Public Health Assessment

Final Release

WASHINGTON COUNTY LEAD DISTRICT – OLD MINES AREA
WASHINGTON COUNTY, MISSOURI

EPA FACILITY ID: MON000705027

Prepared by the
Missouri Department of Health and Senior Services

OCTOBER 20, 2010

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 was prepared by ATSDR's Cooperative Agreement Partner 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.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes 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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Prepared by:

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

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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 Washington County Lead District - Old Mines Area site is to provide the Old Mines community with the best information possible to safeguard its health.

The Old Mines Area is one of three US Environmental Protection Agency (EPA) National Priorities List (NPL) sites in Washington County that were listed primarily due to lead contamination of private drinking wells and residential yards from mining and milling wastes. To a lesser extent, there is concern for barium in drinking water and physical hazards left behind like known and unknown diggings and shafts.

CONCLUSIONS

DHSS has reached four important conclusions in this health assessment:

Conclusion 1
Soil

DHSS concludes that ingesting (swallowing) and/or inhaling (breathing) lead contaminated soil or dust found in many of the residential yards within the Old Mines Area 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
Soil

Residential yards throughout the mining areas of the Old Mines Area contain lead in soil at concentrations above a level of health concern. The primary concern from exposure to lead in Washington County is the effect lead has on the nervous system, especially on children less than 72 months of age.

EPA has removed soil from 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 that had 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.

Residential yards with soil containing lead at concentrations between and including 400 ppm and 1,199 ppm still remain in the Old Mines Area. 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 routes 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 to 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.

Conclusion 2
Groundwater

For past, present and future exposures to untreated lead contaminated well water, DHSS concludes for the Old Mines Area that drinking this water 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.

Basis for Decision
Groundwater

Some private drinking water wells in the Old Mines Area were found to contain lead at concentrations greater than 15 micrograms per liter (µg/L). The primary exposure route to lead contaminated water is through ingestion. The primary concern from exposure to lead in Washington County is the effects lead has on the nervous system, especially on children less than 72 months of age.

EPA is currently using 15 µg/L of lead as the site-specific action level in Washington County as a guideline for providing alternative sources of water to private well users. For those individuals who are using an EPA provided alternative source 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 an EPA alternative source 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 people's health.

Conclusion 3
Groundwater

For past, present and future exposures to barium contaminated well water, DHSS concludes for the Old Mines Area that drinking this water for a year or longer is not expected to harm people's health.

Basis for Decision *Groundwater*	Five private drinking water wells in the Old Mines Area were found to contain barium at a concentration above the EPA's Maximum Contaminant Level (MCL) of 2 ppm. The primary exposure route of concern to barium contaminated water is through ingestion. The form of barium mined in Washington County was barite (barium sulfate), which is not readily dissolved by water and is not likely to cause harmful health effects. EPA provided these residences an alternative source of water. The individuals in these residences no longer need to drink from their contaminated private drinking water well; therefore, they should no longer be exposed to contaminated water.
Conclusion 4	DHSS cannot currently conclude whether exposure to lead through air, sediment, surface water, fish, and edible plants in the Old Mines Area could harm people's health. The information needed to make a decision is not available. DHSS is working with ATSDR, EPA, Missouri Department of Natural Resources (MDNR), Missouri Department of Conservation (MDC) and the Washington County Health Department to gather the needed information.
Basis for Decision	Lead has been found to have adverse effects on the nervous system, especially on children less than 72 months of age. In some former mining areas in Missouri, sampling has found lead in air, sediment, surface water, fish, and/or edible plants. However, the lead levels in these mediums vary greatly between mining areas. Water bodies (streams and lakes), sediment, and fish associated with the mining areas have not been sampled in the Old Mines 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. EPA has removed soils from residential yards containing lead concentrations that exceed Time-Critical Removal Action levels. These yards contained soil with lead contamination at a concentration of 1,200 ppm and greater or lead concentrations of 400 ppm and above for those that had a child less than 72 months of age with an elevated blood lead level.

2. EPA has provided bottled water to residents who have elevated levels of lead or barium in their private drinking water wells.

3. During the remedial phase, EPA will remove soil from residential yards that contain lower concentrations of lead that if they are exposed for a year or longer may harm people's health.

4. EPA/MDNR should sample and identify other potential routes of exposure such as air, sediment, surface water, fish, and edible plants to determine if these may harm people's health.

5. EPA/MDNR should continue to cap diggings/shafts that are found to eliminate these physical hazards.

6. DHSS/ATSDR will coordinate with the Washington County Health Department, MDNR, and EPA to address community health concerns and questions as they arise by providing health professional and community education.

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

8. DHSS/ATSDR will continue to provide health education to the residents of Washington County to inform them of the importance of having their residential yard soils and private drinking water tested for lead and remediated when they are found to be elevated.

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

10. DHSS/ATSDR will review and comment on any additional data from environmental samples collected by EPA, MDNR, or other agency 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), is evaluating the public health impact of the Washington County Lead District – Old Mines Area. ATSDR is a federal agency within the U.S. Department of Health and Human Services and is authorized 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 Old Mines Area from mining and milling wastes is lead in soil and drinking water. To a lesser extent, there is concern for barium in 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 possible adverse health effects.

BACKGROUND

Site Description and History

Washington County has a long history of lead mining dating back to the early 1700s. Early miners often found lead on or near the surface. This early mining was often done by farmers in the area to supplement their income during the winter months. Continuous mining in Washington County began in 1721 when Phillipe Francois Renault brought in slave labor to mine the easily available lead. Numerous small mines rapidly opened in northeastern Washington County and produced as much as 1,500 pounds of lead ore a day. Mining tapered off after 20 years with only intermittent production throughout the rest of the century. In 1799, mining began to be developed on a larger scale when Moses Austin sank a mineshaft to a depth of 80 feet and built a reverberatory furnace in the Potosi area. Until the introduction of the reverberatory furnace in the Potosi area, lead smelting was done with over 20 less efficient log and kiln furnaces. (1, 2)

Along with lead, early lead miners often found barite, also called tiff, as well. This barite was initially a nuisance with little to no value and was tossed aside into waste piles. Around the end of the American Civil War (1861-1865) when local lead deposits decreased and demand for lead declined, uses for barite as a long-lasting white pigment were being discovered. In 1926, barite was discovered to be a useful weighting agent in oil drilling mud, and barite mining boomed. Many of the once abandoned lead mines in the county were mined again for barite. Although mechanical mining for lead and barite began in 1904 with the use of an early steam shovel, hand mining was the mainstay until 1942. After 1942, many of the large mining operations used mechanized mining methods (utilizing shovels and front-end loaders) to mine barite found between the numerous old lead mine pits and shafts. Washington County was the world leader in barite production

for a number of years but production started to decline in 1985 due to competition in other states (1, 3).

During the lead and barite mining, milling and smelting processes, large quantities of lead-containing waste products, called tailings, were generated and deposited on the surface. Because of these processes and the resulting waste products, sites where these activities took place often have lead concentrations in soil substantially greater than the background concentrations for the area. Over time, these contaminants can move to residential areas due to wind or water erosion or from human activities such as using mine wastes as fill material in yards or driveways. In other instances, residential development has expanded into areas that were previously mined. Studies have shown that residential exposure to mining, milling and smelting wastes around these locations is related to a high percentage of children with elevated blood lead levels (4, 5). Because of the findings of these studies, DHSS recommends soil sampling of residential properties around mining areas.

A report published by the Missouri Geological Survey & Water Resources in 1972 evaluated the potential barite ore remaining in the tailings and summarized that there were large reserves present. This 1972 investigation documented barium and lead contamination associated with the tailings areas in general throughout Washington County. (2)

The initial effort to identify if contaminants from historical mining activities in Washington County could be having potential adverse health and environmental impacts began in the spring and summer of 2004 by the Missouri Department of Natural Resources (MDNR). This was part of a statewide project to identify all lead and zinc mining, milling, smelting, and processing sites in Missouri. The purpose of this project was to evaluate and categorize sites based on their potential risk to human health and the environment from contaminated soil and groundwater. These initial efforts focused on sampling 20 public properties to simplify property access issues. This investigation identified elevated lead concentrations above 400 parts per million (ppm) in seven public properties. Lead levels ranged from not detected up to a maximum of 4,067 ppm lead when analyzed using an X-Ray Fluorescence (XRF) instrument (1).

These findings prompted further investigation into other possible contaminated areas in Washington County. See Figure 1. Investigations began in three areas of Washington County that are referred to as the Washington County Lead District – Potosi Area, Richwoods Area, and Old Mines Area. The MDNR investigated and sampled the Potosi Area, while the U. S. Environmental Protection Agency (EPA) investigated and sampled the Richwoods Area and Old Mines Areas (1). See Figure 2. This public health assessment will only discuss the Old Mines Area in northeastern Washington County. The Richwoods Area and Potosi Area will be discussed in separate health assessments.

The Old Mines Area consists of approximately 20 square miles of mining disturbed land located in the northeastern portion of Washington County where lead and barite mining, milling, and smelting activities were conducted for over 200 years. The Old Mines Area

is in a rural area located in the Old Lead Belt of Missouri (1, 2). The approximate central most location is given as the intersection of Missouri State Highways 21 and 47 (2). This is located approximately 10 miles north of the city of Potosi, which is approximately 60 miles southwest of St. Louis, Missouri (See Figure 1 and 2). The Old Mines Area has been further broken down into nine study areas that consist of major disturbed or tailings areas (See Figure 2 and 3). The EPA proposed the Old Mines Area to be placed on the National Priorities List (NPL) on September 19, 2007 and finalized it on March 19, 2008. The NPL is a national list of the most serious contaminated sites that are eligible for federal cleanup under the CERCLA.

The data used for this public health assessment was gathered from the Hazardous Ranking System (HRS) Documentation Record for Washington County Lead District – Old Mines dated September 2007 (2) and conference calls with EPA. This data contains information primarily on lead and barium.

EPA began investigating and sampling in the Old Mines Area in August and September 2005. As of May 2008, EPA had tested 878 private wells in the Old Mines Area. Water sampling results were compared to EPA's site-specific drinking water action level for lead of 15 micrograms per liter (μg/L). This level is typically used by public water systems to trigger treatment of public water supplies when exceeded. EPA is currently using this site-specific action level in Washington County as a guideline to provide alternative sources of water to private well users. Analytical results from the water samples indicate that 124 wells out of the 878 tested contained lead above EPA's site-specific action level. See Table 1. Five wells were found to have a barium concentration above the EPA's Maximum Contaminant Levels (MCLs) of 2,000 μg/L. MCLs are the highest concentrations that EPA will allow in a public drinking water supply. These wells had barium concentrations ranging from 2,080 μg/L to 3,710 μg/L.

Table 1. Water Sampling Results

Total Number of Private Wells Sampled	878
Number of Wells Above EPA's Action Levels for Lead	124

EPA also tested the soil in 962 yards in the Old Mines Area. Soil sample results were compared to EPA's standard cleanup value of 400 ppm and Time-Critical Removal Action level for the Washington County sites of 1,200 ppm lead. See Lead Cleanup for Soil under the Toxicological Evaluation section for an explanation of cleanup levels and action level. The results of soil testing found 60 residential yards with concentrations of lead at 1,200 ppm and above and 230 residential yards with concentrations of lead between and including 400 ppm and 1,199 ppm. See Table 2.

Table 2. Soil Sampling Results

Total Number of Yards Sampled	962
Yards with Lead Below 400 ppm	672
Yards with Lead Between and Including 400-1,199 ppm	230
Yards with Lead At or Above 1,200 ppm	60

ppm = parts per million

Other Sources of Exposure to Contaminants

Prior to its restriction in 1978, lead was used as an additive in paint. A home in which lead-based paint was used may be a potential source of lead exposure, especially for children under 72 months of age. Approximately, 61% of the homes in Washington County were built prior 1979 (6, 7). Lead-based paint can be more assessable to children when it is deteriorating and cracking or in areas of friction where the lead paint can be ground to dust such as windows opening and closing. (8, 9) Therefore, lead-based paint may be a significant source of lead exposure, especially for children.

So far, the evaluation of the Old Mines Area has focused on groundwater and soil contamination, but surface water (streams and confined waters), sediments, and fish present in those water bodies have not been evaluated to determine if contamination is present in these areas (2). If the water bodies and fish in the Old Mines Area are contaminated with lead, this could be another source of human exposure.

No air sampling for lead has been done in Washington County to this point; however, air is not expected to be a major pathway of exposure for this site. Considering the area, vegetation has been able to establish itself somewhat and wind doesn't seem to affect and move the lead contaminated materials like it does at the large tailings piles in areas of St. Francois and Madison Counties. The air pathway could be a problem on unpaved roads with heavy vehicle traffic where the lead contaminated materials were used as surface materials.

The Washington County Lead District Health Consultation published on May 22, 2008, reported that concentrations of barium and arsenic were found in some residential yards in Washington County. This document reported that the concentrations of barium and arsenic available for review at the time were not likely to result in harmful health effects. It is not expected that concentrations of barium and arsenic in the Old Mines Area vary much from those reported in the Washington County Lead District Health Consultation; however, at this time, there is not enough data. In addition, the potential for additive neurological effects of arsenic and lead exposure combined has not been addressed due to lack of data on arsenic at the site.

Washington Co. Health Department Activities

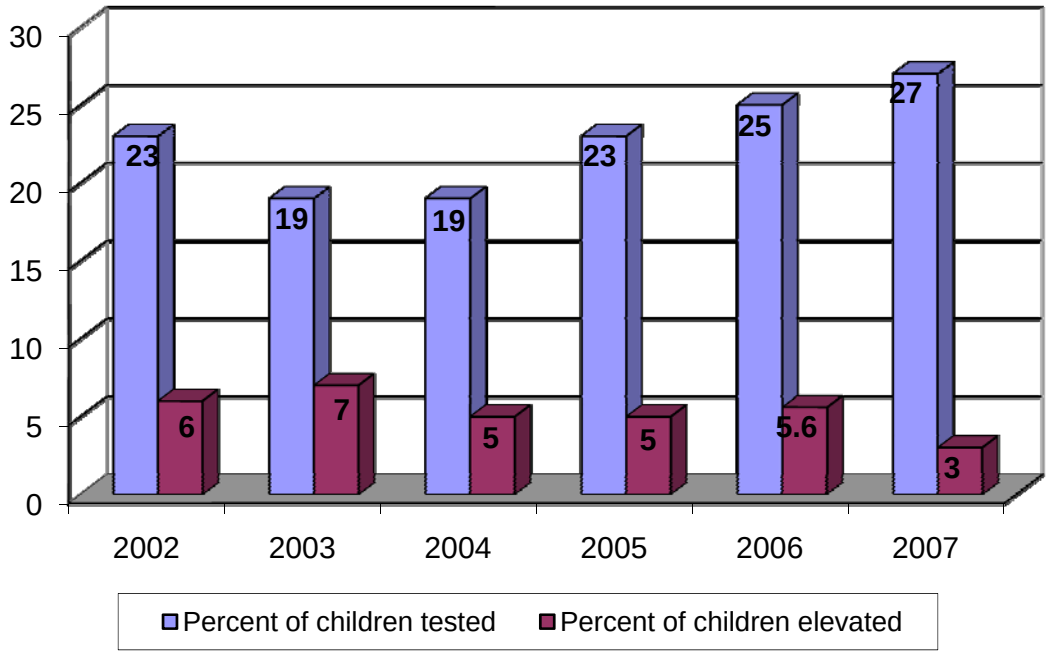
While the U.S. Center for Disease Control and Prevention (CDC), ATSDR and DHSS are concerned about any lead exposure, CDC has set 10 microgram per deciliter (µg/dL) as the blood lead "level of concern" where follow up and intervention should take place to lower the child's blood lead level (7). When a child's blood lead level exceeds this level of concern, the child is said to have an elevated blood lead level. Elevated blood lead levels in children have been known to be a problem in Washington County for many years. Because residential exposure to lead contamination has been correlated with elevated blood lead levels in children, regional ATSDR staff, DHSS, and the Washington

County Health Department (WCHD) have collaborated with MDNR and EPA to encourage blood lead testing.

Beginning on January 1, 2002, Missouri state law required that DHSS implement a childhood lead-testing program which required children less than 72 months of age be tested for lead poisoning. The law also required the reporting of all blood lead samples taken on children to be reported to DHSS. The latest data shows that in 2007, 26% (494 children) of an estimated 1,893 children less than 72 months of age in Washington County had their blood lead levels tested. 3% (16 children) of those tested had elevated blood lead levels compared to a state average of 1.5% (10).

In the graph below, the percent of children in Washington County under 72 months of age that had their blood tested for lead and the number of those children found to be above 10 µg/dL is illustrated in graphic form from 2002 to 2007. Only the data from 2002 thru 2007 is presented in the graph because only after 2002 were all blood lead tests required to be reported, giving a better representation of the number of children who were lead poisoned.

Chart 1: Percent of Children Less than 72 Months of Age Tested and Number of Children Tested with Elevated Blood lead Levels in Washington County



Source: Missouri Department of Health and Senior Services Systematic Tracking of Elevated Lead Levels and Remediation (STELLAR), now the Missouri Health Strategic Architectures & Information Cooperative (MOHSAIC).

Many different agencies at the local, state, and federal levels have taken actions to increase blood lead testing in order to identify children with elevated blood lead levels. These actions include: increased provider (doctors, nurses, etc.) and patient education about the health effects of lead and the importance of testing, Medicaid increasing their funding and outreach to test children of low income families, and the additional interest

in lead due to media coverage. Even with these efforts to increase blood lead testing; approximately 1,400 children in Washington County remain untested.

Because of elevated blood lead levels in children in Washington County and elevated soil and groundwater lead levels found by MDNR and EPA investigations, EPA began a Time-Critical Removal Action in December 2005. To inform the public of what was occurring, EPA conducted public meetings for the Potosi, Richwoods, and Old Mines Areas. As part of the public meetings, DHSS, in cooperation with ATSDR and WCHD, provided free blood lead testing and educational materials to anyone attending the meetings. These agencies will continue to promote childhood lead poisoning prevention efforts through health education and blood lead testing.

Elevated Blood lead Risk Assessment

When a child is found to have an elevated blood lead level, their health care provider, local county health department, and/or managed care agency typically provides health education to the family to try to reduce the child's blood lead level. For every child with a blood lead level of 15 µg/dL or greater, an Elevated Blood Lead Risk Assessment is completed to find what is causing the child to have elevated levels of lead in his or her blood. In the Old Mines Area, the DHSS Bureau of Environmental Epidemiology's Childhood Lead Poisoning Prevention Program (CLPPP) conducts these Risk Assessments. The Risk Assessments typically include testing for lead in drinking water, yard soil, and dust from soil, lead-based paint, or other sources in doorways, windowsills, window troughs, walls, and other areas where the child may be exposed. If the Risk Assessment locates where the child is being exposed to lead, recommendations can be made on removing the specific source(s) of lead and/or preventing the child from coming into contact with the source(s).

Washington County Time-Critical Removal Action

Up to the summer of 2008, much of EPA's efforts have been under an EPA 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, residential yards with lead concentrations of 1,200 ppm and greater or lead concentrations of 400 ppm and above that had a child less than 72 months of age with an elevated blood lead level, were considered time-critical (See Lead Cleanup for Soil under the Toxicological Evaluation section for an explanation of cleanup levels and action level). In addition, private wells found to have water that contained lead levels above 15 µg/L were also considered time-critical.

As of February 2008, EPA has screened 962 properties in the Old Mines Area of which 60 had lead levels of 1,200 ppm and above in soil. Fifty-four of these properties have had the contaminated soil removed and replaced with clean soil. The contaminated soil is being taken to an old tailings pile in Washington County that is being used as a

repository. The remaining 6 properties have thus far not allowed EPA to conduct soil remediation.

EPA has also sampled 878 drinking water wells, of which 124 exceeded EPA's Action Level for lead and 5 exceeded EPA's MCL for barium. EPA has offered to provide bottled water to all of the private wells found contaminated. Of these private well owners, 102 have agreed to and are being provided with bottled water (3). In place of the bottled water, an in-house under-sink filtration system is being considered by EPA as an alternative under a trial program.

Time-Critical Removal Actions for contaminated soil and groundwater will be handled similarly to the other areas in the Washington County Lead District. Those soils that meet or exceed 1,200 ppm of lead will be excavated up to a depth of 12 inches. If the soil at a depth of 12 inches exceeds 1,200 ppm, excavation may continue until concentrations are below 1,200 ppm. If excavation below 24 inches will not achieve a concentration less than 1,200 ppm, EPA may choose to place a warning barrier and restore the area with clean soil. The replacement soil must have lead levels below 240 ppm with any other hazardous substances, pollutants, or contaminants below EPA residential soil screening levels (11).

EPA has completed Time-Critical Removal Actions in the Old Mines Area. Contaminated yards between 400 ppm and 1,199 ppm are expected to be addressed by a future Remedial Action.

Land Use, Natural Resources, and Geology

Except for small communities like Old Mines, Fertile, and others, the Old Mines Area is primarily rural residential with large disturbed and tailings areas that remain from past mining activities. Some of the disturbed areas contain tailings ponds. See Figure 3 for a view of the mining disturbed areas. The remaining areas are diversified with forest, pasture, farmland, and single-family housing on large-sized lots or farmsteads. Natural resources in the area consist of forestland, wildlife, and water bodies, including tailings ponds that are sometimes used for fishing.

Geology of the area consists of surface soils that vary from 10% to 80% clay over a residuum of gravelly clay. The soil and residuum range in thickness from a few feet to over 30 feet in thickness. Early miners often found lead on or near the surface in this red clay residuum. Strip mining for lead and barium has disturbed much of the Old Mines Area. The unconfined Ozark Aquifer that underlies the area is the most important aquifer and the principal source of public and private water supplies in the area. It is highly fractured and ranges from 235 to 370 feet thick. In the Old Mines Area, a topographic high exist that forms two separate watersheds. Study Areas 14, 15, and 16 drain into the Big River while the remaining Study Areas (11 thru 13 and 17 thru 19) drain into the Mineral Fork before empting into the Big River. This topographic high may also be a

groundwater divide in the Ozark aquifer and form an eastern sub-aquifer and western sub-aquifer.

Karst areas with sinkholes, solution-widened cavities, caves, springs, and losing streams are present throughout the study area and county (1, 3). Over 75 caves and 100 springs have been documented in Washington County and surface recharge areas such as numerous sinkholes, losing streams, mine shafts and exploratory borings can allow surface water to easily enter the Ozark aquifer (1). Below the Ozark Aquifer is the St. Francois Confining Unit that is an effective barrier to downward groundwater movement to the St. Francois Aquifer. Interconnections between the two aquifers have probably occurred because of faulting, unplugged drill holes, and improperly completed wells allowing some contamination into the St. Francois Aquifer (1, 3).

Physical hazards

Physical hazards in the Old Mines Area consist of known and unknown deserted diggings and mine shafts. These hazards vary from a shallow depression of a few feet to mine shafts that originally were around 100 feet deep. Over 1,400 of these diggings/shafts sites related to the mineral industry may be present in all of Washington County (1). Some may have become over grown by vegetation and may be unrecognizable until they are stumbled on to. A limited number of smelter remains are still present with dilapidated facilities and/or stone chimneys that could present a falling stone hazard if disturbed.

Demographics

The Old Mines Area consists of small communities such as Old Mines, Fertile, Latty, Bliss, and others for which no individual demographic information is available. The rest of the Old Mines Area is primarily rural with single-family residences on a number of acres. Because of this, there is little to no demographic information available that provides a good representation of the Old Mines Area. To address this lack of specific information, the demographics for Washington County will be used. Little variation is expected in the demographics of Washington County and the Old Mines Area.

From 2000 US Census data, the average percentage of the different races in Washington County were 95.5% white, 2.5% black, 0.7% American Indian and Alaska Native, 0.1% Asian, and 1.3% being other race or two or more races. The percentage of children under five years of age was 6.6% and the percentage of adults over 65 was 11.7%. The percentage of families below the poverty level in 1999 was 17.1% compared to the United States average of 9.2%. The average percentage of homes built before 1979 in Washington County was 61% (6).

Quality Assurance and Quality Control

Various people, organizations, and contractors have been involved in the sampling, research, and analyses of the Old Mines Area, 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

Pathways Analysis

This section addresses the pathways by which residents of the area may have been exposed to lead and to a lesser degree barium from the contaminated tailings, soil, and/or groundwater. The data used for this public health assessment was gathered from the HRS Documentation Record for Washington County Lead District – Old Mines dated September 2007 (2) and conference calls with EPA. This data contains information primarily on lead and barium. Since data was not available for review, it is not known if other contaminants exist at a concentration that may pose a health risk.

When a chemical is released into the environment, the release does not always lead to exposure. Exposure only occurs when a chemical comes into contact with and enters the body. To determine whether the residents of Washington County are exposed to site-related contaminants, particularly those residents living in the vicinity of tailings and mining areas or areas and media affected by the past mining, 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, 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 could exist. Completed and potential exposure pathways could have occurred in the past, could be occurring presently, or could occur in the future.

Exposure Pathways

The five elements of an exposure pathway at the Washington County Lead District – Old Mines Area are:

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

Table 1 in Appendix B illustrates the different exposure pathways present at the Washington County Lead District – Old Mines Area.

Completed Exposure Pathways

Completed exposure pathways for lead contaminated soil, groundwater, and dust at the Washington County Lead District – Old Mines Area have existed in the past, are presently occurring, and will continue in the future until the pathways are lessened or eliminated. Lead is the primary contaminant of the Old Mines Area and to a lesser extent barium. The major exposure pathways are ingestion and inhalation of lead and other contaminants. Dermal contact is not considered a significant pathway of exposure, because lead is not readily absorbed through the skin.

Direct exposure to soil contaminants can occur 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 routes and accumulate in the home. Individuals, especially children, can accidentally ingest this contaminated dust 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 route as ingestion, individuals can also be exposed to this contaminated soil in the yard and contaminated dust in the home by inhalation. 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.

Individuals can be exposed to the lead in water through ingestion while drinking and cooking with contaminated water. Individuals may accidentally ingest lead while bathing and playing in contaminated water. Like exposure to soil, ingestion is a larger exposure factor than inhalation; however, small amounts of lead can be absorbed through the lungs when showering or swimming in contaminated water.

EPA has greatly reduced exposure to lead-contaminated soil and groundwater by completing 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 greater or lead concentrations of 400 ppm and above that had a child less than 72 months of age with an elevated blood lead level. In addition, EPA has identified private drinking water wells with levels of lead greater than 15 µg/L. EPA has offered all of these residents bottled water to eliminate or reduce exposure.

Five wells were found to have a barium concentration above the EPA's MCL of 2 ppm. Individuals drinking from these wells would have a completed exposure pathway; however, 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 or carbonate, are generally not harmful. In fact, doctors sometimes use barium sulfate when performing some medical tests and taking x-rays of the gastrointestinal tract. (12) The form of barium mined in Washington County was barium sulfate (barite) and area geology is dominated by barite and carbonate (limestone and dolomite) bedrocks. In the presence of sulfates and carbonates, other soluble forms of barium, such as barium chloride, react in the environment to form more the stable barium sulfates or carbonates. (12) Although EPA did not collect data on which form of barium was found in these private wells, based on site geology and an awareness of how barium reacts in the environment, it is expected that the form of barium detected in these private wells was barium sulfate or carbonate, which is unlikely to pose a health risk. See Appendix C for more information.

In addition to exposure to soil and groundwater, the CLPPP along with the WCHD has 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. Therefore, lead-based paint may be a significant source of lead exposure, especially for children. However, EPA does not have authority to clean up contamination from lead based paint. Because this source of lead cannot be cleaned up by EPA, educating the public on how they can reduce or eliminate their exposure to lead-based paint is an extremely important part of decreasing Washington County residents' exposure to lead.

Potential Exposure Pathways

Potential exposure pathways are associated with media which have not been tested for lead contamination. These include the water bodies associated with former mining areas and the streams that cross the site. It is not known what levels of lead or other contaminants are present in the water and sediment.

The Missouri's 2009 Fish Advisory states that "Lead's potential to bioaccumulate in fish makes consumption of fish a risk in certain regions of Missouri, especially in mining

areas." This advisory makes consumption recommendations on two water bodies that are in former mining areas. These two consumption recommendations are for individuals to not eat sunfish taken from Big Creek near Glover, Missouri and not to eat sunfish, suckers, or carp taken from Big River in St. Francois and Jefferson counties. Not enough information is available at this time to determine if eating fish taken from water bodies in the Old Mines area pose a health risk.

In addition, plants that are found or grown in areas containing high levels of lead should be investigated. These potential pathways may or may not be present at an exposure level that would cause a health concern. Contaminated garden areas are being addressed by EPA, but EPA may not gain access to sample and remove contaminated soil for all residences.

In other areas of the state where large tailings piles are close to residential areas, inhalation of particles blowing off these piles can be a significant route of exposure. Thus, this route should be considered in the Old Mines Area.

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 (CV) that is 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 (more than 365 days) exposure, intermediate (14 day to 365 days) exposure and acute (less than 14 days) exposure. Environmental Media Evaluation Guides (EMEGs) are CVs that have been derived for a variety of chemicals in various media.

ATSDR has developed Minimal Risk Levels (MRLs) that are an estimate of daily human exposure to a hazardous substance that is likely to have an adverse noncancer health effect over specified exposure duration. Similarly, EPA has developed Reference Doses (RfDs) that estimate the daily lifetime dose of a substance that is unlikely to cause harm in humans. Health assessors use MRLs, RfDs, and CVs to select environmental contaminants of concern. Contaminant concentrations that are less than these values are unlikely to pose a health threat. Contaminant concentrations above MRLs, RfDs, and CVs do not necessarily indicate that a health threat is present, but that further evaluation of the chemical and pathways is needed.

ATSDR has not developed a MRL for human exposure to lead, nor has the EPA developed an RfD. Therefore, the usual approach of estimating human exposure to an environmental contaminant and then comparing this dose to a health guideline (such as an MRL or RfD) cannot be used. Instead, exposure to lead is evaluated by using a biological model that predicts a blood lead concentration that would result from exposure to environmental lead contamination. See Lead Cleanup for Soil under the Toxicological Evaluation section.

Barium

Barium is a silvery-white metal that is found in 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. (12)

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. (12) The form of barium mined in Washington County was barite (barium sulfate), which is not readily dissolved by water and is not likely to cause harmful health effects.

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. (12)

Although EPA did not collect data on which form of barium was found in these private wells, it is likely that the form of barium detected was barium sulfate or carbonate, which is unlikely to pose a health risk. However, much of the barium found in these wells was dissolved. Because of this and the fact that they exceeded the MCL, EPA has provided these well owners with an alternative source of drinking water or water filter. This eliminates exposure to the wells found at this site containing elevated levels of barium in water. See Appendix C for more information.

Lead

Lead is a naturally occurring metal found in the earth's crust (8). It has no characteristic taste or smell (8). It is mined and processed for use in various industries. The practice of depositing mine tailings above ground has made a large volume of lead more accessible

to people. Lead is used in some types of batteries, ammunition, ceramic glazes, medical equipment, scientific equipment, and military equipment (8). At one time, lead was used as an additive in gasoline and in paint. Lead from gasoline was released into the air in automotive exhaust and deposited along roadways (8). Houses built before 1978 may contain lead based paint. Lead in the soils in the inner cities is often attributable lead based paint and leaded gasoline (8).

Lead has no nutritional benefits for humans. Exposure to lead can occur by inhalation or ingestion. Lead is not readily absorbed through the skin, so dermal contact is not an important route of exposure. Lead has the greatest effect on the nervous system, especially in children. Pregnant women can experience complications with their pregnancy ranging from low birth rate to miscarriage if exposed to high concentrations of lead. (8)

Studies have shown that there is a definite correlation between concentrations of lead in soils and blood lead levels in children. In general, blood lead levels increase as the lead concentrations in soil and dust increase. As blood lead levels increase, the likelihood of adverse health effects also increases. Examples of adverse health effects of children exposed to lead include learning difficulties and behavioral problems.

Lead Cleanup for Soil

ATSDR has not developed a MRL for human exposure to lead, nor has the EPA developed an RfD. Therefore, the usual approach of estimating human exposure to an environmental contaminant and then comparing this dose to a health guideline (such as an MRL or RfD) cannot be used. Instead, exposure to lead is evaluated by using a 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 (CDC, 2005). CDC's current blood lead level of concern is10 µg/dL. Using this model, EPA has established a standard cleanup value of 400 ppm for lead in soil using the default parameters in this model (9). The default parameters in the model include many estimated values such as estimated soil ingestion and time spent outdoors. If the default parameters are found to not be accurate in an area being investigated, the cleanup value used at that site may be different.

In addition to the standard cleanup value, EPA typically develops another lead concentration for large sites to prioritize which residential yards need to be remediated first. Residential yards with concentrations above this value are called time-critical yards. For Washington County, EPA has set 1,200 ppm as the Time-Critical Removal Action level. Residential yards with lead concentrations of 400 ppm or greater are also considered time-critical if a child with a blood lead level of 10 µg/dL or greater resides there.

The default parameters used in the model may not take into consideration all of an individual's exposure to lead. An individual can be exposed to lead through many

sources such as drinking water, lead paint, and other items containing lead including certain toys, jewelry, herbal remedies, Mexican candies, water hoses, and others.

Although CDC's current blood lead level of concern is 10 µg/dL, there are several studies suggesting blood lead levels less than10 µg/dL may cause adverse health effects in children. There are many reasons why CDC has not lowered the level of concern below 10 µg/dL. Two of these reasons are that no clinical treatment is known to reduce blood lead levels below 10 µg/dL or reduce the risk for adverse developmental effects and no level of lead in the blood has been found to not be associated with some adverse health effect (13). Because of this, it is vital for health education be provided in the Old Mines Area along with remediation efforts.

The lead concentrations found in the soil and water in Washington County exceed site-specific EPA lead action levels. Residents, especially children, who are exposed to lead contaminated soil or water, may be at risk for adverse health effects. Because the concentration of lead detected in a large number of private drinking water wells exceeds the site-specific action level, EPA has provided these residents with bottled water. EPA is also currently conducting Time-Critical Removal Actions at a large number of residential yards throughout Washington County.

Cancer

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. (12)

While the EPA considers lead to be a probable human carcinogen and the National Toxicity Program (NTP) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens, there have been no studies linking residential ingestion of lead contaminated soil or drinking water with an increase cancer risk (8, 14). Although the American Cancer Society estimates less than half of men and slightly more than a third of women in the United States will develop some form of cancer in their lifetime, the primary health concern for lead in Washington County is not cancer; instead, the primary concern from exposure to lead in Washington County is the effects lead has on the nervous system, especially on children less than 72 months of age (15).

Children's Health Considerations

DHSS, along with ATSDR, realize that children are not small adults. Because their bodies are still developing and their behaviors are different, their susceptibility and exposure may be different than adults. Because of this, DHSS has evaluated the health implications for children who may be exposed at this site.

In general, children are more likely than adults to become exposed to contaminants in soil or water. In their daily activities, children have a tendency to have frequent hand-to-mouth contact and introduce non-food items into their mouths. Because children are smaller and their bodies typically absorb more of the contaminants, it usually takes less of a contaminant to cause adverse health effects in children than adults.

It is not known whether children are more or less sensitive to the health effects caused by barium exposure. People who ingest elevated levels of barium may experience gastrointestinal disturbances, such as vomiting, abdominal cramps, diarrhea. Exposure can also cause difficulties in breathing, increased or decreased blood pressure, numbness around the face, and muscle weakness. (12)

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 (8). 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 (8). 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 amount 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 (8). Lead has the greatest effect on the nervous system, especially in children. In children, low levels of lead can cause weakness in fingers, wrists, or ankles. Unborn children can also be exposed to lead through their mothers and are at risk of premature births, low birth weight, decreased mental ability, learning difficulties, and reduced growth as young children (8).

Yearly blood lead testing before a child is 72 months old is key in determining if the child has been exposed to lead. Eliminating exposure pathways by controlling contamination sources, practicing good personal hygiene, and eating a proper diet high in calcium can reduce the risk of lead poisoning in children.

Children who exhibit pica behaviors may be at an even greater risk of becoming exposed to contaminants in soil than other children. Individuals who exhibit pica behaviors have a craving to put non-food items in their mouth or eat non-food items, such as dirt, paint chips, sand, etc. Children exhibiting pica behavior in Washington County may be more likely to experience adverse health effects from lead and barium found in the soil and should be seen by a physician.

COMMUNITY HEALTH CONCERNS

During 2005, EPA and MDNR completed an investigation of Washington County lead and barite mining areas. To inform the community of their findings and the follow-up that was expected to take place, EPA and MDNR held public meetings/public availability sessions on October 17, 2005 in Cadet, Missouri and on October 18, 2005 in Potosi, Missouri. EPA and MDNR then held public meetings on June 7 and June 8, 2006 to update the community about the progress made at the Washington County Lead District sites and ask for comments on the Administrative Record for each site. In cooperation with the WCHD and ATSDR, DHSS provided free blood lead screenings for those interested at the meetings. Few public health concerns were expressed at the meetings, but some residents did express a desire to get the lead-contaminated soils replaced so that they no longer posed any danger to the children (16). Some health concerns were expressed during the 2005 sampling event by several citizens concerning the health effects of consuming fish from area lakes that were once associated with mining activities (1).

Conversations in early 2008 with personnel of the WCHD that work with the public on a daily basis and do blood lead testing for the county indicated that citizens have not expressed any health concerns about the lead contamination to them. Even though the residents aren't concerned about the lead, they are usually willing to let EPA test their yards and private wells and perform remediation if necessary.

DHSS, along with ATSDR, released a version of this document for public comment on September 30, 2009. Comments were accepted until February 5, 2010. In addition, two public meetings were hosted by DHSS during this comment period in Washington County. The meetings were held on January 21, 2010 at the Washington County Health Department in Potosi, MO, and at the Richwoods School in Richwoods, MO. The purpose of these meetings was to provide citizens with a chance to discuss the content of this health assessment in person with DHSS and ATSDR health officials. In addition, it was an opportunity for health officials to address any comments or questions citizens may have had. No additional questions or comments were received about this health assessment during the comment period.

CONCLUSIONS

CONCLUSIONS	DHSS has reached four important conclusions in this health assessment:
Conclusion 1 *Soil*	DHSS concludes that ingesting (swallowing) and/or inhaling (breathing) lead contaminated soil or dust found in many of the residential yards within the Old Mines Area 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
Soil

Residential yards throughout the mining areas of the Old Mines Area contain lead in soil at concentrations above a level of health concern. The primary concern from exposure to lead in Washington County is the effects lead has on the nervous system, especially on children less than 72 months of age.

EPA has removed soil from 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 ppm and greater or lead concentrations of 400 ppm and above for those that had 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.

Residential yards with soil containing lead at concentrations between and including 400 ppm and 1,199 ppm still remain in the Old Mines Area. 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 routes 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 to 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.

Conclusion 2
Groundwater

For past, present and future exposures to untreated lead contaminated well water, DHSS concludes for the Old Mines Area that drinking this water 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.

Basis for Decision
Groundwater

Some private drinking water wells in the Old Mines Area were found to contain lead at concentration greater than 15 µg/L. The primary exposure route to lead contaminated water is through ingestion. The primary concern from exposure to lead in

	Washington County is the effects lead has on the nervous system, especially on children less than 72 months of age. EPA is currently using 15 µg/L of lead as the site-specific action level in Washington County as a guideline for providing alternative sources of water to private well users. For those individuals who are using an EPA alternative source 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 an EPA provided alternative source 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 people's health.
Conclusion 3 *Groundwater*	For past, present and future exposures to barium contaminated well water, DHSS concludes for the Old Mines Area that drinking this water for a year or longer is not expected to harm people's health.
Basis for Decision *Groundwater*	Five private drinking water wells in the Old Mines Area were found to contain barium at a concentration above the EPA's MCL of 2 ppm. The primary exposure route of concern to barium contaminated water is through ingestion. The form of barium mined in Washington County was barite (barium sulfate), which is not readily dissolved by water, is not likely to cause harmful health effects. EPA provided these residences an alternative source of water. The individuals in these residences no longer need to drink from their contaminated private drinking water well; therefore, they should no longer be exposed to contaminated water.
Conclusion 4	DHSS cannot currently conclude whether exposure to lead through air, sediment, surface water, fish, and edible plants in the Old Mines Area could harm people's health. The information needed to make a decision is not available. DHSS is working with ATSDR, EPA, MDNR, Missouri Department of Conservation (MDC) and the WCHD to gather the needed information.
Basis for Decision	Lead has been found to have adverse effects on the nervous system, especially on children less than 72 months of age. In some former mining areas in Missouri, sampling has found lead in air, sediment, surface water, fish, and/or edible plants. However, the

lead levels in these mediums vary greatly between mining areas. Water bodies (streams and lakes), sediment, and fish associated with the mining areas have not been sampled in the Old Mines Area to determine if they contain elevated levels of contaminants. More testing is needed to determine if they may harm people's health.

The areas where EPA has tested soil in Washington County have been primarily residential yards and public areas such as schools. It is likely that there are nonresidential areas in Washington County, which have not been tested for lead or other mining related contaminants that contain elevated concentrations of mining related contaminants.

Known and unknown digging/shaft sites related to the mineral industry exists in the Old Mines Area. Some of these may have been over grown by vegetation and unrecognizable until they are stumbled on. Because of the possibility of tripping or falling into, these diggings/shafts pose a physical hazard.

RECOMMENDATIONS

1. EPA should continue to investigate residential yards, including newly developed residential properties, and other areas where individuals, especially children, might be exposed to elevated lead and other metals contamination, and remediate appropriately.

2. EPA should continue to identify and sample private wells in the area to determine if elevated levels of lead or other contaminants are present and take action to prevent exposure to drinking water with elevated levels of contaminants. Barium speciation should be considered for future sampling to determine what form of barium is present in wells in the area.

3. EPA/MDNR should extend their sampling to outside the Richwoods, Potosi, and Old Mines Areas in Washington County.

4. WCHD/DHSS should continue their efforts to test the blood of children in the community and follow-up on elevated blood leads as necessary.

5. WCHD/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

Washington 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 and identify other potential routes of exposure such as air, sediment, surface water, fish, and edible plants to determine if these pose a health risk.

8. EPA/MDNR should continue to cap diggings/shafts that are found to eliminate these physical hazards.

9. When developing property, DHSS recommends having the property properly assessed for lead and other mining related contaminants to avoid potential future exposures.

PUBLIC HEALTH ACTION PLAN

This Public Health Action Plan (PHAP) for the Washington County Lead District – Old Mines Area contains a description of actions to be taken 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 coordinate with WCHD, MDNR, and EPA to address community health concerns and questions as they arise by providing health professional and community education.

2. DHSS/ATSDR will coordinate with WCHD, MDNR, and EPA to implement the recommendations in this public health assessment.

3. DHSS/ATSDR will continue to provide health education to the residents of Washington County to inform them of the importance of having their residential yard soils and private drinking water tested for lead and remediated when they are found elevated.

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

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

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CERTIFICATION

This Washington County Lead District – Old Mines Area Public Health Assessment was prepared by the Missouri Department of Health and Senior Services, Bureau of Environmental Epidemiology, under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with the approved methodologies and procedures existing at the time the Public Health Assessment was initiated. Editorial review was completed by the Cooperative Agreement partner.

Technical Project Officer, CAT, CAPEB, DHAC

The Division of Health Assessment and Consultation (DHAC), has reviewed this public health assessment and concurs with its findings.

Team Lead, CAT, CAPEB, DHAC, ATSDR

APPENDIXES

Appendix A:

Figure 1: Washington County Lead District Site Location Map
Figure 2: Washington County Lead District Sites
Figure 3: Washington County Lead District – Old Mines

Appendix B:

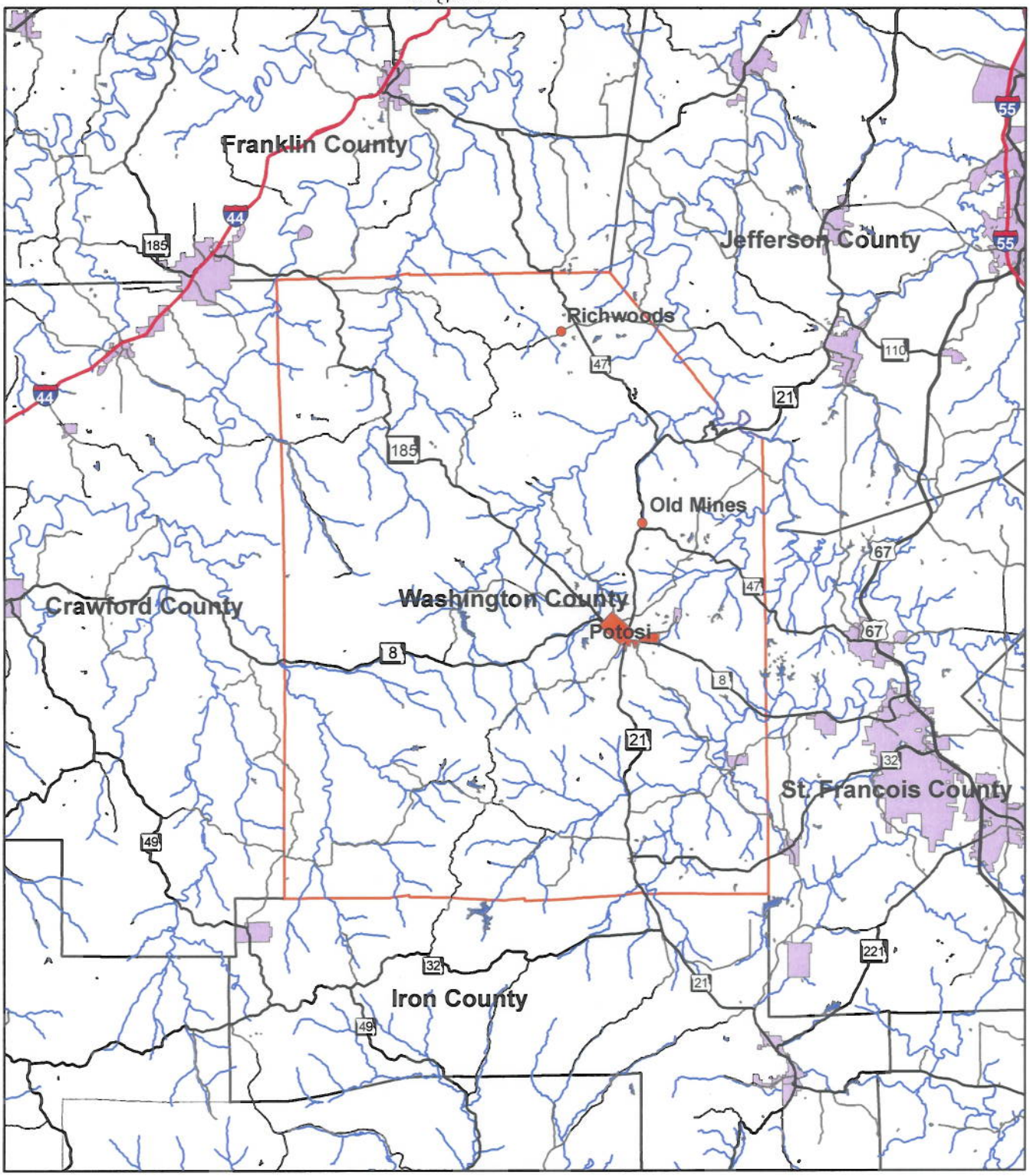
Table 1: Washington County Lead District – Old Mines Area Exposure Pathways

Appendix C:

Additional Barium Discussion

Appendix A

Figure 1



towns EPA Sites are Named for
Interstate
US highway
Missouri highway
Lettered county roads
City
Lakes
Rivers
Washington County
County Boundaries

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0 2 4 8 12 16
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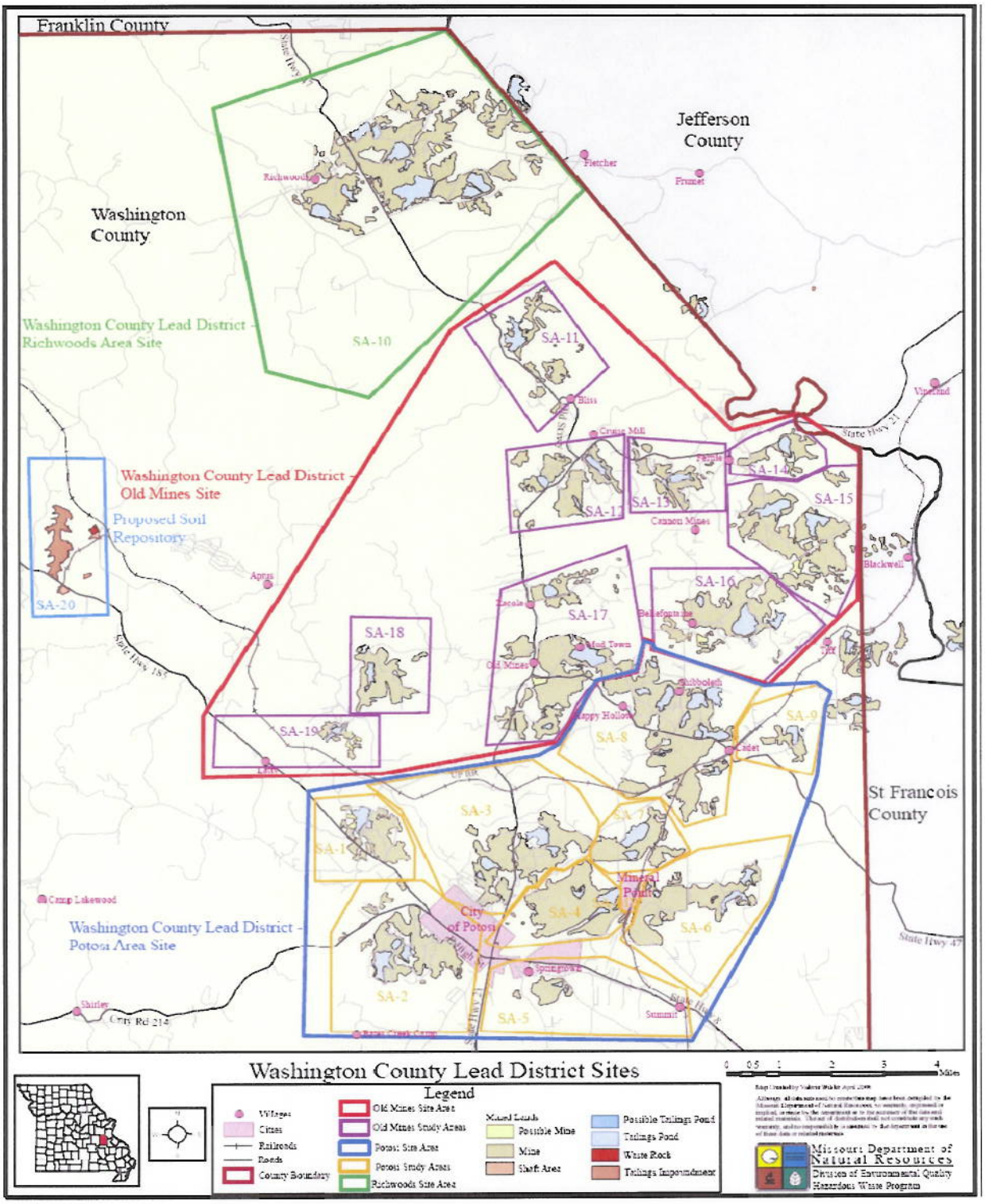
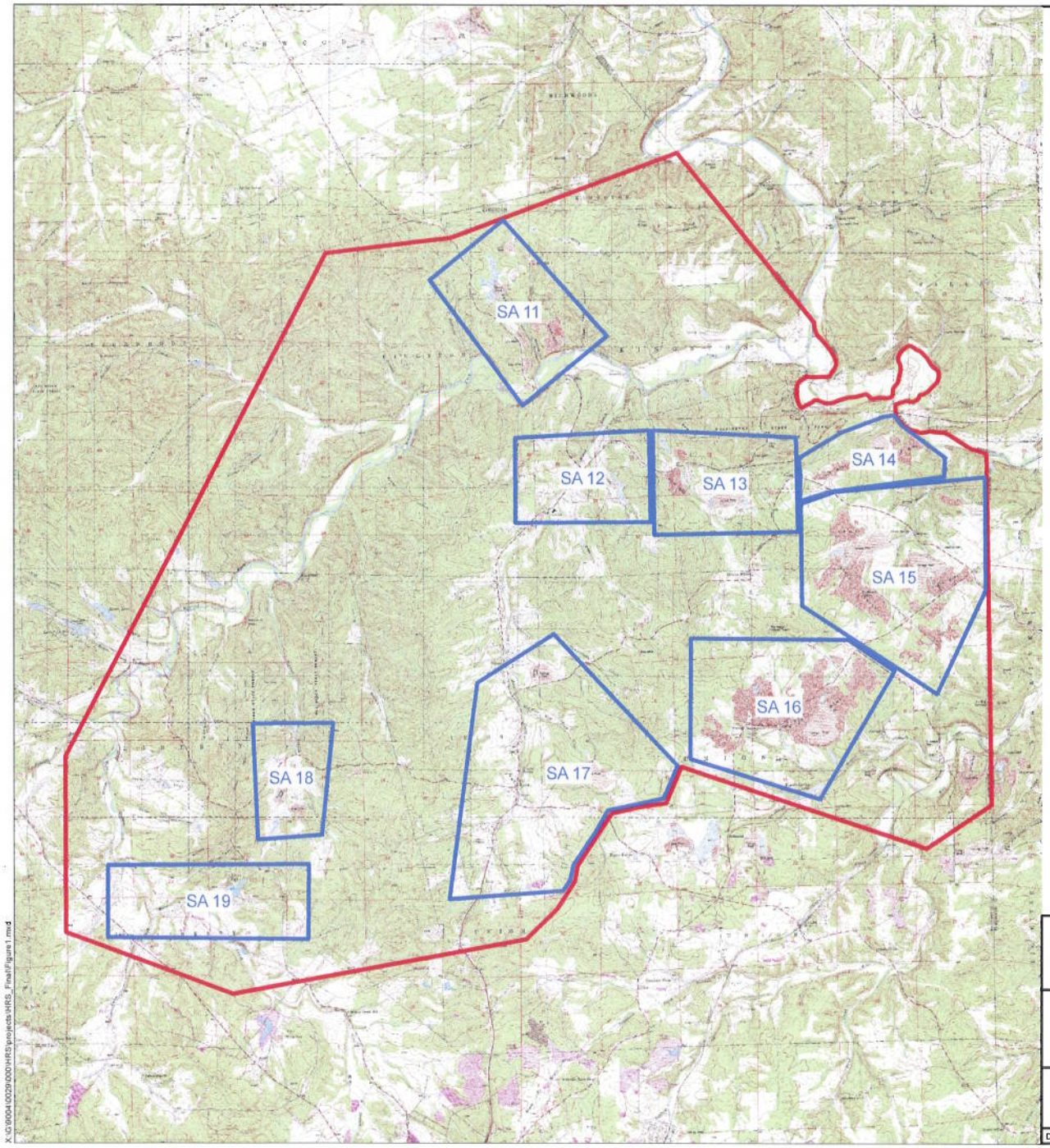
Figure 2: Washington County Lead District



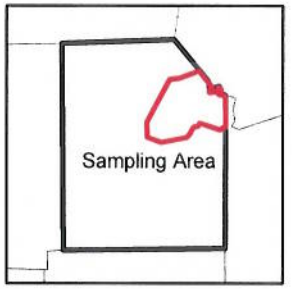
Source: Missouri Department of Natural Resources



Legend

Old Mines Sampling Area

Study Area



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0 1 2

Miles

Source: USGS Ebo, MO 7.5 Minute Topo Quad, 1978
USGS Fletcher, MO 7.5 Minute Topo Quad, 1969
USGS Mineral Point, MO 7.5 Minute Topo Quad, 1970
USGS Old Mines, MO 7.5 Minute Topo Quad, 1969
USGS Potosi, MO 7.5 Minute Topo Quad, 1980
USGS Richwoods, MO 7.5 Minute Topo Quad, 1978

Washington County Lead District
Old Mines Sampling Area
Washington County, Missouri

Figure 3
Topographic Site Location Map

TETRA TECH EM INC.

Date: 01/26/2007 Drawn By: Colin Willits Project No: 19004.L.06.0029.000

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Appendix B

Table 1: Washington County Lead District – Old Mines 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	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

Appendix C

Additional Barium Discussion

Five private drinking water wells were found to have a barium concentration above the EPA's Maximum Contaminant Levels (MCLs) of 2,000 μg/L. These wells had barium concentrations ranging from 2,080 μg/L to 3,710 μg/L. The well found to have a concentration of 3,710 μg/L barium was also found to contain lead at a concentration of 35.7 μg/L. MCLs are the highest concentrations that EPA will allow in a public drinking water supply. However, exceeding an MCL does not necessarily indicate that a health threat is present, but that further evaluation is needed.

The concentration of barium in drinking water that may result in adverse health effects depends greatly on what other chemical the barium is bound to. This is due primarily to how readily the barium compound dissolves in water or in the stomach. Barium compounds that are soluble, such as barium chloride, are expected to be more of a health concern due to their greater potential to be absorbed by the body. (12)

Barium compounds that do not dissolve well, such as barium sulfate, are generally not harmful. The insoluble, nontoxic nature of barium sulfate has allowed doctors to use barium sulfate when performing some medical tests and taking x-rays of the gastrointestinal tract. (12) The form of barium mined in Washington County was barite (barium sulfate), which is not readily dissolved by water or gastrointestinal tract and is not likely to cause harmful health effects.

Health assessors use CVs to select environmental contaminants of concern. Contaminant concentrations that are less than these values are unlikely to pose a health threat. One example of a CV is ATSDR's MRLs, which are an estimate of daily human exposure to a hazardous substance that is likely not to have an adverse noncancer health effect over specified exposure duration. To calculate these CVs, health assessors typically use a no-observed-adverse-effect level (NOAEL) or lowest-observed-adverse-effect level (LOAEL). A NOAEL is the highest scientifically tested dose of a substance that has been reported to not have an adverse health effect on people or animals studied. A LOAEL is the lowest scientifically tested dose of a substance reported to cause an adverse health effect in people or animals studied. These doses are then divided by an uncertainty value to account for variation in sensitivity to substances among the human population and the uncertainty of extrapolating animal data to the case of humans. In addition, the doses are divided by a modifying factor to reflect additional concerns that are not accounted for by the uncertainty factors.

For chronic ingestion of barium, the NOAEL chosen was from a study using a form of barium chloride that resulted in a dose of 65 milligrams of barium per kilogram of body weight per day (mg/kg/day). This dose was then divided by an uncertainty factor of 100 (10 to account for human variability and 10 for extrapolating animal data to be used for humans). The dose was also divided by a modifying factor of 3. This resulted in an oral MRL for barium of 0.2 mg/kg/day for exposures lasting more than a year. (12)

$$\frac{65 \text{ mg/kg/day}}{100 \times 3} = 0.2 \text{ mg/kg/day}$$

This calculated MRL can then be compared to the concentration of barium found in the private drinking water wells in the Old Mines Area. This can be done by first documenting that 1,000 µg/L can also be expressed as 1 micrograms per liter (mg/L). Then assumptions are made for human body weight and amount of water a person drinks in a day. The values used for body weight are typically 70 kilograms (kg) for an adult and 10 kg for a child. (Note: 70 kg is about 154 pounds, and 10 kg is about 22 pounds). The values used for the amount of water consumed per day are 2 liters per day (L/day) for an adult and 1 L/day for a child. The dose is then calculated by multiplying the concentration of the contaminant in the water by the amount of water consumed and then dividing that number by the body weight. In the calculations below, the highest concentration of barium 3.71 mg/L found in a private well and the lowest concentration that exceeded the MCL were placed in the formulas.

Adult

$$\frac{2.08 \text{ mg/L} \times 2 \text{ L/day}}{70 \text{ kg}} = 0.059 \text{ mg/kg/day}$$

$$\frac{3.71 \text{ mg/L} \times 2 \text{ L/day}}{70 \text{ kg}} = 0.106 \text{ mg/kg/day}$$

Child

$$\frac{2.08 \text{ mg/L} \times 1 \text{ L/day}}{10 \text{ kg}} = 0.208 \text{ mg/kg/day}$$

$$\frac{3.71 \text{ mg/L} \times 1 \text{ L/day}}{10 \text{ kg}} = 0.37 \text{ mg/kg/day}$$

Both calculated doses for children are higher than the MRL of 0.2 mg/kg/day. This would indicate there is a potential health risk associated with drinking the water from these wells if all of the barium detected in the water was in a soluble form, such as barium chloride. However, it is our profession opinion that it is reasonable to assume that much of this barium was in a different form.

Barium compounds that dissolve in water do not tend to remain in the environment in that form for a long period of time. This is because they dissolve in the water and quickly combine with other chemicals (sulfate and carbonate) to form a longer lasting barium compounds (barium sulfate and barium carbonate). Because of this, barium sulfate and barium carbonate are the forms of barium most commonly found in water unless the water has recently been contaminated by soluble barium compounds released from a waste site. (12)

The geology of Washington County is abundant with barite (barium sulfate) and carbonate bedrocks (limestone and dolomite). In the presence of sulfates and carbonates, other soluble forms of barium, such as barium chloride, react in the environment to form more the stable barium sulfates or carbonates. (12) In addition, there is currently no known release of a soluble barium compound into the environment at this site. Because of this, it is our professional opinion that the barium detected in private drinking water wells was likely in a sulfate or carbonate form; and therefore, it would pose less or no health risk. However, much of the barium found in private drinking water wells in the Old Mines Area was dissolved. Because of this and the fact that levels exceeded the MCL, EPA has provided these 5 well owners with an alternative source of drinking water or water filter, in order to eliminate exposure.