
DV = data validation
SDG = sample delivery group