Public Health Assessment

Final Release

WASHINGTON COUNTY LEAD DISTRICT – RICHWOODS AREA
WASHINGTON COUNTY, MISSOURI

EPA FACILITY ID: MON000705032

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 - Richwoods Area site is to provide the Richwoods community with the best information possible to safeguard its health.

The Richwoods 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 Richwoods 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 Richwoods 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 and one schoolyard 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 Richwoods 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 Richwoods 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 Richwoods 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 EPA provided alternative sources of drinking water, they no longer need to drink water from their well; therefore, they should no longer be exposed to contaminated water through ingestion. For individuals who have refused EPA provided 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 people's health.
Conclusion 3 *Groundwater*	For past, present and future exposures to barium contaminated well water, DHSS concludes for the Richwoods Area that drinking this water for a year or longer is not expected to harm people's health.

Basis for Decision *Groundwater*	One private drinking water well in the Richwoods Area was 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 this residence an alternative source of water. The individuals in this residence 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 Richwoods 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 Richwoods 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 may harm people's health if exposed for a year or longer.

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 - Richwoods Area site. 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 Richwoods Area site is lead in soil and drinking water from mining and milling wastes. 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

Missouri has a rich history of lead mining dating back to the 1700s. Mining began along the Meramac River and in the St. Francois Mountains in the southeast part of the state, and then expanded throughout the southern half of the state as new lead deposits were discovered (1). Lead mines were opened in Washington County in 1725 and mining continued in the county until around the end of the American Civil War when local lead deposits decreased and demand for lead declined (2). See Appendix B Figure 1.

Around the same time the lead industry was declining, more uses for barium were being discovered, and the barium industry was growing. In Washington County, barium sulfate, called barite or “tiff”, had previously been a discarded waste product from lead mining, but it became a valuable resource around the end of the American Civil War. It did not take long for lead mining to be replaced by barite mining, and many of the once abandoned lead mines in the county were mined again for barite. By 1941, Missouri accounted for 40 percent of barite production in the United States, and remained the world’s leading producer of barite until the 1980’s. (2, 3)

During the lead and barite mining, milling and smelting processes, large quantities of lead-containing waste products 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 (3, 4). Because of the findings of these studies, DHSS recommends soil sampling of residential properties around mining areas.

For the past several years, the Missouri Department of Natural Resources (MDNR) has been conducting a statewide inventory of lead mining, milling and smelting sites in Missouri. Because of its mining history, Washington County was one of the first counties to be investigated in southeast Missouri. According to the MDNR's Inventory of Mines, Occurrences and Prospects database, approximately 1,426 historical mining sites are located in Washington County.

Beginning in June 2005, MDNR and EPA staff collected soil samples and private drinking water well samples from residential properties and lead mining source areas in Washington County. As of May 2008, the focus of sampling efforts has been within three areas of Washington County named the Potosi Area, Old Mines Area, and Richwoods Area. See Appendix B Figure 2. EPA proposed each of these areas separately for the National Priorities List (NPL) on September 19, 2007 and finalized them 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. This public health assessment will only discuss the Richwoods Area located in the northeast portion Washington County. The Potosi and Old Mines sites are discussed in separate public health assessments.

Richwoods Area

The Richwoods Area is located in the northeastern section of Washington County approximately 12 miles north of Potosi, Missouri on State Highway 21. This area includes approximately 45 square miles and has approximately 3,581 people living within a 4-mile radius of the Richwoods Area. The Richwoods Area is primarily rural with a few businesses. There is no public water supply in the area; therefore, residents use private ground water wells for their water supply. (5, 6)

The first mining in the Richwoods Area was done on a small scale by manual labor with a pick and shovel. Transportation of materials would have been difficult, creating the need for smelters to be located relatively close to the mines. As time passed, techniques and technologies advanced allowing mining to occur on a much larger scale. In the 20th century, technology had advanced to allow large-scale strip mining. Washer plants would separate barite from waste gravel. This process required large amounts of water and created waste mud and sand often called tailings. These waste materials would typically have significantly elevated levels of lead and barium. (6)

Tailings ponds were created to manage these mining wastes and water. Six of the larger tailings ponds in the Richwoods Area range in size from 28 acres to 171.6 acres. These

tailings ponds vary greatly in their appearance. Some are covered with trees and water, while others are dry and barren. Others are a combination of these with swampy, intermittent water with areas of exposed tailing containing sparse grasses and trees. (6)

These tailings ponds are the largest man-made sources of lead and barium contamination in the Richwoods Area. In addition, other mining activities may also be sources. In some instances, individuals may have built their homes on these sources or removed materials from sources to use as fill materials around their homes, driveways, playgrounds, etc. In other instances, contaminated materials from these sources may have migrated and contaminated groundwater, surface water, and soil.

Site investigation

The data used for this public health assessment was gathered from the Hazardous Ranking System (HRS) Documentation Record for Washington County Lead District - Richwoods dated September 2007 and conference calls with EPA. (6) This data only contains information on lead and barium.

As of May 2008, EPA had tested 346 private wells in the Richwoods 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 in more than 10% of the homes they supply. 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 59 wells out of the 346 tested contained lead above 15 µg/L (see Table 1). One well was found to have a barium concentration of 3.41 parts per million (ppm), which is above the EPA's Maximum Contaminant Level (MCL) for barium of 2 ppm. MCLs are the highest concentrations of a contaminant that EPA will allow in a public drinking water supply.

Table 1. Water Sampling Results

Total Number of Private Wells Sampled	346
Number of Wells Above 15 µg/L (EPA's Action Levels for Lead)	59

µg/L = micrograms per liter

EPA also tested the soil in 346 yards in the Richwoods Area. Soil sample results were compared to EPA's standard cleanup value of 400 ppm and time-critical 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. Results of the soil testing found 13 residential yards and 1 schoolyard with concentrations of lead above 1,200 ppm and 52 residential yards with concentrations of lead between 400 ppm and 1,200 ppm (see Table 2).

Table 2. Soil Sampling Results

Total Number of Yards Sampled	346
Yards with Lead Below 400 ppm	278
Yards with Lead Between and Including 400-1,199 ppm	52
Yards with Lead Above 1,200 ppm	14

ppm = parts per million

Soil from six tailings ponds in the Richwoods Area were tested for arsenic, barium, cadmium, and lead. Lead and barium where found to be of most concern with the highest level of lead found being 4,610 ppm and the highest level of barium found being 10,300 ppm. The highest level of lead detected is well above EPA's Time-Critical Removal Action level of 1,200 ppm. The highest level of barium found is slightly above ATSDR's Reference Dose Media Evaluation Guide (RMEG) of 10,000 ppm. RMEGs are comparison values (CVs) that represent concentrations that are unlikely to result in adverse noncarcinogenic health effects for daily exposures based on EPA's oral reference doses. Concentrations above CVs do not necessarily indicate that a health threat is present, but that further evaluation of the chemical and pathway is needed.

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 (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, 10) Therefore, lead-based paint may be a significant source of lead exposure, especially for children.

So far, the evaluation of the Richwoods 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 (6). If the water bodies and fish in the Richwoods 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 Richwoods 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

The U.S. Centers for Disease Control and Prevention's (CDC's) current blood lead level of concern is 10 micrograms of lead per deciliter of blood (10 µg/dL). When a child's blood lead level is found to be above this level of concern, the child is said to have an elevated blood lead level. 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 collaborated with MDNR and EPA to encourage blood lead testing. In 2003 and 2004, 19% of the children in Washington County less than 72 months of age were tested with 7% (25 children) of these children found with elevated levels of blood lead in 2003 and 19% (16 children) of children in 2004. In 2005, the percentage of children tested was 23% (415) with 5% (20) of the children tested having elevated blood lead levels. Twenty-five percent (464) of children in Washington County were tested for blood lead in 2006 with 5.6% (26) having elevated levels of blood lead compared to 2.2% of children tested with elevated blood lead levels statewide in 2006. In 2007, the percentage of children less than 72 months of age having their blood lead levels tested was 27% (494) with the percentage of children elevated being 3% (16) compared to a state average of 1.5%.

From 2005 to 2007, approximately 19% (19 to 20 children) of children living in Richwoods zip code 63071 had their blood lead tested. See Appendix B Figure 3. While the percentage of children in zip code 63071 tested remain about the same, the percentage of children with elevated blood lead levels decreased from 15% (3 children) in 2005 to 10% (2 children) in 2006 to 5% (1 child) in 2007. Because of the small population of children living in the Richwoods zip code, we cannot determine the reason for this decrease in the percentage of elevated blood lead levels. The decrease in the number of children with elevated blood lead levels in Richwoods may be a result of these children moving out of the area or becoming greater than 72 months of age instead of an actual reduction in blood lead levels. Another explanation of this reduction may be that blood lead testing is voluntary and the same children are not necessarily tested every year.

Currently, the Washington County Health Department is providing blood lead testing for free to Washington County residents. Regional ATSDR staff, DHSS, and the Washington County Health Department have also provided free blood lead testing at several public meetings held in the area.

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 Richwoods 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).

Richwoods 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 above 1,200 ppm, and residential yards with lead concentrations greater than 400 ppm 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.

A total of 13 residential yards and 1 school property in the Richwoods Area were identified as time-critical properties and were remediated by EPA. These remediated properties have had the contaminated soil removed and replaced with clean soil. The replacement soil has lead levels below 240 ppm with all other hazardous substances, pollutants, or contaminants below EPA residential soil screening levels. The contaminated soil has been taken to a tailings pond in Washington County to help promote vegetative growth on that pond.

In addition, EPA identified 59 private drinking wells with levels of lead greater than 15 µg/L. EPA has offered all of these residents bottled water to eliminate or reduce exposure. Forty-six residents are receiving bottled water, while 13 well owners have refused to receive the bottled water.

Land Use, Natural Resources, and Geology

Bedrock in the Richwoods Area is primarily made up of a combination of dolomite, sandstone, chert, and/or limestone with the presence of many faults, fissures, springs, fens, caves, and sinkholes. Geologic activity has formed a well-developed fault and fracture system in the area. (6)

Much of the area has been heavily mined leaving behind large disturbed areas, some of which contain large tailings ponds. The remaining areas are diversified with forest, pasture, farmland and single-family housing on large-sized lots or farmsteads.

In the past, natural resources of the Richwoods Area were the lead and barium deposits that were mined and are now depleted or not economically profitable to mine. Presently natural resources consist of forestland, wildlife, and lakes left over from the past mining activities that may contain fish.

Geology of the area consists of soil dominantly tiff gravelly clay. The soil and residuum range in thickness from 0 to 20 feet in depth. Several sections of the Richwoods Area site have been disturbed because of the strip mining for lead and barium. The area is underlain by the unconfined Ozark Aquifer, which is highly fractured and ranges from less than 250 feet to 890 feet thick. Karst areas with sinkholes, solution-widened cavities, caves, springs, and losing streams are present. The Ozark aquifer is the major source of drinking water for private wells in the areas. Below the Ozark Aquifer is the St. Francois Confining Unit that is an effective barrier to prevent downward groundwater movement into 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 (6).

Physical hazards

Physical hazards in the Richwoods Area and much of Washington County consist of known and unknown digging/shaft sites that were related to the mineral industry. These hazards vary from a shallow depression of a few feet to mine shafts that originally were around 100 feet deep. Some may be over grown by vegetation and unrecognizable until they are stumbled on to.

Demographics

The Richwoods Area includes approximately 45 square miles of land in northeastern Washington County and has approximately 3,581 people living within a 4-mile radius of the Richwoods Area (6). The Richwoods Area consists of the small community of Richwoods for which no demographic information is available. The rest of the Richwoods 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 Richwoods 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 Richwoods Area.

The US Census Bureau found in the 2000 census that Washington County was made up of a population that is 95.5% white, 2.5% black, 0.7% American Indian and Alaska Native, and 0.1% Asian. 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% (7).

DISCUSSION

Pathways Analysis

This section addresses the pathways by which residents of the area may have been exposed to lead 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 - Richwoods dated September 2007 and conference calls with EPA. (6) This data only contains information 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 in the Richwoods Area are exposed to site-related contaminants, 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 – Richwoods 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 A illustrates the different exposure pathways present at the Washington County Lead District – Richwoods Area.

Complete Exposure Pathways

EPA has found elevated levels of lead in 65 residential yards and at one school. 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 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.

EPA has found 59 private drinking wells in the Richwoods Area with elevated levels of lead in the water. Individuals can be exposed to the lead in this water through ingestion while drinking and cooking with contaminated water. Individuals may accidentally ingest contaminated water while bathing and playing in this 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 by completing their Time-Critical Removal Action for residential yards and drinking water. 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 that contained lead in soil at concentrations above 1,200 ppm or lead concentrations greater than 400 ppm for those that had a child less than 72 months of age with an elevated blood lead level. A total of 13 residential yards and 1 school property in the Richwoods Area were time-critical properties and were remediated by EPA. In addition, EPA identified 59 private drinking wells with levels of lead greater than 15 µg/L. EPA has offered all of these residents bottled water to eliminate or reduce exposure and is providing bottled water to 46. The remaining residents have chosen not except EPA's alternative water source.

One private drinking water well was found to have a barium concentration above the EPA's MCL of 2 ppm. Individuals drinking from this well 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. (11) 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. (11) Although EPA did not collect data on which form of barium was found in this private well, based on site geology and an awareness of how barium reacts in the environment, it is expected that the form of barium detected in this private well 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 Washington County Health Department 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

EPA has finished the Time-Critical Removal Action for residential yards and private drinking wells; however, there are still several sources, media, and points of exposure that have not been fully investigated. In certain areas of the state, tailings from lead mining have been released into the environment and contaminated sediment, surface water, and fish.

The Missouri's 2009 Fish Advisory states "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 Richwoods 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 Richwoods 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 (CVs) that are media-specific concentrations used by health assessors to select environmental contaminants of concern. Contaminant concentrations that are less than their CVs are unlikely to pose a health threat. Contamination levels above CVs 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 not 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. (11)

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. (11) 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. (11)

Although EPA did not collect data on which form of barium was found in this private well, it is likely that the form of barium detected in this private well was barium sulfate or carbonate, which is unlikely to pose a health risk. However, much of the barium found in this well was dissolved. Because of this and the fact that it exceeded the MCL, EPA has provided this well owner with an alternative source of drinking water or water filter. This eliminates exposure to the only well found at this site to contain 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 (9). It has no characteristic taste or smell (9). 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 (9). 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 (9). Houses built before 1978 may contain lead based paint. Lead in the soils in the inner cities is often attributable to lead based paint and leaded gasoline (9).

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. (9)

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 is 10 µg/dL. (12) Using this model, EPA has established a standard cleanup value of 400 ppm for lead in soil using the default parameters in this model (10). 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 than 10 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 (13). One of which is that no clinical treatment is known to reduce blood lead levels below 10 µg/dL or reduce the risk for adverse developmental effects (13). In addition, no level of lead in the blood has been found to not be associated with some

adverse health effect (13). For these reasons, it is vital that health education be provided in the Richwoods Area along with remediation efforts to reduce exposures to lead.

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. (11)

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 (9, 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. (11)

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 (9). 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 (9). 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 (9). 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 (9).

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 Washington County Health Department 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 (17).

Conversations in early 2008 with personnel of the Washington County Health Department 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 are not 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 Richwoods 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 Richwoods 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 and one schoolyard 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 Richwoods 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 Richwoods 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 Richwoods 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 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 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 Richwoods Area that drinking this water for a year or longer is not expected to harm people's health.
Basis for Decision *Groundwater*	One private drinking water well in the Richwoods Area was 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 this residence an alternative source of water. The individuals in this residence 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 Richwoods 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 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 Richwoods 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 Richwoods Area. Some of these may have been grown over by vegetation and unrecognizable until they are stumbled on to. 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. Washington County Health Department/DHSS should continue their efforts to test the blood of children in the community and follow-up on elevated blood leads as necessary.

5. Washington 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 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. People should be cautious of purchasing property on formerly disturbed land because the property could have lead-contaminated soils.

PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for the Washington County Lead District – Richwoods 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 involved parties. The purpose of the PHAP is to ensure that this 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. Included is a commitment from DHSS and/or ATSDR to follow up on this plan to ensure that it is implemented.

1. DHSS/ATSDR will coordinate with Washington County Health Department, 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 Washington County Health Department, 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 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.

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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REFERENCES

1. Lead Mining History (webpage). United States Geological Survey. Available at: URL: http://mo.water.usgs.gov/mining/minehistory.htm.

2. Our Legacy (webpage). Available at: URL: http://stjamespotosi.org/pothist1.html.

3. Agency for Toxic Substances and Disease Registry. Big River Mine Tailings Superfund Site Lead Exposure Study. Atlanta: US Department of Health and Human Services; 1998.

4. Agency for Toxic Substances and Disease Registry. Jasper County Superfund Site Lead and Cadmium Exposure Study. Atlanta: US Department of Health and Human Services; 1995.

5. U.S. Environmental Protection Agency. NPL Site Narrative for Washington County Lead District – Richwoods. Available at: URL: http://www.epa.gov/superfund/sites/npl/nar1768.htm.

6. U.S. Environmental Protection Agency. Hazardous Ranking System (HRS) Documentation Record Washington County Lead District - Richwoods. September 2007.

7. US Census Bureau, Census 2000, Table DP-1. Profile of General Demographic Characteristics: 2000, Washington County, Missouri. 2000. Available at: URL: http://www.census.gov/.

8. Center for Disease Control and Prevention. Preventing Lead Poisoning in Young Children. Atlanta: US Department of Health and Human Services. 2005 August.

9. Agency for Toxic Substances and Disease Registry. Toxicological profile for lead, update. Atlanta: US Department of Health and Human Services. 2007 August.

10. US Environmental Protection Agency. Superfund Lead-Contaminated Residential Sites Handbook. 2003 August.

11. Agency for Toxic Substances and Disease Registry. Toxicological profile for barium, (Draft for Public Comment), update. Atlanta: US Department of Health and Human Services; 2005 September.

12. Agency for Toxic Substances and Disease Registry. DHAC Guidance for Evaluating Cleanup Levels for Lead in Soil. Atlanta: US Department of Health and Human Services.

13. U.S. Center for Disease Control and Prevention. Why not change the blood lead level of concern at this time? Available at: URL: http://www.cdc.gov/nceh/lead/faq/changeBLL.htm.

14. National Toxicology Program. Lead (CAS No. 7439-92-1) and Lead Compounds Substance Profiles. Report on Carcinogens, Eleventh Edition; 2004.

15. American Cancer Society. Cancer facts and figures, 2007. Atlanta: American Cancer Society, Inc.; 2007.

16. Emails with Dianna Whittaker, EPA Community Involvement Coordinator. 2008 April 8.

17. Missouri Department of Natural Resources. Integrated Site Inspection/Removal Assessment Report, Washington County Lead District – Potosi Area Site, Washington County, Missouri. CERCLIS ID No. MON000705023. 2006 June 16.

CERTIFICATION

This Washington County Lead District – Richwoods 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

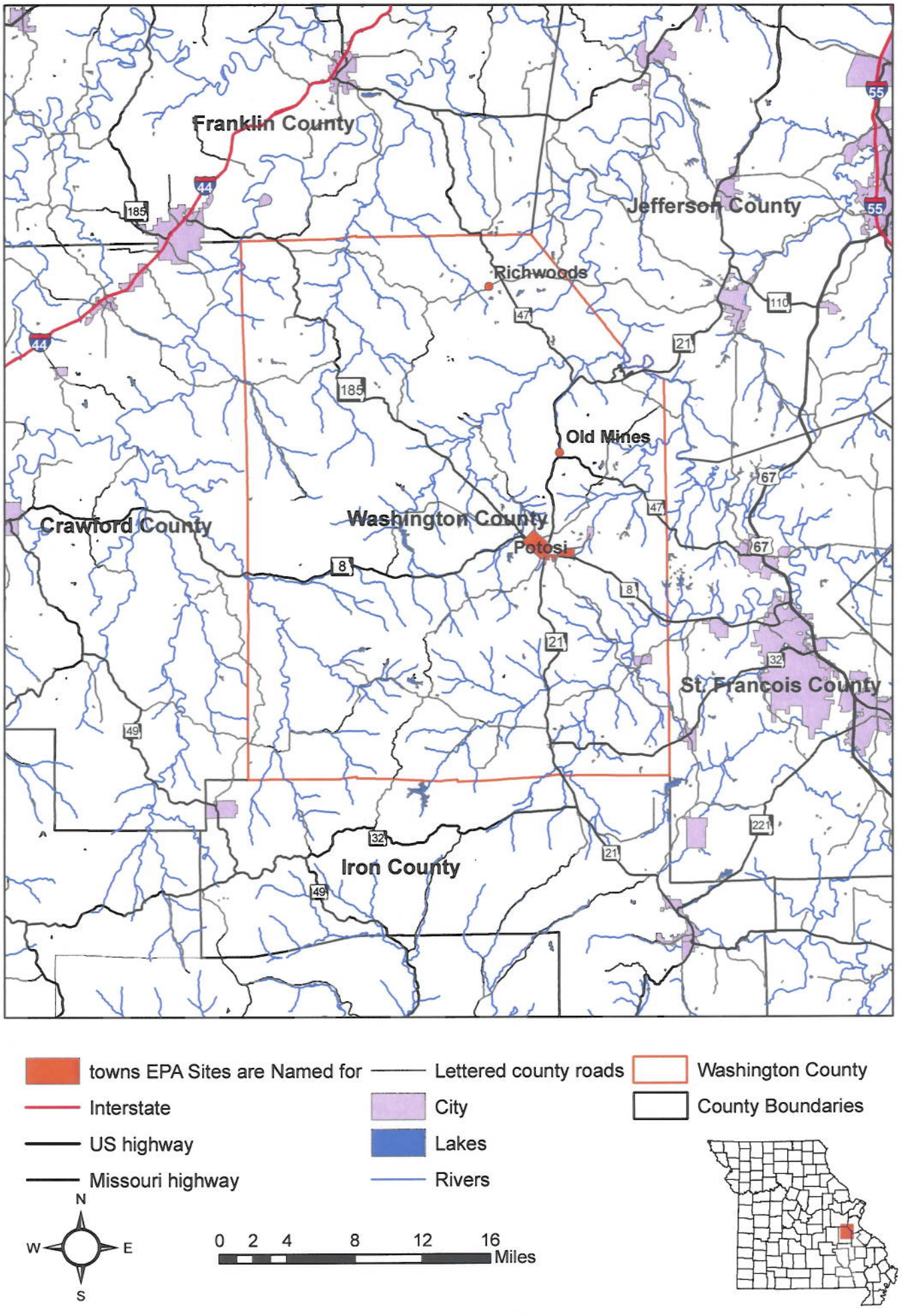
Appendix A

Table 1: Exposure Pathway Analysis, Richwoods Area

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	Contaminated Soil Carried into the Home by Shoes, Pets and Other Mediums.	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 B

Figure 1: Washington County


Franklin County
Jefferson County
Richwoods
Old Mines
Crawford County
Washington County
Potosi
St. Francois County
Iron County
towns EPA Sites are Named for
Interstate
US highway
Missouri highway
Lettered county roads
City
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Rivers
Washington County
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0 2 4 8 12 16
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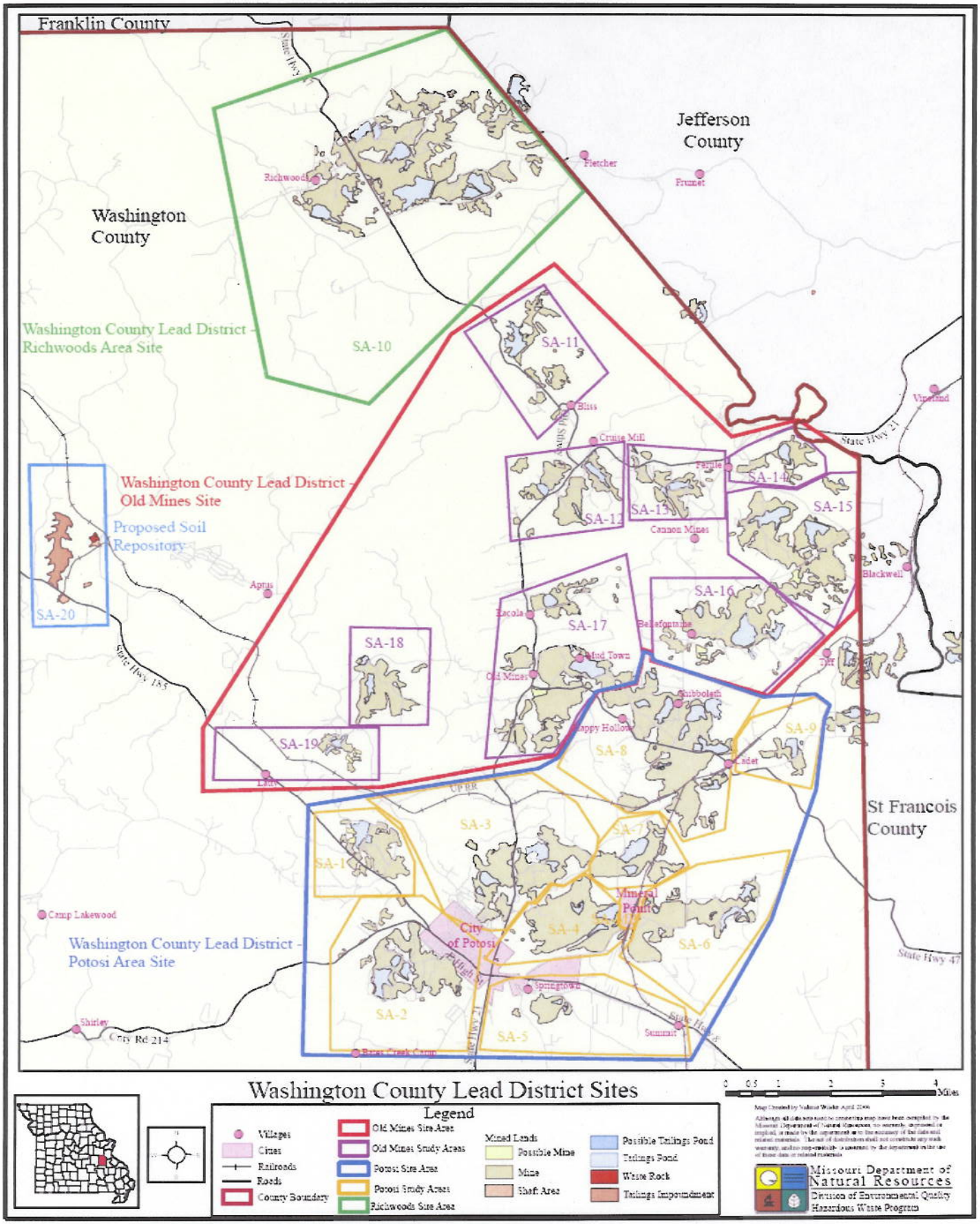
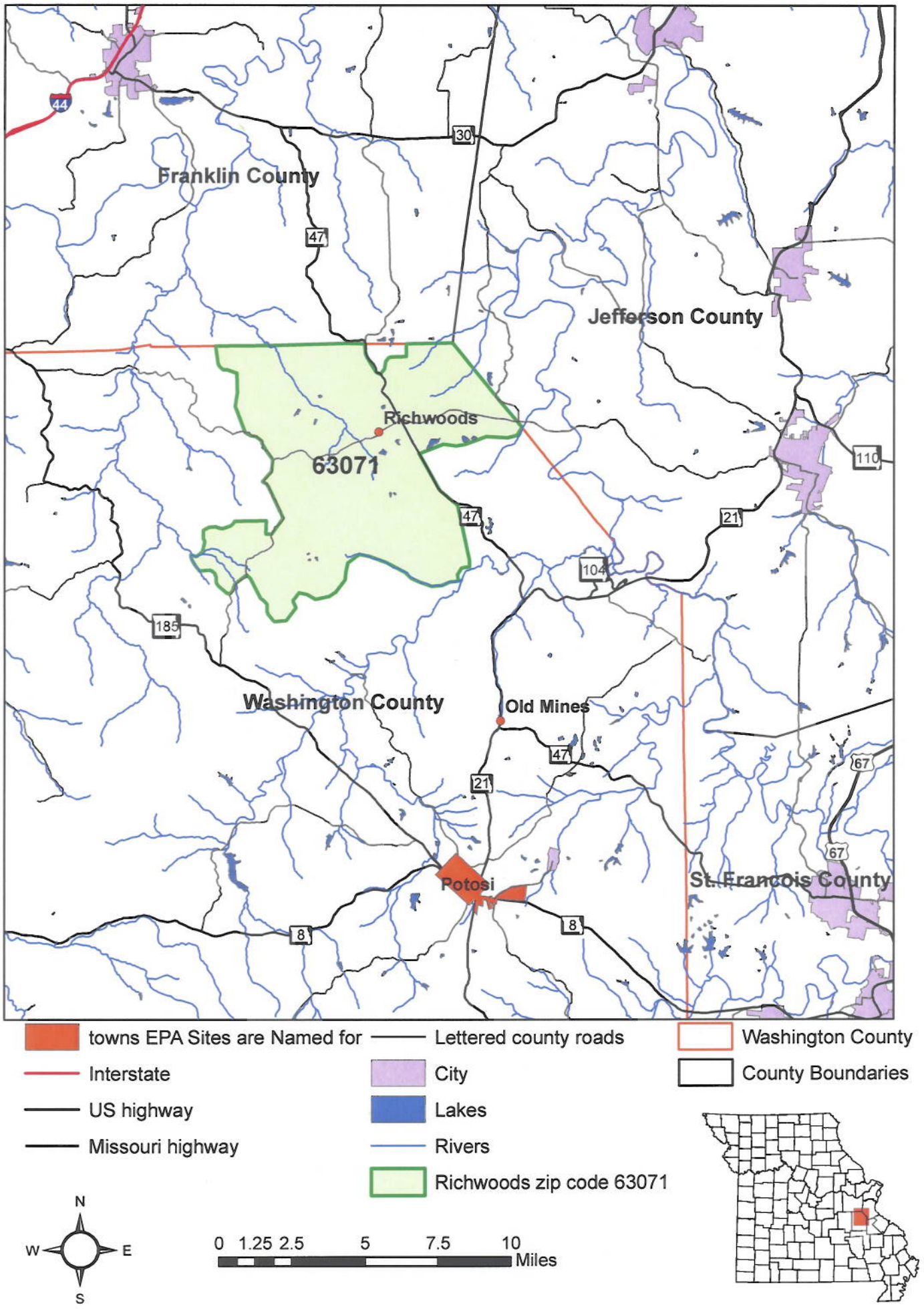
Figure 2: Designated EPA Areas in Washington County



Source: Missouri Department of Natural Resources, 2006.

Figure 3: Richwoods Zip Code Area 63071


Franklin County
Jefferson County
Richwoods
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Washington County
Old Mines
Potosi
St. Francois County
towns EPA Sites are Named for
Interstate
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Missouri highway
Lettered county roads
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Miles

Appendix C

Additional Barium Discussion

One private drinking water well was found to have a barium concentration of 3.41 parts per million (ppm). This concentration exceeds the EPA's Maximum Contaminant Levels (MCLs) of 2 ppm. MCLs are the highest concentrations of a contaminant 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. (11)

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. (11) 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. (11)

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

This calculated MRL can then be compared to the concentration of barium found in the private drinking water well of 3.41 ppm. This can be done by first documenting that ppm can also be expressed as 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.

Adult

$$\frac{3.41 \text{ mg/L} \times 2 \text{ L/day}}{70 \text{ kg}} = 0.097 \text{ mg/kg/day}$$

Child

$$\frac{3.41 \text{ mg/L} \times 1 \text{ L/day}}{10 \text{ kg}} = 0.34 \text{ mg/kg/day}$$

The calculated dose for children is higher than the MRL. This would indicate there is a potential health risk associated with drinking this private well water 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. (11)

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. (11) 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 this private drinking water well 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 this well was dissolved. Because of this and the fact that the level exceeded the MCL, EPA has provided this well owner with an alternative source of drinking water or water filter, in order to eliminate exposure.