Public Health Assessment

Public Comment Release

SOUTHWEST JEFFERSON COUNTY MINING

JEFFERSON COUNTY, MISSOURI

EPA FACILITY ID: MON000705443

Prepared by
Missouri Department of Health and Senior Services

MARCH 16, 2011

COMMENT PERIOD ENDS: MAY 16, 2011

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment-Public Comment Release was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR's Cooperative Agreement Partner has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate. This document represents the agency's best efforts, based on currently available information, to fulfill the statutory criteria set out in CERCLA section 104 (i)(6) within a limited time frame. To the extent possible, it presents an assessment of potential risks to human health. Actions authorized by CERCLA section 104 (i)(11), or otherwise authorized by CERCLA, may be undertaken to prevent or mitigate human exposure or risks to human health. In addition, ATSDR's Cooperative Agreement Partner will utilize this document to determine if follow-up health actions are appropriate at this time.

This document has previously been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i) (6) (H) for their information and review. Where necessary, it has been revised in response to comments or additional relevant information provided by them to ATSDR's Cooperative Agreement Partner. This revised document has now been released for a 30-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This will conclude the public health assessment process for this site, unless additional information is obtained by ATSDR's Cooperative Agreement Partner which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Missouri Department of Health and Senior Services
Division of Community & Public Health
Section for Disease Control and Environmental Epidemiology
Bureau of Environmental Epidemiology
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

This information is distributed by the Agency for Toxic Substances and Disease Registry for public comment under applicable information quality guidelines. It does not represent and should not be construed to represent final agency conclusions or recommendations.

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SUMMARY

INTRODUCTION

The top priority for the Missouri Department of Health and Senior Services (DHSS), in cooperation with the federal Agency for Toxic Substances and Disease Registry (ATSDR), in evaluating the public health impact of the Southwest Jefferson County Mining site is to provide the Jefferson County community with the best information possible to safeguard its health.

The Southwest Jefferson County Mining site is on the U.S. Environmental Protection Agency (EPA) National Priorities List (NPL) primarily due to lead contamination of residential yards soils and private drinking water wells. The contamination is the result of mining, milling, and smelter wastes, and widespread use of lead contaminated soil for landscaping. To a lesser extent, there is concern for cadmium and barium in drinking water, cadmium and arsenic in soil, and physical hazards left behind from past mining activities.

CONCLUSIONS

DHSS has reached four important conclusions in this health assessment:

Conclusion 1
Mining Related Soil

DHSS concludes that ingesting (swallowing) and/or inhaling (breathing) lead contaminated soil or dust found in many of the residential yards within the Southwest Jefferson County Mining site for a year or longer may harm people's health. This conclusion applies to past, present, and future exposure to lead at this site.

Basis for Decision

Residential yards throughout the mining areas in the Southwest Jefferson County Mining site contain lead and infrequently arsenic and cadmium in soil at concentrations above a level of health concern. The primary concern from exposure to lead in Jefferson County is the effects lead has on the nervous system, especially on children less than 72 months of age.

EPA has removed soil from numerous residential yards with lead concentrations above EPA's Time-Critical Removal Action level. These yards contained soil with lead contamination at a concentration of 1,200 parts per million (ppm) and greater or lead concentrations of 400 ppm and above for those homes with a child less than 72 months of age with an elevated blood lead level. After

EPA's Time-Critical Removal Actions, these yards are no longer expected to harm people's health due to lead contamination.

Some residential yards with soil containing lead above EPA's Time-Critical Removal Action level, and numerous residential yards with soil containing lead at concentrations between 400 ppm and 1,199 ppm, still remain in the Southwest Jefferson County Mining site. A future EPA Remedial Action is expected to clean up these yards where access can be gained. Exposure to the soil in these yards for a year or longer may harm people's health. Individuals, especially children, can be exposed to this contaminated soil directly by accidentally ingesting the soil while working, playing, gardening, or spending time in the yard. This contaminated soil can be tracked indoors by shoes, pets, and other means and accumulate in the home. Individuals, especially children, can accidentally ingest this contaminated dust in the home. Although not as major of a route as ingestion, individuals can also be exposed by inhalation of contaminated dust in the yard and contaminated dust in the home. When this soil or dust is stirred up and becomes airborne, individuals, especially children, may breathe it in and absorb the lead through their lungs.

All lead exposure sources are important to consider, so lead-based paint or other non-site related sources of lead may add to these concerns.

Conclusion 2
Hauled in soil

DHSS concludes that ingesting and/or inhaling lead contaminated soil or dust for a year or longer from residential yards where lead-contaminated topsoil was hauled in may harm people's health. This conclusion applies to past, present, and future exposure to lead in these yards.

Basis for Decision

Residential yards throughout Jefferson County have been contaminated with lead contaminated soil that has been hauled from areas on the Big River floodplain to residential locations where it was used for landscaping and fill purposes. The primary concern for exposure to lead from these yards is the effects lead has on the nervous system, especially on children less than 72 months of age.

EPA is removing soil from residential yards with lead concentrations above EPA's Time-Critical Removal Action level. A future EPA Remedial Action is expected to clean up the soils with lead contamination between 400 ppm and 1199 ppm. For detailed removal information, see conclusion 1.

All lead exposure sources are important to consider, so lead-based paint or other non-site related sources of lead may add to these concerns.

Conclusion 3
Groundwater

For past, present, and future exposures to lead contaminated well water, and to a lesser extent cadmium contaminated well water, DHSS concludes for the Southwest Jefferson County Mining site that drinking this water untreated for a year or longer may harm people's health. For present and future exposures of individuals who are using an EPA provided alternative source of drinking water, DHSS concludes that because water from their contaminated private drinking water well is not being ingested, it is not expected to harm people's health through the other exposure routes of inhalation or skin contact.

Basis for Decision

A number of private drinking water wells in the Southwest Jefferson County Mining site were found to contain lead at concentrations greater than 15 parts per billion (ppb) or cadmium above 5 ppb. The primary exposure route to lead or cadmium contaminated water is through ingestion. The primary concern from exposure to lead in Southwest Jefferson County Mining site is the effects lead has on the nervous system, especially on children less than 72 months of age. All lead exposure sources are important to consider, so lead-based paint or other non-site related sources of lead may add to these concerns.

EPA is currently using 15 ppb of lead and 5 ppb for cadmium as the site-specific action level in the Southwest Jefferson County Mining site as a guideline for providing alternative sources of drinking water to private well users. For those individuals who are using EPA provided alternative sources of drinking water, they no longer need to drink water from their well; therefore, they are no longer being exposed to contaminated water through ingestion.

For individuals who have refused EPA alternative sources of drinking water, they may still be drinking water from a contaminated private drinking water well. If these individuals are not drinking water from an alternative source or are not effectively filtering their well water, they may continue to be exposed to contaminated water that may harm their health.

Conclusion 4

DHSS cannot currently conclude whether exposure to lead through air, sediment, surface water, fish, and edible plants in the

Southwest Jefferson County Mining site could harm people's health. The information needed to make a decision is very limited. DHSS is working with ATSDR, EPA, Missouri Department of Natural Resources (MDNR), Missouri Department of Conservation (MDC) and the Jefferson County Health Department to gather the needed information.

Basis for Decision

Water bodies (streams and lakes), sediment, and fish associated with the mining areas have not been sufficiently sampled in the Southwest Jefferson County Mining site area to determine if they contain elevated levels of contaminants. More testing is needed to determine if they may harm people's health.

Next Steps

To protect residents:

1. Under a Time-Critical Removal Action, EPA is removing lead contaminated soil with levels of 1,200 ppm and greater. Also under the Time Critical Removal Action, for residences with a child less than 72 months of age with an elevated blood-lead level or an expectant mother, EPA is removing soil with lead contamination of 400 ppm or greater.

2. During the Remedial Phase, EPA will remove soil from residential yards that contain lower concentrations of lead down to 400 ppm, where if exposure occurred for a year or longer, may harm people's health.

3. EPA has and should continue to provide bottled water to residents who have elevated levels of lead or cadmium in their private drinking water wells.

4. EPA/MDNR should take additional samples of other media, such as air, sediment, surface water, fish, and edible plants, so it can be determined if exposure to these media may harm people's health.

5. DHSS/ATSDR will coordinate with the Jefferson County Health Department, MDNR, and EPA to provide community health education to the public and health professionals, encourage residences to have their yard soils and private drinking water wells tested and remediated if found elevated, and address community concerns as they arise.

6. EPA/MDNR should eliminate physical hazards left from the mining processes when found.

7. DHSS/ATSDR will coordinate with Jefferson County Health Department, MDNR, and EPA to implement the recommendations in this public health assessment.

8. DHSS/ATSDR will assist Jefferson County Health Department in continuing to encourage residents of Jefferson County to have yearly blood lead testing conducted for children less than 72 months of age and expectant mothers.

9. DHSS/ATSDR will review and comment on any additional data from environmental samples collected by EPA, MDNR, or other agencies as it becomes available.

PURPOSE AND HEALTH ISSUES

The Missouri Department of Health and Senior Services (DHSS), in cooperation with the federal Agency for Toxic Substances and Disease Registry (ATSDR), are evaluating the public health impact of the Southwest Jefferson County Mining site. ATSDR is a federal agency within the U.S. Department of Health and Human Services and is mandated by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) to conduct public health assessments at hazardous waste sites.

The primary contaminant of concern in the Southwest Jefferson County Mining Site is lead in soil and drinking water from mining, milling waste, former smelter areas, and from using lead contaminated soil for landscaping. To a lesser extent, there have been infrequent instances when cadmium and arsenic were elevated in samples of soil or drinking water. This public health assessment will determine if exposures to site related contaminants have occurred in the past, present, or future at a level of health concern and recommend actions to reduce or prevent exposure and possible adverse health effects.

BACKGROUND

Site Description and History

The Southwest Jefferson County Mining site includes all of Jefferson County, encompassing 664 square miles. Jefferson County is bordered on the north by St. Louis County and the Meramec River, on the east by the Mississippi River, on the south by St. Francois County and Ste. Genevieve County and on the west by Franklin and Washington Counties. For the purpose of investigating the contamination from past mining, the county was divided into four quadrants (See Figure 1). According to the Missouri Geological Survey Inventory of Mines, Occurrences, Prospects (IMOP) database the northeast (NE) quadrant has six mining sites, the northwest (NW) quadrant contains 12 mining sites, the southeast (SE) quadrant contains 42 mining sites, and the southwest (SW) quadrant contains 192 mining sites. Of these, 202 of the mining sites were designated for lead or lead and other commodities, particularly zinc and barite (commonly called tiff), while the remaining sites were exclusively for tiff mining. Besides the suspected mining sites, lead contaminated soil was hauled from farm fields in the Big River floodplain to numerous residences and businesses throughout Jefferson County for landscaping and fill purposes (See Figure 2). This public health assessment will not include the Doe Run smelter in Herculaneum that is being addressed by a separate Potentially Responsible Party (PRP) lead Remedial Action. (1)

The U.S. Environmental Protection Agency (EPA) proposed the Southwest Jefferson County Mining site for the National Priorities List (NPL) on April 9, 2009, and finalized it on September 23, 2009. The NPL is EPA's national list of the most seriously contaminated sites that are eligible for federal cleanup under CERCLA.

Mining activities began in Jefferson County in the early 1800s in the southern area, where Cambrian dolomite source rock is concentrated along the Big River and other major streams. Two mines were in operation as early as 1818: Gray's mine, located on the Big River, and McKane's mine located on Dry Creek. The Valles Mines site was also in operation around this time with its major mining operations running from approximately 1824 through the 1930's. Many other mines were opened in the 1830s and 1840s for the production of lead, zinc, and tiff. By 1855, smelters were operating in Jefferson County at Valles Mines, Mammoth Mines, and Sandy Mines. Historical records indicate that over three million pounds of lead was shipped out of Jefferson County annually during this time period. (1,2,3)

Site Investigations

Mining Related

Previous investigations in Jefferson County have focused on the greater Herculaneum area and the Doe Run Company currently operating smelter, and the Valles Mines area. As mentioned earlier, the Herculaneum site is being addressed under a PRP lead Remedial Action and will not be discussed in this public health assessment. The Valles Mine site was investigated by the Missouri Department of Natural Resources (MDNR) in a PRE-CERCLIS Site Screening Report dated December 23, 2002, and in a Preliminary Assessment, Site Inspection, Removal Assessment Report dated March 31, 2005. The investigations found elevated levels of lead in surface soils, the remains of the chat piles, sediment, surface water, and the abandoned railroad bed. Maximum levels of lead were found in surface soils in the vicinity of the smelter at 50,800 parts per million (ppm), in the centerline of the railroad bed at 14,300 ppm, and 3,900 ppm in the chat pile material. Two of the six private yards sampled in the vicinity of the site were found to have lead contamination slightly above EPA's time critical cleanup level of 1,200 ppm at a maximum of 1,320 ppm. (3,4)

In March 2007, Tetra Tech completed a Pre-CERCLIS Site Screening Assessment of the Jefferson County Lead site for EPA that determined the southwest quadrant was the area most impacted by past lead mining. Samples were taken from nine source areas (chat piles and mine tailings). Seven samples were analyzed with an x-ray fluorescence spectrometer (XRF) with lead levels ranging from 442 ppm to 7,070 ppm. Two of the source area samples were analyzed by EPA Region 7 laboratory with lead levels ranging from 1,190 ppm to 8,820 ppm. From the laboratory samples, the maximum level detected for cadmium was 159 ppm, for zinc was 151,800 ppm, and for arsenic was 28.1 ppm. Five of the source areas are located in areas that have been developed for residential use. (1)

Residential soil samples were also analyzed with an XRF. Of the 125 residential and school yards sampled, nine contained levels of lead above the Time-Critical Removal level of 1,200 ppm and 21 contained levels above EPA's secondary Non Time-Critical

Removal Action of 400 ppm. None of the samples of school properties contained elevated levels of lead. Samples were also taken of 106 private drinking water wells of which twelve had lead levels above EPA's Safe Drinking Water Act action level of 15 parts per billion (ppb) that ranged from 15.7 ppb to 71.8 ppb. One of the other wells had a cadmium level of 5.7 ppb, slightly above EPA's Maximum Contaminant Level (MCL) of 5 ppb for public drinking water systems. (1)

On May 7, 2008, Tetra Tech completed a Preliminary Assessment Report for the Jefferson County Lead Site for EPA that discussed EPA removal assessment sampling. As part of the assessment, soil was sampled from over 350 properties. Each residential yard was broken into quadrants (called cells) for sampling. Of these, 156 cells contained lead at 1,200 ppm or greater. About 200 soil samples were submitted to EPA's laboratory for analyses. Thirty nine of the samples contained lead above 400 ppm with 26 above 1,200 ppm. Soils were also analyzed for cadmium, barium, and arsenic. (1) Only a few soil samples exceeded ATSDR's Environmental Media Evaluation Guide (EMEG) levels for a child. Four samples exceeded the EMEG for arsenic (20 ppm) with a maximum of 40.4 ppm while four also exceeded the EMEG for cadmium (10 ppm) with a maximum of 25.5 ppm. EMEGs are comparison values used to determine if a chemical is at a level needing further evaluation of the chemical and the exposure pathways. Levels below an EMEG are not expected to pose a health threat.

A total of 310 groundwater samples contained detectable concentrations of lead ranging from one ppb to 94 ppb. One sample (sample # 3388-070) contained 3,070 ppb lead in water from a shallow well (80 feet deep). This sample reportedly had dirt in the water. A total of 92 samples contained lead at concentrations above the Safe Drinking Water Act action level of 15 ppb. A total of 46 residential wells contained detectable barium ranging from 10.8 ppb to an estimated value of 1,640 ppb. The sample taken from, well sample # 3388-070, had a barium level of 6,490 ppb, but was reported to have dirt in the water. Barium levels in all tested private wells, except well sample #3388-070, were below the MCL of 2,000 ppb. Cadmium was reported in 34 residential wells at concentrations ranging from 1.05 ppb to 21.1 ppb, with four wells above the MCL for cadmium of 5 ppb. Arsenic was only detected above its MCL of 10 ppb at 10.2 ppb in well sample # 3388-070. (1) See Table 1 for a summary of the contamination at the site.

Topsoil Related

In anticipation of purchasing clean replacement soil for remediating lead contaminated yards under the Time-Critical Removal Action, EPA sampled soil from a farm field in September 2006. The soil was found to contain lead ranging from 1,000 ppm to nearly 4,000 ppm. After correspondence with the land owner, it was discovered that soil from the farm had been hauled throughout the county for landscaping and fill by several trucking companies. In January 2007, EPA received a request from the Jefferson County Health Department to perform a soil removal action at the residence of a child with an elevated blood-lead level. Sampling determined that the soil was contaminated with lead at a maximum of 5,700 ppm. EPA obtained a list from the trucking company of approximately 100 locations where they had hauled the lead contaminated soil and began

sampling soil at these locations. At the present time, the focus at the site is to remediate the yard soils contaminated with over 1,200 ppm of lead under a Time-Critical Removal Action to eliminate exposure to these elevated levels of lead. From early sampling at the site, approximately 22% of the yards tested contained levels of lead exceeding 400 ppm and roughly 6% had soil that exceeded 1,200 ppm of lead. The yards with soil levels between 400 ppm and 1,199 ppm are expected to be remediated under a future EPA Remedial Action.

Because the size of the site includes all of Jefferson County and the large number of yards and private wells contaminated with lead, the site was divided up into separate Operable Units (OUs). The locations where the lead contaminated soil was transported and used for landscaping and fill became separate Operable Units (OUs) (5,6,7).

OU-00: Site wide:

Historical Mining Residential Soils: Includes mining sites and residential soils that have been affected by mining or an unknown source of contamination. Remediation of residential soils with lead levels at 1,200 ppm and above is occurring under the Time-Critical Removal Action. The mining sites and yards with lead levels between 400 ppm and 1199 ppm (Non Time-Critical) are expected to be addressed by a future Remedial Action.

Summary Table of Residential Yards and Drinking Water Wells Activity in Operable Unit 00 as of October 11, 2010

Number of yards with lead levels above 1,200 ppm	158
Number of yards remediated	124
Number of private drinking water wells with lead levels above 15 ppb	38
Number of private drinking water wells with cadmium levels above 5 ppb	2
Number of residences offered alternative water for drinking	40

ppm = parts per million ppb = parts per billion

OU-02: Residential Soils: Soils with high concentrations of lead contamination delivered by a trucking company from a contaminated farm field to numerous residences and businesses throughout Jefferson County.

Summary Table of Residential Yards Activity in Operable Unit 02 as of October 11, 2010

Number of yards with lead levels above 1,200 ppm	82
Number of yards remediated	73

ppm = parts per million

OU-03: Residential Soils: Soils with high concentrations of lead contamination delivered by numerous trucking companies from a contaminated farm field to numerous residences and businesses throughout Jefferson County.

Summary Table of Residential Yards Activity in Operable Unit 03 as of October 11, 2010

Number of yards with lead levels above 1,200 ppm	117
Number of yards remediated	113

ppm = parts per million

As of October 11, 2010, EPA has cleaned up over 300 residential yards and offered an alternative source of drinking water to 40 well owners. EPA continues to sample residential yards and private drinking water wells. Yards with 1,200 ppm of lead and above are expected to be excavated and backfilled with clean soil (below 240 ppm of lead). Properties are prioritized by (1) households of pregnant women, (2) households with children 6 years old or less, and (3) households where children reside. Residents with contaminated private wells are offered bottled water as an alternative source of drinking water, but a study is being completed to determine if the installation of point-of-use filtration systems is a better alternative to providing uncontaminated drinking water. (5,6,7) Schools in Desoto, Festus, Hillsboro, along with schools in other areas have been sampled and remediated if lead levels were above guidelines (Personal conversation with Jim Silver, EPA's On-Scene Coordinator). Non time-critical yards are expected to be cleaned up under a future EPA Remedial Action.

On March 18, 2010, DHSS personnel conducted a site inspection with EPA and MDNR to determine the present condition of the site and the activities that were occurring. We visited the different OUs and observed residences being remediated, past remedial actions, and areas to be remediated.

Other Sources of Exposure to Contaminants

Lead exposure can occur from many sources, all of which are important to consider. Another potential source of lead exposure, especially for children under 72 months of age, is lead-based paint. A large percentage of homes in Jefferson County were built before 1979. These homes may have lead-based paint because its use in residential paint was not restricted until 1978. Other sources of lead in these older homes could be lead pipes and/or lead based solder used on connections. From 2,000 census data considering Jefferson County as a whole, 55.4 % of homes were built before 1979 (8). Presently this percentage is expected to be lower since many new residences have been built since the 2,000 census. But the older homes may have deteriorating and cracking lead paint and areas of friction (like windows) where the lead-based paint is ground to dust. These are areas where children can easily be exposed to lead contamination through their high

hand-to-mouth activity (9). Therefore, lead-based paint may be an important additional source of lead exposure.

Jefferson County Health Department Activities

Prior to the Southwest Jefferson County Mining site being listed as an EPA National Priorities List site, elevated blood-lead levels were known to be a problem in Jefferson County. The U.S. Center for Disease Control and Prevention (CDC) has set 10 microgram per deciliter (µg/dL) as the blood-lead level at which public health actions should be initiated. At levels above 10 µg/dL, follow up and intervention should take place to lower the child's blood-lead level (9). DHSS data show that in Jefferson County, 2% (333 children of an estimated population of 17,462) of the children less than 72 months of age had their blood lead tested in 1996. Of those tested, 8% (28 children) were found to have blood-lead levels above 10 µg/dL.

In more recent data, the number of children whose blood-lead level was tested has increased. For the calendar year of 2008 in Jefferson County, 12% (2,001 children of an estimated population of 17,184) of the children less than 72 months of age had their blood lead tested. Of those tested, 1% (18 children) was found to have blood-lead levels above 10 µg/dL. Factors that may have increased the blood-lead testing numbers and lowered the percentage of children over 10 µg/dL were: increased provider (doctors, nurses, etc.) education, patient and community education about lead poisoning, increased effort by the Jefferson County Health Department (JCHD) to sample more children, and increased Medicaid funding and outreach for testing of children in low income families.

Because of the elevated blood-lead levels in children in Jefferson County and elevated soil and groundwater lead levels found in MDNR and EPA investigations, EPA began a Time Critical Removal Action in approximately 2007. Investigations during the Time-Critical Removal Action discovered that lead-contaminated soils had been hauled throughout Jefferson County for landscaping and fill. Excavation of soils with lead levels equal to or over 1,200 ppm is ongoing, with properties being prioritized by (1) households of pregnant women, (2) households with children six years old or less, and (3) households where children reside (6). Removal of Non Time-Critical lead levels (400 ppm to 1,199 ppm) will be taken care of in a future EPA Remedial Action. EPA removal and remedial actions should eliminate present and potential exposure pathways and lower the number of children exposed to lead contamination for those residences who has allowed sampling and remediation.

Elevated Blood Lead Risk Assessment

When the JCHD or a health care provider identifies a child with a blood lead level above 10 µg/dL, the child is said to have an elevated blood lead level. When a child is found to have an elevated blood lead level, their health care provider, local county health department, and/or managed health care agency typically provides health education to the

family to reduce the child's blood lead level. For every child with a blood lead level above 15 µg/dL, an Elevated Blood Level Risk Assessment is completed to find what is causing the child to have an elevated blood lead level. In Jefferson County, the county health department performs the risk assessments. The risk assessments typically include testing for lead in drinking water, yard soil, dust from soil, lead-based paint, or other interior sources such as doorways, windowsills, window troughs, walls, along with other areas the child may come into contact with lead. JCHD offers blood lead testing for citizens of Jefferson County to determine if they have an elevated blood lead level.

Land Use, Natural Resources, and Geology

Besides the larger municipalities (Arnold, Hillsboro, Desoto, Pevely, Festus, Crystal City, Herculaneum) and smaller cities, the county is mostly rural with rolling hills and some agriculture. Residents may be located on single family rural acreage or large lots in major subdivisions, with some around lakes.

In the past, natural resources in Jefferson County included lead and barite deposits, mostly in the southwest portion of the county, that were mined but are now depleted or not economically profitable to mine. Presently, natural resources consist of forestland, wildlife, and water bodies, including tailings ponds that are sometimes used for fishing. Jefferson County lies on the margin of the Springfield-Salem Plateaus section of the Ozark Plateau physiographic province. Exposed bedrock units range in age from Cambrian to Pennsylvanian with the Cambrian unit being mostly massive dolomite. From these formations, zinc, lead, and barium ores were mined. These ore bodies occurred along the Big River and larger creeks in southern Jefferson County. (1)

Domestic groundwater wells draw their water from either alluvial (stream deposited material) or deep bedrock aquifers. Below the alluvium lies the Ozark aquifer that varies between 200 to 835 feet in thickness. Beneath the Ozark aquifer is the St. Francois Confining unit that consists of a 325-foot thick layer of shale, fine-grained limestone, and dolomites. The confining unit is an effective barrier to downward groundwater movement. Beneath the confining unit lies the St. Francois aquifer. (1)

Physical Hazards

Physical hazards are present at some of the mining sites and may include old equipment, mining waste, concealed or open mine shafts, and the possibility of drop-off areas. Residential areas have few, if any, mining related physical hazards.

Demographics

According to the 2000 census data, Jefferson County has a population of 198,099. See Figure 3 for a breakdown of the location of certain population groups. The population of

Jefferson County is 97.5% white, 0.7% black or African American, 0.3% American Indian and Alaska Native, 0.4% Asian, 0.2% some other race, and 0.9% two or more races. The percentage of children under five is 7.2% with the percentage of adults over 65 years of age being 9.2%. The percentage of families below the poverty level in Jefferson County is 4.9% and the percentage of homes built before 1979 is 55.4%. (8)

Quality Assurance and Quality Control

Various people, organizations, and contractors have been involved in the sampling, research, and analyses at this site, resulting in Quality Assurance and Quality Control (QA/QC) information of varying degrees of accuracy and precision.

In preparing this public health assessment, DHSS and ATSDR have relied on the information provided in the referenced documents and have assumed that adequate quality assurance and quality control measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. The validity of the analysis and, therefore, the conclusions in this public health assessment are valid only if the referenced information is complete and reliable.

DISCUSSION

Pathway Analysis

This section addresses the pathways by which residents of the area may have been exposed to lead, and to a lesser degree, arsenic, cadmium, and barium from the contaminated tailings, soil, and/or groundwater. When a chemical is released into the environment, the release does not always result in exposure. Exposure only occurs when a chemical comes into contact with and/or enters the body. To determine whether the residents of Jefferson County were exposed to hazardous substances from the site, DHSS conducted an analysis of exposure pathways. For a chemical to pose a health risk, a completed exposure pathway must exist. ATSDR has determined that an exposure pathway consists of five elements, including: a source of contamination, transport through an environmental medium such as soil or water, a point of exposure, a route of human exposure, and a receptor population. Completed exposure pathways require that all five of the elements of exposure exist. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present. Potential exposure pathways, however, have at least one of the five elements missing or uncertain, but all five elements could exist. Completed and potential exposure pathways could have occurred in the past, could be occurring presently, or could occur in the future. Exposure at this site is through the ingestion or inhalation of lead-contaminated tailings/soil that have been placed on the land surface or moved where humans can come into contact with them, or ingestion of contaminated groundwater. Dermal contact is not considered a pathway of exposure, because lead is not readily absorbed through the skin.

Completed Exposure Pathways

Lead has been found to be the main contaminant at the Southwest Jefferson County Mining site and has contributed to elevated blood-lead levels in children less than 72 months of age. The five elements of a completed exposure pathway at the Southwest Jefferson County Mining site are:

1. **Contaminant source –** lead contaminated tailings, soils, and groundwater.
2. **Environmental medium and transport** – soil, groundwater, dust, surface water, sediment, fish, air, and garden vegetables.
3. **Point of exposure** – areas where exposure to lead contamination is taking place.
4. **Route of exposure** – ingestion and inhalation.
5. **Receptor population** – those that ingest and/or inhale lead contamination.

Completed Exposure Pathways

Completed exposure pathways at the Southwest Jefferson County Mining site have existed in the past, are presently occurring, and will continue in the future, until the pathways to contaminated soil and groundwater are lessened or eliminated. See Table 2 for a list of exposure pathways. Lead is the primary contaminant and to a lesser extent arsenic and cadmium. The major exposure pathways are ingestion and inhalation of lead and other contaminants.

Exposure to soil contaminants can occur by directly or accidentally ingesting the soil while working, playing, gardening, or spending time in the yard. This contaminated soil can be tracked indoors by shoes, pets, and other methods and accumulate in the home. Individuals, especially children, can accidentally ingest this contaminated dirt in the home. Children are more likely to be exposed to household dust and other forms of contaminated media because of their high hand-to-mouth activity. Although not as major of a route as ingestion, individuals can also be exposed to this contaminated soil in the yard and contaminated dirt in the home by inhalation. When this soil or dust is stirred up and becomes airborne, individuals may breathe it in and absorb the lead through their lungs. Lead is not readily absorbed through the skin, so dermal contact with lead contaminated soil is not an important route of exposure.

Individuals can be exposed to the lead in their water supply through ingestion while drinking and cooking with contaminated water. Individuals may accidentally ingest lead contaminated water while bathing, playing, or swimming. Dermal contact to lead in water is not an important route of exposure.

In addition to exposure to soil and groundwater, the DHSS Childhood Lead Program along with the Jefferson County Health Department have identified children in the area with elevated blood lead levels whose homes had elevated levels of lead in indoor dust.

The high levels of lead in the indoor dust may have come from elevated levels of lead in outdoor soil, dust from lead based paint in the home, or other sources. This completes an exposure pathway through ingestion and inhalation of lead contaminated indoor dust.

EPA has greatly reduced exposure to lead-contaminated soil and groundwater by their Time-Critical Removal Action. The intent of an EPA Time-Critical Removal Action is to identify and eliminate critical exposure pathways in an expedient manner. For this Time-Critical Removal Action, EPA has removed soil from residential yards with lead concentrations of 1,200 ppm and above and yard of residency with lead concentrations greater than 400 ppm that had a child less than 72 months of age with an elevated blood lead level. In addition, EPA has identified private drinking wells with levels of lead greater than 15 ppb. EPA has offered all of these residents bottled water to eliminate or reduce exposure.

Potential Exposure Pathways

Potential exposure pathways consist mostly of those areas where the environment has not been tested for lead contamination. These include the water bodies associated with past disturbed mining areas and the streams that cross the site. Limited sampling has determined that levels of lead or other contaminants are present in the water and sediment. Also, the fish in these water bodies have not been tested to see if they contain lead at a level of health concern. Garden produce grown in lead contaminated soil or wild edible plants growing in mining disturbed soils could be a potential source of exposure. Exposures to these potential pathways may or may not be at a level of health concern. Contaminated garden areas with 1,200 ppm of lead and above are being addressed as part of EPA's Time Critical Removal Action, but they may not be granted access to sample and remove contaminated soil at all residences.

TOXICOLOGICAL EVALUATION

Introduction

This section will discuss the health effects of exposure to specific contaminants found at the site. A discussion of non-cancerous health effects and the possibility of the contaminants causing cancer are evaluated in this section. ATSDR has developed Comparison Values (CVs) that are media-specific concentrations used by health assessors to select environmental contaminants of concern. Contaminant concentrations that are less than the CV are unlikely to pose a health threat. Contamination levels above the CV do not necessarily indicate that a health threat is present, but that further evaluation of the chemical and pathways is needed. CVs are usually developed for chronic exposure (more than 365 days), intermediate exposure (14 day to 365 days) and acute exposure (less than 14 days). Environmental Media Evaluation Guides (EMEGs) are media-specific CVs that have been derived for a variety of chemicals including arsenic, cadmium, and barium.

ATSDR has not developed a CV for lead, instead, exposure to lead is evaluated by using an EPA biological model that predicts a blood lead concentration that would result from exposure to environmental lead contamination. The modeled blood lead concentration is then compared to the level of concern for blood lead concentrations in children as recommended by the CDC (10). Using this model, EPA has established a standard clean up value of 400 ppm for lead in residential soil using the default parameters in this model (11). The default parameters in the model include estimated soil ingestion and time spent outdoors. If the default parameters are found to not be accurate in an area being investigated, the clean up value used at that site may be different than what is listed above.

Lead, and to a lesser extent arsenic, barium, and cadmium have been found in tailings piles, soils, and groundwater in mostly the southwest portion of Jefferson County. In addition, lead contaminated soil has been hauled to residential areas throughout the rest of the county. The tailings areas and residential yards vary as to the amount of exposure that occurs in each area. Although lead is naturally occurring, the practice of depositing mine tailings above ground has made a large volume of lead more accessible to people. From natural processes and human activities, the contaminated tailings and soil have been moved throughout the community in different media where exposures occur.

Lead

Lead is a naturally occurring metal found in the earth's crust. It has no characteristic taste or smell. It is mined and processed for use in various industries. It is used in some types of batteries, ammunition, ceramic glazes, medical equipment, scientific equipment, and military equipment. At one time, lead was used as an additive in gasoline and paint (10). Paint containing lead may still be present in older homes and becomes more available for uptake into the body if it is deteriorated or flaking. Tailings contaminated with lead have been deposited on the ground surface in tailings piles and also moved by nature and man into areas where exposure can easily occur. Lead contaminated soils have also been hauled to use as landscaping in other parts of Jefferson County.

The pathways of concern for lead exposure are inhalation and ingestion. Lead is not readily absorbed through the skin, so dermal contact is not an important route of exposure**.** The correlation between lead-contaminated soil and blood lead level are influenced by many factors, including access to soil, levels of lead in soil, behavior patterns (especially of children), presence of ground cover, seasonal variation of exposure conditions, particle size and composition of lead compounds found at various sites, and the route of exposure. These complex factors explain in some instances discrepant findings that are reported in the literature (12).

Children are more sensitive to the effects of lead than adults. The Centers for Disease Control and Prevention (CDC) considers lead poisoning the number one preventable health problem facing children (9). No safe blood lead level (BLL) in children has been determined, but CDC has set the current level of concern at greater than or equal to (≥) 10

microgram of lead per deciliter of blood (10 µg/dL)(9,10). Children identified with BLLs ≥ 10 µg/dL should prompt public health actions and receive follow-up services as recommended in CDC's Managing Elevated Blood Lead Levels among Young Children (9). Health effects of lead poisoning at these BLLs include decreased attention span, hyperactivity, and lower IQ scores. Recent studies have shown that adverse health effects can also occur in children with blood-lead levels below 10 µg/dL (9,10). Needleman and Gatsonis report that children's IQ scores are inversely related to blood lead levels. Several studies provide sufficient evidence that children's mental process or the faculty by which knowledge is acquired was adversely affected by lead (12).

Lead has no nutritional benefits for humans and has its greatest effect on the nervous system, especially in children. An unborn child can also be exposed to lead if their mothers have lead in their bodies. This exposure can cause problems such as premature births, low birth weight, decreased mental ability, learning difficulties, and reduced growth as young children. Young children can also be exposed to lead in their mother's breast milk if she has elevated lead in her system (10).

The biologic fate of inorganic lead in the human body is well known. Inorganic lead is not metabolized but is directly absorbed, distributed, and excreted. Once in the blood, lead is disturbed primarily among three compartments -- blood, soft tissue (kidney, bone marrow, liver, and brain), and mineralizing tissue (bones and teeth). Mineralizing tissue contains about 95% of the total body burden of lead in adults (10).

The lead concentrations found in the soil and well water in Jefferson County exceed site-specific EPA action levels. Residents, especially children, who are exposed to lead contaminated soil and well water, may be at risk for adverse health effects. To alleviate these exposure pathways, EPA is remediating lead contaminated residential soils and providing bottled water under a Time-Critical Removal Action. A future Remedial Action will address those residences in the Non Time-Critical Removal Action range of lead contamination.

Arsenic

Arsenic is an element that is widely distributed in the earth's crust. Inorganic arsenic occurs naturally in soils and many kinds of rock, especially in minerals and ores that contain copper and lead. Inorganic arsenic is expected to be the form present at the site. Arsenic cannot be destroyed in the environment; however, it can change its form or become attached or separated from particles. It can change its form by reacting with oxygen or other molecules present in air, water, or soil, or by the action of bacteria that live in soil or sediment. (13)

The pathways of uptake for arsenic at the site are ingestion and inhalation. Arsenic contaminated soil or water on the skin is a minor pathway at this site; however direct skin contact with high concentrations of inorganic arsenic compounds may cause the skin to become irritated, with some redness and swelling. However, it does not appear that skin contact is likely to lead to any serious internal effects. Skin exposure to the low levels of

arsenic in the soil at this site is not a concern. After ingestion or inhalation exposure to arsenic, the liver changes some of the arsenic to a less harmful organic form, which is excreted in the urine. Most of the arsenic will be gone within several days, but some will remain in the body for several months or longer. Inorganic arsenic has been recognized as a human poison since ancient times, and large oral doses (above 60 ppm in food or water) can produce death. Smaller doses of inorganic arsenic (0.3 to 30 ppm in food or water) may cause irritation of your stomach and intestines, with symptoms such as stomachache, nausea, vomiting, and diarrhea. Other effects from ingestion of inorganic arsenic include decreased production of red and white blood cells which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function causing a "pins and needle" sensation in the hands and feet. (13)

ATSDR has developed an EMEG for arsenic in soil of 20 ppm for children and 200 ppm for adults for chronic exposure (greater than 365 days). ATSDR has also developed an acute value (less than 14 days) of 10 ppm for the pica child. A pica child has a craving to put non-food items in their mouths or eat non-food items, such as dirt, paint chips, etc. (13).

A soil sample of one quadrant from each of 175 individual properties was analyzed for arsenic by the EPA's Region 7 laboratory as part of the EPA Removal Assessment. The level of arsenic in these soil samples ranged from 1.14 ppm to 40.4 ppm. Of the 175 samples taken, only four contained arsenic above the EMEG for children of 20 ppm (1). The data show that arsenic concentrations in soil appear sporadic and unrelated to lead concentrations.

Children, and especially those with pica behavior, could be exposed to elevated levels of arsenic in residential soil. Because we do not have data on whole yards, only one quadrant each, it is unknown what average exposure throughout any whole yard would be. Although health concerns are unknown, exposure to elevated levels of arsenic could still be occurring in portions of these residential yards. EPA's removal of the lead contaminated soil will also address any arsenic contamination, and the possibility of exposure, in yards co-located with elevated lead levels. Any remaining elevated arsenic contamination should be considered in future remedial actions at the site.

Source areas contain higher levels of arsenic that would allow for greater exposure. However, the time spent in the source areas is expected to be limited with only short-term exposure.

Of the 310 groundwater samples taken as part of the EPA Removal Assessment, only well sample # 3388-070 tested above the MCL for arsenic. This well is a shallow 80 foot deep that contained a level of 10.2 ppb of arsenic, slightly above the MCL of 10 ppb.

Barium

Barium is a silvery-white metal that is found in barite ores containing mixtures of elements. When combined with other chemicals such as sulfur or oxygen, it forms

barium compounds. These compounds are used to make paint, bricks, ceramics, glass, rubber, and other products. Barium compounds are also used by the oil and gas industries to make drilling mud that makes it easier to drill through rock by keeping the drill bit lubricated. (14)

The health effects of the different barium compounds vary depending on how well the compound dissolves in water or in the stomach. Barium compounds that do not dissolve well, such as barium sulfate, are generally not harmful. In fact, doctors sometimes use barium sulfate when performing some medical tests and taking x-rays of the gastrointestinal tract. (14)

Barium is sometimes found naturally in drinking water and food. The barium compounds that are usually found naturally do not dissolve or mix well with water, so the amount of barium found occurring in drinking water naturally is usually small. Certain foods, such as Brazil nuts, seaweed, fish, and some plants, may contain high concentrations of barium, but the concentration is not usually enough to be a health concern. (14)

Barium concentrations in residential yards ranged from 74 ppm to 3,500 ppm in laboratory samples, below the ATSDR's chronic EMEG for a child of 10,000 ppm**.** A total of 46 residences had levels of barium in their wells above 1,000 ppb, but only a single well contained barium above its MCL of 2,000 ppb in laboratory analyses. Again, this is the same shallow well (sample # 3388-070) that contained elevated levels of other contaminants. Barium was detected slightly above health guidelines in only this one instance.

Since levels of barium are below health guidelines, except for one well that is unlikely to be used as a source for potable water, no health effects are expected from the exposure to barium.

Cadmium

Cadmium is a soft, silver-white metal that occurs naturally in the earth's crust. Cadmium is not usually present in the environment as a pure metal, but as a mineral combined with other elements. It is most often present in nature as complex oxides, sulfides, and carbonates in zinc, lead, and copper ores. Cadmium has many industrial uses and is used in consumer products including batteries, pigments, metal coatings, plastics, and some metal alloys. (15)

The exposure route of concern for cadmium in Jefferson County is ingestion of contaminated drinking water. Cadmium can also be ingested from food, since low levels are present in most foods with the highest levels present in shellfish, liver, and kidney meats. Cigarette smoke also contains cadmium and can double the daily intake. Ingestion of high levels of cadmium in contaminated food or water can severely irritate the stomach, leading to vomiting and diarrhea, and sometimes death. Cadmium is a cumulative toxicant and ingestion of lower levels for a long period of time can lead to a buildup of cadmium in the kidneys and, possibly, kidney damage. The kidney is the main

target organ for cadmium toxicity following chronic-duration exposure by oral routes. The EPA has classified cadmium as a probable human carcinogen by inhalation based on limited evidence of an increase in lung cancer in humans and evidence of lung cancer in rats. Studies on humans and animals ingesting cadmium have not found increases in cancer, although additional research is needed. (15)

Two private wells were found to have cadmium levels slightly above the MCL for cadmium (maximum of 5.69 ppb vs. MCL of 5 ppb) and the single well sample # 3388-070 that had an estimated concentration of 11.8 ppb. Considering that cadmium was detected only slightly above its MCL in a few private wells, no adverse health effects are expected, especially since EPA has offered bottled water to these households to eliminate exposure.

Of the 175 soil samples that were analyzed in the laboratory for cadmium, only four exceeded ATSDR's Chronic EMEG for a child of 10 ppm, but did not exceed the EMEG for an adult of 100 ppm. The maximum detected in the four samples that exceeded the EMEG was 25.5 ppm. Since only four soil samples exceeded the cadmium EMEG for a child and these yards also have elevated levels of lead contamination, these yards should be remediated by EPA eliminating exposure pathways and health concerns.

Cancer

The American Cancer Society estimates that in the United States, slightly less than half of all men and slightly more than one-third of all women will develop some form of cancer in their lifetime (16).

While the EPA considers lead to be a probable human carcinogen and the National Toxicology Program (NTP) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens based on limited studies (11,17), there has been no studies linking residential ingestion or inhalation of lead contaminated soil or drinking water to increased cancer risks. The primary health concern for lead at the Southwest Jefferson County Mining site is not cancer, but lead's effect on the nervous system, especially for children less than 72 months of age.

Arsenic is considered by EPA, the International Agency for Research on Cancer, and the National Toxicology Program to be a human carcinogen by the inhalation and ingestion exposure routes. Exposure by the inhalation route in workers has shown the predominant carcinogenic effect is increased risk of lung cancer. In general, most researchers observe that risk increases as a function of exposure and duration. Most of the research on arsenic causing lung cancer comes from studies involving workers at copper smelters and arsenical chemical plants. When exposure occurs by the ingestion route, the main carcinogenic effect is increased risk of skin cancer. This is based on epidemiological studies of populations exposed to levels of arsenic in drinking water. Other studies have shown that inorganic arsenic can also increase the risk of bladder, liver, kidney, and prostate cancer (13). Since arsenic was detected above its MCL in only one well that is

not expected to used for human consumption, carcinogenic health effects are not expected.

Barium has not been shown to cause cancer in humans. The EPA has determined that barium is not likely to be carcinogenic to humans following ingestion and that there is insufficient information to determine whether it will be carcinogenic to humans following inhalation exposure. (14)

Cadmium is considered a probable human carcinogen (limited human, sufficient animal studies) from inhalation by EPA and a known human carcinogen by NTP. An association has been found between occupational inhalation exposure to cadmium and lung cancer (15). Although no air sampling has been done in Jefferson County, concentrations of cadmium are not expected to be anywhere near occupational levels, and no carcinogenic health effects are expected.

Mixtures

Lead is the major contaminant of concern at this site and has no nutritional value for humans. Although leads greatest damaging effect on the human body is to the nervous system, it also can damage the kidneys with exposure to high levels. Cadmium can also affect the kidneys after long-term exposure to low levels. Although both lead and cadmium can affect the kidneys, given the low levels of exposures, no expected synergistic (additive) health impacts are expected. The cleanup of contaminated residential yards and providing an alternative drinking water source for contaminated private wells by EPA should further reduce any exposure.

Children's Health Considerations

In general, children are more likely than adults to be exposed to contaminants in soil and water. In their daily activities, children have a tendency for frequent hand-to-mouth contact and often introduce non-food items into their mouths. Because children are smaller, their bodies/organ systems are still developing, and they typically absorb more of the contaminants, so it usually takes less of a contaminant to cause adverse health effects in children than adults (10).

Children are more susceptible to lead poisoning than adults, and children are also more likely to be exposed to lead contaminated materials. Infants and young children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or ground. They can also be exposed to lead through breast milk if the mother has elevated levels of lead in her system. Also, compared to adults, a larger proportion of the amount of lead swallowed will enter the blood in children (10). While about 99% of the amount of lead taken into the body of an adult will leave as waste within a few weeks, only about 32% of lead taken into the body of a child will leave as waste (10). All of these factors result in children being more affected by lead than adults when they have similar lead concentrations in their environment.

When children are exposed to lead contaminated materials, a variety of adverse health effects can occur depending on the level of lead to which they are exposed and the duration of exposure. These effects include learning disabilities, slowed growth, hyperactivity, impaired hearing, and at very high exposure levels, even brain damage. Unborn children can also be exposed to lead through their mothers if their bodies contain lead and are at risk of premature birth, low birth weight, decreased mental ability, learning difficulties, and reduced growth as young children (10).

Children who exhibit pica behavior may be at an even greater risk of exposure to contaminants in soil than other children. Individuals who exhibit pica behaviors have a craving to put non-food items in their mouths or eat non-food items, such as dirt, paint chips, etc (10).

CDC's current level of concern is 10 microgram of lead per deciliter of blood (10 μg/dL). Recent studies have shown that adverse health effects can also occur in children with blood-lead levels below 10 μg/dL (9,11). Yearly blood-lead testing before a child is 72 months of age is key to determining if the child has been exposed. Eliminating exposure pathways by controlling contamination sources, practicing good personal hygiene, and eating a proper diet high in calcium can lessen the risk of lead poisoning (9).

COMMUNITY HEALTH CONCERNS

Community health concerns vary considerably around the site. If residents have agreed to have their property sampled and their yard is affected by the contamination, they are generally concerned and want the property cleaned up. To prevent lead contaminated soil from continuing to be sold for landscaping, the county commission is considering a regulation that soil must be sampled and confirmed clean. However, some residents will not permit their property to be sampled, and they and their families may continue to be exposed to the lead contamination.

CONCLUSIONS

DHSS has reached four important conclusions in this health assessment:

Conclusion 1
Mining Related Soil

DHSS concludes that ingesting (swallowing) and/or inhaling (breathing) lead contaminated soil or dust found in many of the residential yards within the Southwest Jefferson County Mining site for a year or longer may harm people's health. This conclusion applies to past, present, and future exposure to lead at this site.

Basis for Decision

Residential yards throughout the mining areas in the Southwest Jefferson County Mining site contain lead and infrequently arsenic and cadmium in soil at concentrations above a level of health concern. The primary concern from exposure to lead in Jefferson County is the effects lead has on the nervous system, especially on children less than 72 months of age.

EPA has removed soil from numerous residential yards with lead concentrations above EPA's Time-Critical Removal Action level. These yards contained soil with lead contamination at a concentration of 1,200 parts per million (ppm) and greater or lead concentrations of 400 ppm and above for those homes with a child less than 72 months of age with an elevated blood lead level or an expectant mother. After EPA's Time-Critical Removal Actions, these yards are no longer expected to harm people's health due to lead contamination.

Some residential yards with soil containing lead above EPA's Time-Critical Removal Action level, and numerous residential yards with soil containing lead at concentrations between 400 ppm and 1,199 ppm, still remain in the Southwest Jefferson County Mining site. A future EPA Remedial Action is expected to clean up these yards where access can be gained. Exposure to the soil in these yards for a year or longer may harm people's health. Individuals, especially children, can be exposed to this contaminated soil directly by accidentally ingesting the soil while working, playing, gardening, or spending time in the yard. This contaminated soil can be tracked indoors by shoes, pets and other means and accumulate in the home. Individuals, especially children, can accidentally ingest this contaminated dust in the home. Although not as major of a route as ingestion, individuals can also be exposed by inhalation of contaminated dust in the yard and contaminated dust in the home. When this soil or dust is

stirred up and becomes airborne, individuals, especially children, may breathe it in and absorb the lead through their lungs.

All lead exposure sources are important to consider, so lead-based paint or other non-site related sources of lead may add to these concerns.

Conclusion 2
Hauled in Soil

DHSS concludes that ingesting and/or inhaling lead contaminated soil or dust for a year or longer from residential yards where lead-contaminated topsoil was hauled in may harm people's health. This conclusion applies to past, present, and future exposure to lead in these yards.

Basis for Decision

Residential yards throughout Jefferson County have been contaminated with lead contaminated soil that has been hauled from areas on the Big River floodplain to residential locations where it was used for landscaping and fill purposes. The primary concern for exposure to lead from these yards is the effects lead has on the nervous system, especially on children less than 72 months of age.

EPA is removing soil from residential yards with lead concentrations above EPA's Time-Critical Removal Action level. For detailed removal information, see conclusion 1.

All lead exposure sources are important to consider, so lead-based paint or other non-site related sources of lead may add to these concerns.

Conclusion 3
Groundwater

For past, present, and future exposures to lead contaminated well water, and to a lesser extent cadmium contaminated well water, DHSS concludes for the Southwest Jefferson County Mining site that drinking this water untreated for a year or longer may harm people's health. For present and future exposures of individuals who are using an EPA provided alternative source of drinking water, DHSS concludes that water from their contaminated private drinking water well is not expected to harm people's health through inhalation or skin contact.

Basis for Decision

A number of private drinking water wells in the Southwest Jefferson County Mining site were found to contain lead at concentrations greater than 15 parts per billion (ppb) or cadmium above 5 ppb. The primary exposure route to lead or cadmium

contaminated water is through ingestion. The primary concern from exposure to lead in Southwest Jefferson County Mining site is the effects lead has on the nervous system, especially on children less than 72 months of age. All lead exposure sources are important to consider, so lead-based paint or other non-site related sources of lead may add to these concerns.

EPA is currently using 15 ppb of lead and 5 ppb for cadmium as the site-specific action level in the Southwest Jefferson County Mining site as a guideline for providing alternative sources of water to private well users. For those individuals who are using EPA alternative sources of drinking water, they no longer need to drink water from their well; therefore, they are no longer being exposed to contaminated water through ingestion.

For individuals who have refused EPA alternative sources of water, they may still be drinking water from a contaminated private drinking water well. If these individuals are not drinking water from an alternative source or are not effectively filtering their well water, they may continue to be exposed to contaminated water that may harm people's health.

Conclusion 4	DHSS cannot currently conclude whether exposure to lead through air, sediment, surface water, fish, and edible plants in the Southwest Jefferson County site could harm people's health. The information needed to make a decision is very limited. DHSS is working with ATSDR, EPA, Missouri Department of Natural Resources (MDNR), Missouri Department of Conservation (MDC) and the Jefferson County Health Department to gather the needed information.
Basis for Decision	Water bodies (streams and lakes), sediment, and fish associated with the mining areas have not been sufficiently sampled in the Southwest Jefferson County Mining site area to determine if they contain elevated levels of contaminants. More testing is needed to determine if they may harm people's health.

RECOMMENDATIONS

1. EPA should continue to investigate residential yards, including newly developed residential properties, and other areas where individuals, especially children and expectant mothers, might be exposed to elevated lead and possibly other contaminants like arsenic and cadmium, and remediate appropriately.

2. EPA should continue to identify and sample private wells in the area to determine levels of lead and possibly other contaminants, like arsenic and cadmium, and take action to prevent exposure to drinking water with elevated levels of contaminants.

3. EPA/MDNR should continue and extend their sampling to other areas throughout Jefferson County where contamination may exist from past mining activities or the transport of lead contaminated soil and eliminate physical hazards left from the mining processes when found. EPA/MDNR should also include testing for other potentially mining related contaminants, such as arsenic, to determine if other contaminants may impact public health and require future actions.

4. Jefferson County Health Department/DHSS should continue their efforts to test the blood lead levels of children in the community and follow-up on children with elevated blood lead levels as necessary.

5. Jefferson County Health Department/DHSS should continue their efforts in reaching out to the community to educate them on the adverse health effects of lead exposure.

6. Indoor dust within a home may contain lead from a variety of sources, including lead based paint. Therefore, all agencies involved in remediation efforts in Jefferson County should work toward educating the public on how to reduce or eliminate their exposure to all sources of lead, including lead-based paint.

7. EPA/MDNR should sample other media, such as air, sediment, surface water, fish, and edible plants, so it can be determined if exposure to lead in these media can harm people's health.

8. Before developing property previously disturbed by mining, people should make sure that the property has been properly evaluated for lead and other mining-related contaminants.

9. EPA and Jefferson County should continue their efforts to ensure that lead-contaminated soils are not being hauled throughout the county for landscaping and fill.

PUBLIC HEALTH ACTION PLAN

This Public Health Action Plan (PHAP) for the Southwest Jefferson County Mining site contains a description of actions by the Missouri Department of Health and Senior Services (DHSS), the Agency for Toxic Substances and Disease Registry (ATSDR), and other stakeholders. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards, but provides an action plan to mitigate and prevent adverse human health effects resulting from past, present, and future exposures to hazardous substances at or near the site. Below is a list of commitments of public health actions to be implemented by DHSS, ATSDR, or other stakeholders at the site:

1. DHSS/ATSDR will work with the Jefferson County Health Department to provide health education and blood lead screening for the residents of Jefferson County so they can reduce or eliminate their exposure to all sources of lead.

2. DHSS/ATSDR will continue to coordinate with the Jefferson County Health Department, MDNR, and EPA to provide necessary community health education to the public and health professionals and address community health concerns and questions that may arise.

3. DHSS/ATSDR will work with the Jefferson County Health Department to encourage residents of Jefferson County to have yearly blood lead testing of children less than 72 months of age and expectant mothers.

4. DHSS/ATSDR will work with the Jefferson County Health Department to encourage residents of Jefferson County to have their yards soils and private drinking water wells tested for lead and cadmium and remediated when they are found elevated.

5. DHSS/ATSDR will coordinate with the Jefferson County Health Department, MDNR, and EPA to implement the recommendations in this public health assessment.

6. DHSS/ATSDR will review additional sampling data from further investigations and provide guidance regarding possible health risk as needed.

7. DHSS/ATSDR will update this public health assessment as needed.

8. DHSS/ATSDR will assist EPA and Jefferson County officials, as appropriate, in their efforts to draft an ordinance prohibiting the selling of lead contaminated soil for landscaping and fill.

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APPENDIXES

Appendix A:

Figure 1: Jefferson County Site Location Map with Mining Sites
Figure 2: Jefferson County Site Map with Elevated Residential Soils, 2008
Figure 3: Jefferson County Site Location and Demographic Statistics

Appendix B:

Table 1: Summary of Contaminants in the Southwest Jefferson County Mining Site and Health Guidelines
Table 2: Southwest Jefferson County Mining Site Exposure Pathways

Appendix A

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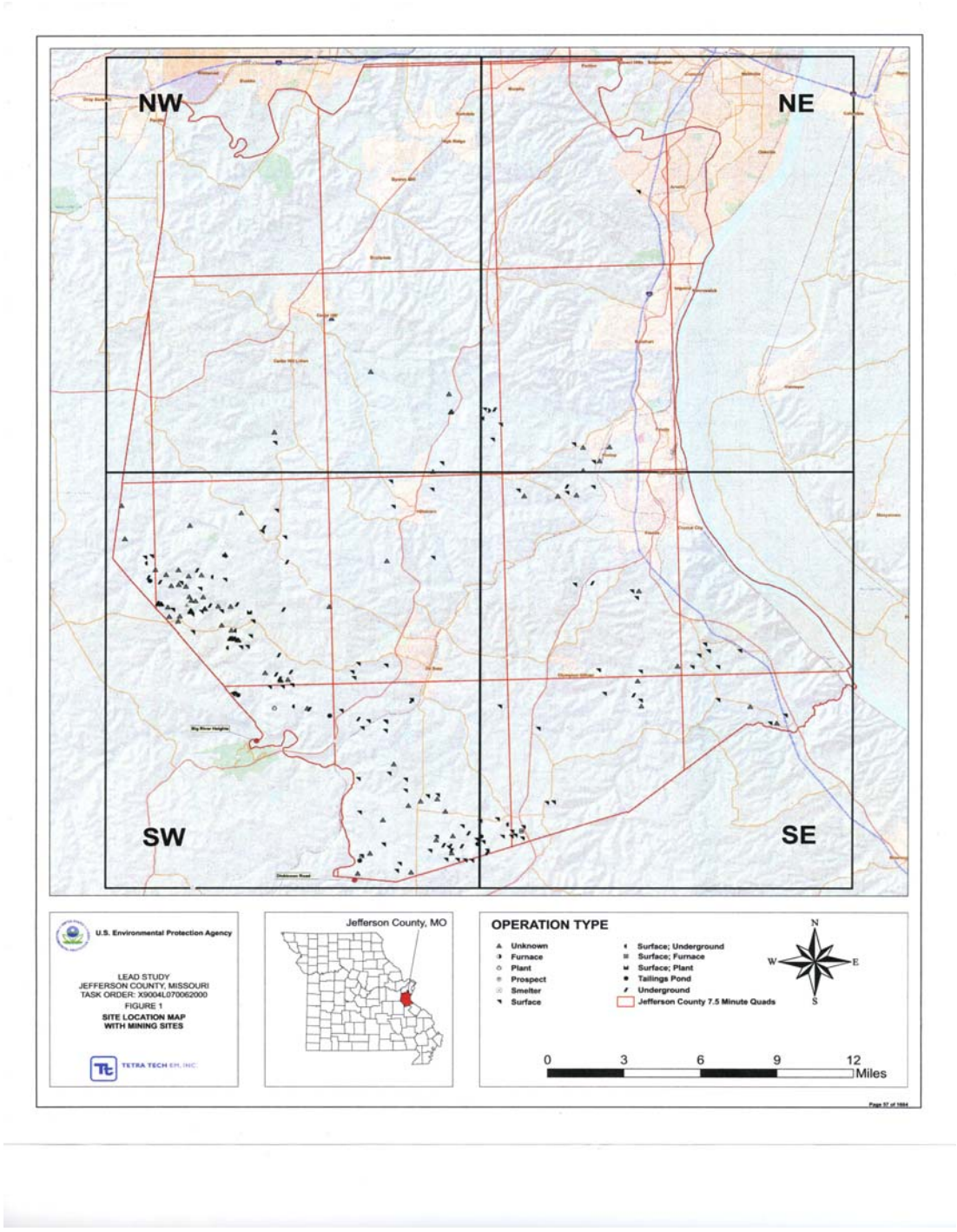
- Figure 1: Jefferson County Site Location Map with Mining Sites
- Figure 2: Jefferson County Site Map with Elevated Lead Levels in Residential Soils, 2008
- Figure 3: Jefferson County Site Location and Demographic Statistics

Figure 1

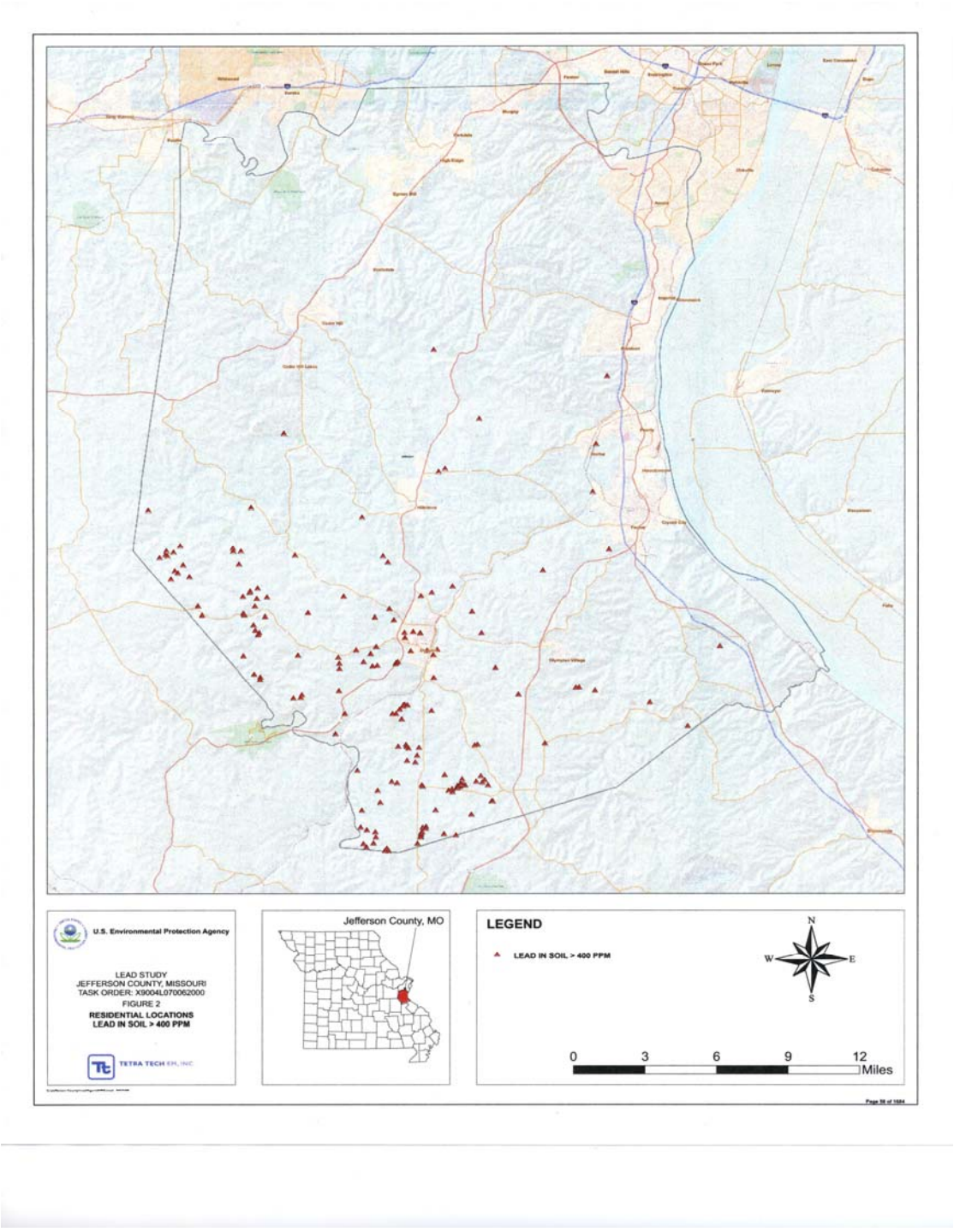
Jefferson County Site Location Map with Mining Sites



Source: **Tetra Tech EM, Inc. Preliminary Assessment Report, Jefferson County Lead Site, May 7, 2008**

Figure 2

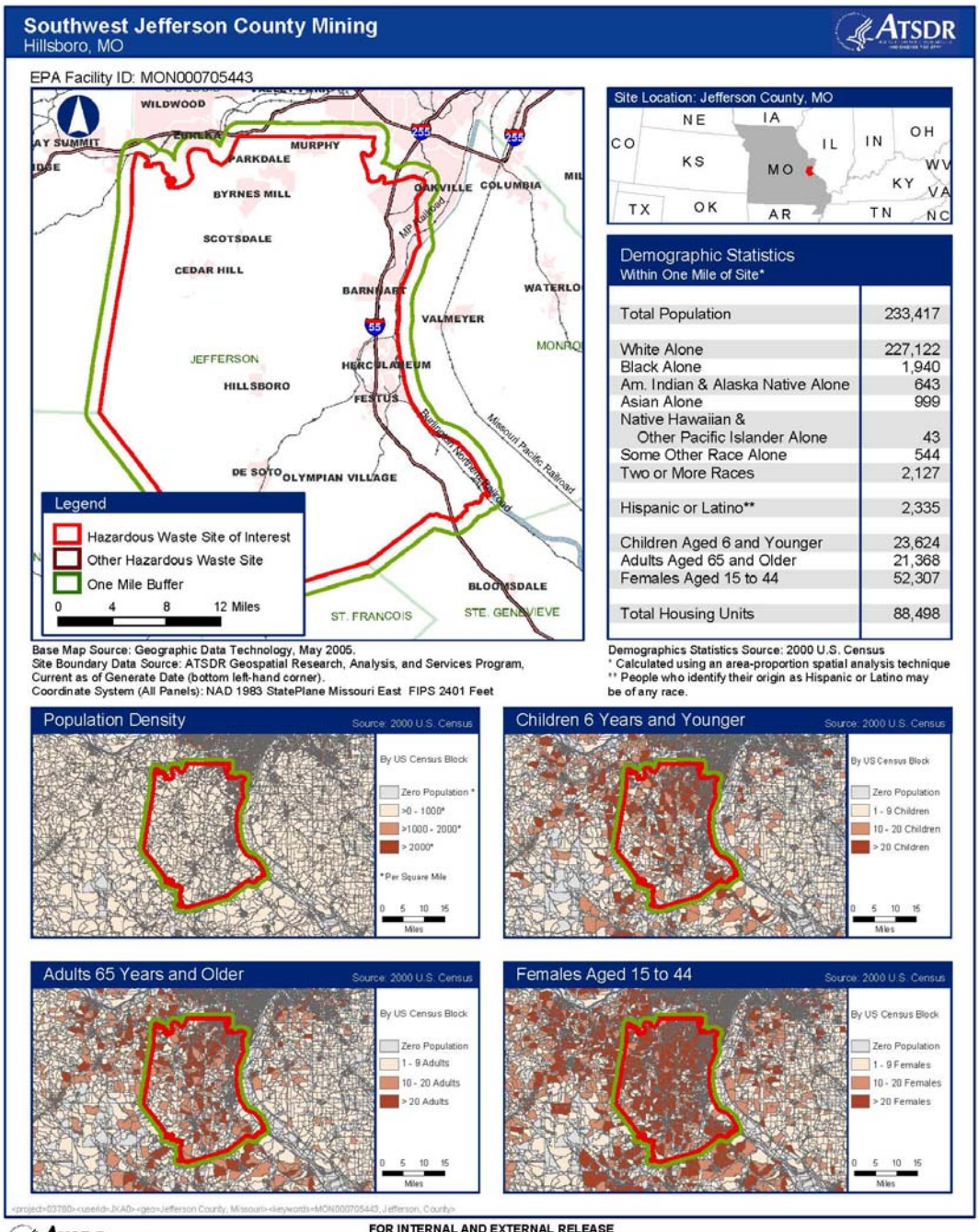
Jefferson County Site Map with Elevated Lead Levels in Residential Soils, 2008



Source: **Tetra Tech EM, Inc. Preliminary Assessment Report, Jefferson County Lead Site, May 7, 2008**

Figure 3

Jefferson County Site Location and Demographic Statistics



Appendix B

Table 1:

Summary of Contaminants in the Southwest Jefferson County Mining Site and Health Guidelines

Table 2:

Southwest Jefferson County Mining Site Exposure Pathways

Table 1

Summary of Contaminants in the Southwest Jefferson County Mining Site and Health Guidelines

Levels are in parts per million (ppm) unless otherwise noted

Contaminant	Location	Media	Maximum Level or Range at Residences	Screening Value & Source
Lead	Smelter	Soil	50,800	400 EPA for residential yards (Residential soils equal to and above 1,200 ppm are remediated under an EPA time-critical removal action, residential soils between 400 and 1,199 ppm are remediated under a future Remedial Action)
Lead	Tailings Piles	Tailings	8,820	
Lead	Railroad Bed	Tailings	14,300	
Lead	Residential Soils	Soil	14.7 – 7,280	
Lead	Sediment	Sediment	3,470	
Cadmium	Tailings Piles	Tailings	159	5 ATSDR EMEG – child
Cadmium	Residential Soils	Soil	ND – 25.5	
Arsenic	Tailings Piles	Tailings	28.1*	20 ATSDR EMEG – child
Arsenic	Residential Soils	Soils	ND – 40.4	
Zinc	Tailings Piles	Tailings	151,800	20,000 ATSDR EMEG – child
Zinc	Residential Soils	Soils	31.3 – 1,770	
Lead	Drinking Water Wells	Water	1 – 94 ppb †	15 ppb EPA PDWS
Barium	Drinking Water Wells	Water	10.8 – 1,640 ppb †	2,000 ppb EPA MCL
Cadmium	Drinking Water Wells	Water	ND – 21.1 ppb	5 ppb EPA MCL
Arsenic	Drinking Water Wells	Water	ND – 7.25 ppb †	10 ppb EPA MCL

References 1,3,10,13,14,15

ppb = parts per billion

EPA PDWS = Environmental Protection Agency Public Drinking Water Action Level

EPA MCL = Environmental Protection Agency Maximum Contaminant Level for Public Water Supplies

ATSDR EMEG = Agency for Toxic Substance and Disease Registry Environmental Media Evaluation Guide

ND = Not Detected

* Limited number of samples analyzed

† One unusual well sample (#3388-070) contained 3,070 ppb lead, 6,490 ppb barium, and 10.2 ppb arsenic, but reportedly had dirt in the water.

Table 2

Southwest Jefferson County Mining Area Site Exposure Pathways

Pathway Name	Exposure Pathways Elements					Time	Type of Pathway
	Source	Environmental Medium	Point of Exposure	Route of Exposure	Receptor Population		
Soil	Mining and Smelting Waste, Contaminated Landscape Soil	Soil	Smelting and Tailings Areas, Private Yards, and Driveways	Ingestion and Inhalation	Residents, Visitors, and Transient Populations	Past, Present, and Future	Completed
Indoor Dust	Mining and Smelting Waste	Soil Dust	Inside Homes	Ingestion and Inhalation	Residents, Visitors, and Transient Populations	Past, Present, and Future	Completed
Groundwater	Mining and Smelting Waste	Groundwater	Private Drinking Wells	Ingestion	Residents, Visitors, and Transient Populations	Past, Present, and Future	Completed
Sediment	Mining and Smelting Waste	Sediment	Tailings Areas, Streams, and Ponds or Lakes	Ingestion	Residents, Visitors, and Transient Populations	Past, Present, and Future	Potential
Surface Water	Mining and Smelting Waste	Surface Water	Area Streams and Lakes	Ingestion	Stream and Lake Users	Past, Present, and Future	Potential
Fish	Mining and Smelting Waste	Fish	Locally Caught Fish	Ingestion	Individuals Eating Locally Caught Fish	Past, Present, and Future	Potential
Edible Plants	Mining and Smelting Waste	Edible Plants	Locally Grown or Gathered Plants	Ingestion	Gardeners and Individuals Eating Plants Gathered in the Area	Past, Present, and Future	Potential