U. S. Army Corps of Engineers

St. Louis Riverfront - Meramec River Basin Ecosystem Restoration Feasibility Study with Integrated Environmental Assessment

Draft - 2018

Appendix E

Hazardous, Toxic, Radioactive Waste Analysis

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1 INTRODUCTION

1.1 OVERVIEW

The Old Lead Belt, which includes Jefferson, Washington, St. Francois and Madison Counties in Missouri were found to be rich in the mineral galena, amongst others, and were mined for lead ore and zinc from as early as 1720 (NAS, 2017). Industrial mining and smelting practices were prevalent from 1864 to 1972, during which approximately 10 million tons of Lead (Pb) and two million tons of Zinc (Zn) (USBM, 1972) were reportedly produced from the estimated 291 million tons of mine waste produced (Pavlowsky 2017). The mining and smelting processes left large quantities of mine waste that were either stockpiled in mountainous uncapped piles or directly released into the Big River. Wind, rain and floods have led to hundreds of uncontrolled releases of waste minerals contaminated by lead, cadmium and other toxic metals. The released materials have deposited in the channels and floodplains and continue to migrate through the Big River watershed.

The U.S. Environmental Protection Agency (USEPA) Superfund Region 7 (SUPR VII) is currently in the Remedial Investigation/Feasibility Study phase of the Superfund Process dictated by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) for most Operable Units (OU) related to these mining activities. The result of this process is expected to be a conceptual plan for remediating mine waste and establishing acceptable benchmarks and final target concentrations through Records of Decision (ROD), which will also establish the concentration at which soils and sediment are considered Hazardous, Toxic, and/or Radioactive Waste (HTRW) per USACE policy. These RODs may affect USACE and Sponsor ability to operate at sites with concentrations found to be at or above target levels due to USACE policy of avoiding HTRW. Sediment and soils containing lead concentrations within the project area that are above Probable Effects Concentrations (PEC) for aquatic species will be referred to as "contaminated" materials.

Table 1-1 shows a comparison of standard soil sieve sizes vs. estimated grain size of typical mining and smelting waste products found in the Big River sediments and floodplain. This table represents a compilation from investigations of mining practices and tailings piles by approximate timeframe (Pavlowsky R. T., 2017).

Table 1-1: Sieve and Grain Sizes of Mine Waste and Smelting Byproducts

Grain Type:	**Gravel**								**Coarse Sand**
Sieve Size (Imp.):	**2.000"**	**1.500"**	**1.000"**	**0.750"**		**0.375"**	**0.004"**		**10**
(mm):	53.9	33.1	26.9	17.0	16.0	9.52	4.76	4.0	2.00
Byproduct:					4-16mm, Coarse Tailings, ≤1860s				
Grain Type:	**Medium and Fine Sands**								**Fines**
	Medium		**Fine Sand**						
Sieve Size (Imp.):	**20**	**40**	**60**		**80**	**100**	**200**	**230**	**>230**
(mm):	0.840	0.420	0.250	0.200	0.177	0.149	0.074	0.063	<0.063
Byproduct:				0.06-0.20 mm, Fine Tailings, 1860s to 1972					Effluent/Slimes
Note: Concentration of lead (Pb) is typically inversely related to grain size; finer grain sediments carry higher metal content									

1.2 PURPOSE

The USACE, St. Louis District, performed a Phase I Environmental Site Assessment (ESA) pursuant to ASTM 1527-13 for the Authorized Study Area. The purpose was to identify recognized environmental conditions involving Hazardous, Toxic, and Radioactive Waste (HTRW) within the Authorized Study Area. For the purpose of this study, recognized environmental conditions (RECs) are defined as a past, present, or likely future release of hazardous substances into the soil of a site.

The record search included Federal, State, tribal, and local databases to identify sites where the presence or likely presence of heavy metals, primarily lead (Pb) that have been previously documented.

The ultimate goal is to provide a reasonable assessment of areas of concern (i.e, RECs) so that project management and local sponsors can make decisions on property projects or future testing requirements.

1.3 METHODOLOGY

This following report was prepared in accordance with the applicable requirements contained in the following references:

U.S. Army Corps of Engineers Regulation ER 1165-2-132, Water Resources Policies and Authorities for Hazardous, Toxic, and Radioactive Waste Guidance for Civil Works Projects, 26 June 1992;

U.S. Army Corps of Engineers, Lower Mississippi Valley Regulation 1165-2-9, Water Resources Policies and Authorities for Hazardous, Toxic, and Radioactive Waste Guidance for Civil Works Projects, 14 June 1996; and

American Society of Testing and Materials Standard (ASTM) E1527-13, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.

2 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW)

Hazardous waste is defined as a waste either that is listed as such in regulations issued by the USEPA or that exhibits one or more of the following characteristics: corrosive, ignitable, reactive, or toxic constituents. Industrial sources generate the vast majority of hazardous waste.

2.1 NATURE OF HTRW

The landscape of the Meramec River Basin, in particular the Big River, has been shaped by mining due to rich deposits of lead, silica, zinc, barite, limestone and other minerals. Portions of the Meramec River Basin lay within "The Old Lead Belt" (OLB) which encompasses significant reaches of the Big River throughout St. Francois and Washington Counties, Missouri, before flowing into the study area.

Throughout much of its history, the OLB was a leader in lead production within the U.S. and the world. Mining activities in the St. Francois County and Washington County portions of the OLB were conducted as small scale surface diggings from the 1700s through most of the 1800s. The discovery of vast subsurface deposits of disseminated lead ore and the invention of the diamond core drill in the 1860's led to the rapid development of large scale industrial mining in St. Francois County (Buckley 1908).

Ore in the area contains approximately 4 percent lead, 1 percent zinc and 0.15 percent copper (Doe Run, 2018) and massive quantities of lead mineral containing ore must be extracted from the mines, milled and processed to obtained the small proportion of lead concentrate which is then smelted to produce metallic lead. Industrial mining production from the late 1800's through the closure of the mines in 1972 resulted in the production of an estimated 250 million tons of mine waste. It is estimated that 23% still remains stored in the remaining tailings piles and 32% of the lead waste was released to and is stored in channel sediments and floodplain deposits of the Big River from St. Francois County through the project area (Pavlowsky 2010).

The mining industry improved separation of metal concentrates from rock ores over its history. Early mine waste was produced in the form of gravel sized "chat". The "chat piles" are located in six major piles on or near the Big River upstream of the study area. These six piles, known as the Bonne Terre, Desloge, Leadwood, Elvins, Federal and National sites total over in volume of chat and tailings and cover over four (4) square miles (Pavlowsky, Owen, & Martin, 2010), or 1,936 football fields. Later ore processing and beneficiation methods resulted in the production of sand, generally known as tailings, and finer grained materials ("slimes") that were pumped into impoundments as slurry for disposal. The tailings impoundment at the massive dam at the Federal site is an example of this type of storage. These fine grained materials are transported more rapidly within the Big River and have been transported and deposited downstream. As described above, mine wastes and associated heavy metals have been transported en masse from the releases in St. François County and are completely incorporated into floodplain soils and in-stream sediments from Leadwood to the Meramec River confluence.

Massive amounts of waste material were discharged directly or subsequently released into the Big River during active mining operations. In 1977 at the Desloge Pile (Newsfields, 2007) a steep slope failed resulting in approximately 50,000 cubic yards of mine waste sloughing directly into the Big River from a single event. Currently, all major tailings piles in St. Francois County have been mostly stabilized though tributaries from the piles to Big River continue to contribute impacted material to the system.

Lead mining in Washington County was mainly restricted to pre-industrial scale mining of near surface deposits. Early lead miners discarded large quantities of barite or "tiff" during the process. Barite was later discovered to be a marketable commodity used in oil and gas drilling mud, paints and ingested for medical radiology purposes. Barite was deposited mainly as residuum in the soil/bedrock interface. As a result, mining of barite occurred largely as surface strip mining. Industrial scale mining for barite began at the turn of the century and peaked in 1957 with 13.4 million tons produced state wide (*dnr.mo.gov/geology/geosrv/imac/barite.htm* accessed May 3, 2018).

Tributaries draining the Washington County Barite District have high concentrations of barite, but low concentrations of lead and other toxic heavy metals. Barite or barium sulfate is considered non-toxic due to its very low solubility; whereas other forms of barium do have some toxicity.

Based on USEPA, the following tailings piles have been stabilized or are undergoing construction stabilization under the regulatory framework of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as "Superfund".

- Bonne Terre: Chat pile stabilized in 2007. The Bonne Terre East Tailings Flat is currently being used as an on-site soil repository for lead-contaminated soils. Upon completion, this area will be capped with clean soil/rock.
- Elvins: Area was stabilized in 2009.
- Leadwood: Area was stabilized in 2010.
- National: Area was stabilized in 2012.
- Federal: Area was stabilized in 2016.
- Doe Run: Not yet addressed.
- Hayden Creek: Area was partially stabilized in 2012.

2.2 CERCLA REGULATED MATERIAL

2.2.1 NATURE OF CERCLA REGULATED MATERIAL IN BIG RIVER WATERSHED

The USEPA record of decision (ROD) for Big River Mine Tailings Superfund Site, St. Francois County, Missouri Operable Unit (OU) 1 (USEPA, 2011) estimates that over 100 years of lead mining produced over 291 million tons of mine waste (see Section 1.1). OU1 includes lead contaminated surface soils present at residential properties across the Site that have been contaminated as a result of migration of metal-bearing materials from past mining and ore processing practices via water erosion from run off, wind-blown mine waste and human activities. The USEPA record of decision for Southwest Jefferson County Mining Site (USEPA, 2012) and Big River Mine Tailings Superfund Site, St. Francois County, Missouri Operable Unit (OU) 1 (USEPA, 2011) set a remediation level of 400 ppm for residential soils based on site specific health risk assessments.

A significant portion of the mining waste is located in the eight major piles, identified above. These piles were predominately barren of vegetation and access to the waste piles was unrestricted before the USEPA removal actions and stabilization of the mine waste piles started in the early 2000's. The general magnitude of the piles as described in the USEPA ROD (2011) prior to USEPA efforts are defined as: Desloge Pile - 600 acres in size and up to 100 feet deep; Elvins Pile - 149 acres and 170 feet higher than surrounding area; Bonne Terre Pile (eastern portion) - 306 acres and up to 50 feet deep, Bonne Terre Pile (western portion) - approximately 39 acres and about 160 feet higher than the surrounding area; the Federal Pile - over 1,000 acres; and the Leadwood Pile - approximately 563 acres in size.

The mine waste contains elevated levels of lead and other heavy metals which pose a threat to human health and the environment. The mine waste has contaminated soils, sediments, surface water and groundwater. These materials also may have been transported by wind and water erosion or manually relocated to other areas.

2.2.2 EXTENT OF HEAVY METALS IN THE BIG RIVER WATERSHED

This section briefly summarizes the extent of CERCLA related materials in and around the study area. For further information, please refer to the documents listed below.

- Distribution, Geochemistry, and Storage of Mining Sediment in Channel and Floodplain Deposits of the Big River System in St. Francois, Washington, and Jefferson Counties, Missouri (Pavlowsky), 2010
- Mussel Community Associations with Sediment Metal Concentration and Substrate Characteristics in the Big River, Missouri, USA, (USFWS), 2009
- Effects of Mining-Derived Metals on Riffle-Dwelling Crayfish and In-situ Toxicity to Juvenile *Orconectes hylas* and *Orconectes luteus* in the Big River of Southeast Missouri, USA (USGS), 2010,
- Residential Soil Samples, (USEPA)
- Analysis of Soil and Sediment in the Big River Watershed Utilizing Pb Isotopes for Source Distribution, Synchrotron Speciation for Phase Identification, and In-Vitro Bio accessibility for Risk Assessment (USEPA), 2017

Almost all of the contaminated sediment and lead storage in Jefferson County today originally came from the historical mining operations in St. Francois County (USEPA, 2017), which have been selectively transported downstream in association with channel sediment according to size. Floodplain contamination is generally more severe and extends further downstream compared to channel sediments. Floodplain surface soils less than two decades old contain between 1,000 ppm and 2,000 ppm of lead. In these layers, lead concentrations decrease downstream from the mining areas in St. Francois County due to the influence of dilution and upstream deposition. It is estimated (Pavlowsky, 2010) that of the 227 million Mg (250 million tons) of contaminated sediment produced as mine waste, currently 3,700,000 m^3 (8 million tons[1]) is stored in the channel and 86,800,000 m^3 (192 million tons[1]) is stored in the floodplain. Of that, about 63% of the contaminated sediment is stored in Jefferson County. It is also estimated in total (Pavlowsky, 2010) for the Big River 3,800 Mg (4,188 tons) of lead is stored in channel bed and bar deposits and 226,000 Mg (249,000 tons) lead is stored in the floodplain. USEPA (2017) analysis of soil and sediment in the Big River Watershed utilizing lead Isotopes for source distribution confirmed that the source of contamination in the Big River watershed correspond to the piles in St. Francois County, Missouri.

[1] Imperial tonnage was calculated using Pavlowsky 2010 bulk density of 2 g/cm^3

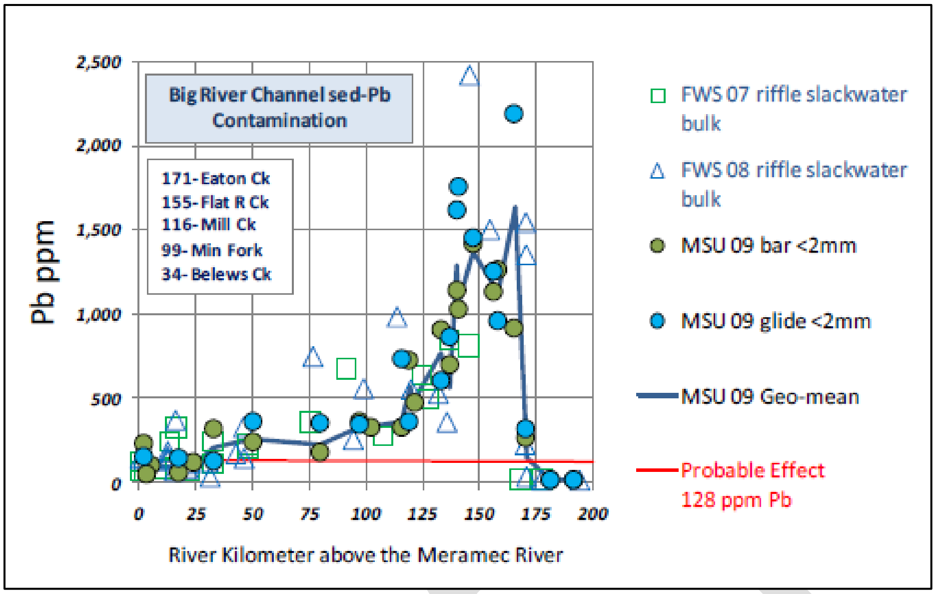

Figure 2-1. Pavlowsky Big River Lead Concentrations Per River Kilometer

Table 2-1 Bulk Lead Concentrations Averaged

	Meramec River	Big River RM 0-10	Big River RM 10-35	Big River RM 35-75	Big River RM 75-113
In-Stream Average Lead (ppm)	2	256	275	456	1,137
Floodplain Average Lead (ppm)		506	648	1,452	1,443

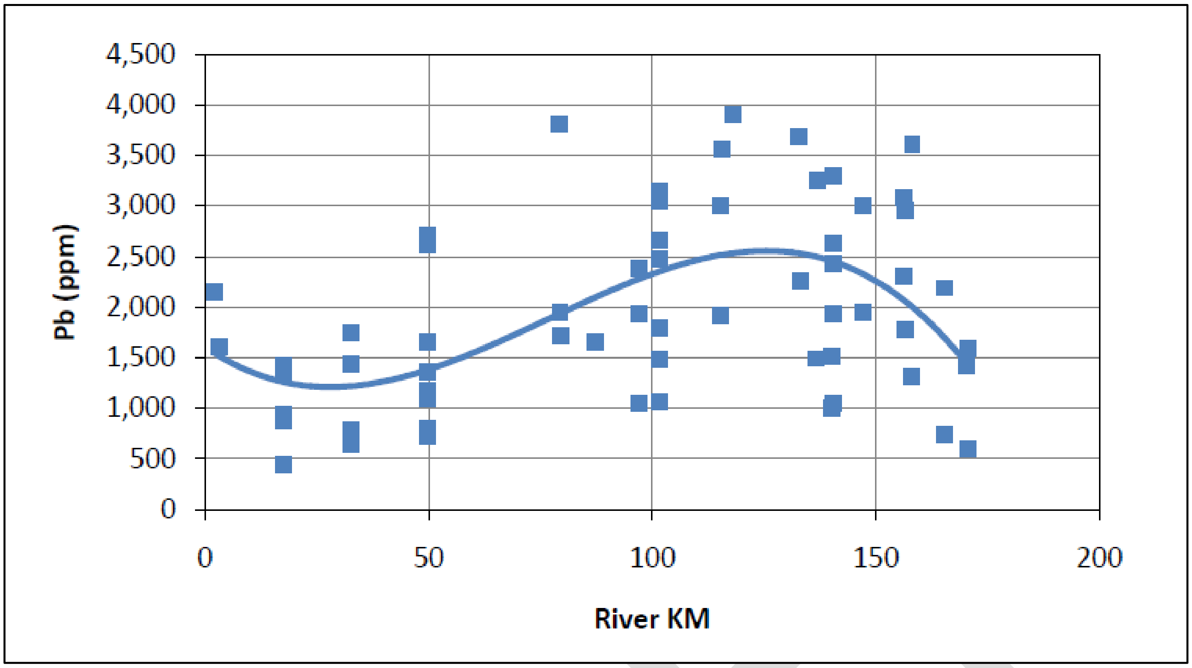

Figure 2-2. Pavlowsky (2010)**Mean Floodplain Lead Concentrations**

Additional review of soil samples was done by the USACE to ascertain the extent of CERCLA regulated material. Based on the results of these data sets, it was determined that Barium (Ba), Cadmium (Cd), and Zinc (Zn) are not considered an HTRW concern since their average concentrations are not found above the regional screening levels (RSLs)[2]. It was also confirmed that Lead (Pb) is a contaminant of concern but it cannot be ascertained whether it is an HTRW concern until the USEPA identifies a remedial action level; however, since heavy metals are known to be present in the study area, there is an associated risk that a restoration site may have an HTRW concern. Therefore, to manage that risk it is imperative to obtain soil samples prior to construction activities.

2.2.3 RESIDENTIAL USEPA SOIL SAMPLES

Results of sampling completed during the Pre-Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Site Screening Assessment for Jefferson County conducted by Tetra Tech in 2007 and 2008, were used for USEPA to identify multiple residential properties exhibiting lead levels greater than the TCRA level of 1,200 ppm, and numerous other properties at levels greater than the non-TCRA level of 400 ppm (Tetra Tech, 2007 and 2008).

[2] Per USEPA, RSLs are used for site "screening" and as initial cleanup goals, if applicable. RSLs are considered to be protective to humans over a lifetime and are not always applicable to a particular site and do not address non-human health endpoints, such as ecological impacts. RSLs are not cleanup standards; however, they help identify areas, contaminants, and conditions that require further federal attention at a particular site.

Metal	Chemical of Potential Concern		
	Soil	Groundwater	Surface Water[1]
Arsenic	X	X	X
Barium	-	X	X
Cadmium	-	X	X
Lead	X	X	X
Zinc	-	X	X

Notes:
[1] COPCs for surface water have not yet been established and will include all Target Analyte List metals, excluding mercury, until the Human Health and Ecological Risk Assessments are complete.

Figure 2-3. Chemicals of Potential Concern

Tributary inputs, such as the Flat River Creek, remains a source of tailings to the Big River. However, the piles that erode to Flat River Creek have been capped. Mill Creek and Mineral Fork Creek both contain elevated lead and zinc concentrations in channel sediments, but these are usually below the PEC. Floodplain deposits in these creeks tend to be also elevated in both lead and zinc concentrations, but that appears related to Big River floodplain deposition. The release of contaminated sediment from Mill Creek and Mineral Fork Creek to the Big River does not appear to influence the regional trend of mining-related sediment contamination along the main stem of the Big River.

3 CONCLUSIONS

Based on the data reviewed and information gathered during this and previous, assessments, it appears there is evidence of CERCLA regulated material within the Authorized Study Area. In late 2019, the USEPA is scheduled to finalize a remedial action level in the record of decision for the Big River and its floodplain for the Southwest Jefferson County Superfund Site. Because the USEPA has not issued a ROD for this site yet, the extent of HTRW concern is uncertain. Based upon sediment samples, the average lead concentrations within the study area are within 100 ppm and 1,000 ppm, with a general downward trend from upstream in St. Francois County to Big River's confluence with the Meramec River. The restoration measures proposed for the Meramec River Basin Ecosystem Restoration project have been managed so that disturbance of CERCLA materials above HTRW levels of concern will be avoided. These management measures may impact the number of sites, reducing cost and benefits alike, but not the identified measures.

Best management practices will be employed during construction at the study areas to avoid the suspension of sediment and the release of any contamination into the water column.

- An erosion control plan will be created and implemented to control the entry of sediments into the Big River and/ or tributaries and their migration downstream of the work area.
- Construction will occur during low water level to avoid the introduction of sediment into the water column.
- Material that is excavated from the Authorized Study Area is considered "cleaned material". Once excavated, the sediment will fall into two categories depending on their fate and are regulated by different laws. Material that is used on site to

construct features is still covered by Section 404(b) Clean Water Act, and requires consideration of the potential impacts of the placement of the material. Material that will not be reused on site, but will instead be dewatered and removed to an upland disposal site, is classified as "soil" and is regulated as by the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This sediment will be tested as required for proper upland disposal at a landfill facility or designated EPA repository. The testing will be completed in the next phase of this project.

Currently, USEPA is working to finish the Remedial Investigation (RI) on OU4 and its expected completion is by September 2018. This RI phase is primarily concerned with site characterization and includes data collection, risk assessments, evaluation of the nature and extent of contamination, and will identify Remedial Action Objectives.