ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

Jacobsville Neighborhood Soil Contamination Site:
OU1 and OU2
Evansville, Vanderburgh County, Indiana

CERCLIS NO: INN000508142

SEPTEMBER 30, 2015

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

Comment Period Ends:

OCTOBER 30, 2015

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

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

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

Please address comments regarding this report to:

Agency for Toxic Substances and Disease Registry
Attn: Records Center
1600 Clifton Road, N.E., MS F-09
Atlanta, Georgia 30333

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1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

PUBLIC HEALTH ASSESSMENT

Jacobsville Neighborhood Soil Contamination Site:
OU1 and OU2

Evansville, Vanderburgh County, Indiana

CERCLIS NO: INN000508142

Prepared by:

Western Branch
Division of Community Health Investigations
Agency for Toxic Substances and Disease Registry

Foreword

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, the U.S. EPA, and the individual states regulate the investigation and cleanup of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements. The public health assessment process allows ATSDR scientists and public health assessment cooperative agreement partner's flexibility in document format when presenting findings about the public health impact of hazardous waste sites. The flexible format allows health assessors to convey to affected populations important public health messages in a clear and expeditious way.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high-risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries, to evaluate possible the health effects that may result from exposures. The science of environmental health is still developing, and at times scientific information on the health effects of certain substances is not available.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the

evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals, and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the public comments that related to the document are addressed in the final version of the report.

Conclusions: The report presents conclusions about the public health threat posed by a site. Ways to stop or reduce exposure will then be recommended in the public health action plan. ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA or other responsible parties. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also recommend health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Manager
ATSDR Record Center
Agency for Toxic Substances and Disease Registry
1600 Clifton Road, Mailstop E-60
Atlanta, GA 30333

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List of Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
BLL	blood lead level
CDC	Centers for Disease Control and Prevention
CV	comparison value
DHHS	Department of Health and Human Services
EPA	U.S. Environmental Protection Agency
IARC	International Agency for Research on Cancer
IDEM	Indiana Department of Environmental Management
kg	kilogram
LOAEL	lowest-observed-adverse-effect-level
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
MRL	minimal risk level
NOAEL	no-observed-adverse-effect-level
NPL	National Priorities List
PHA	public health assessment
ppm	parts per million
RfD	reference dose
ROD	record of decision
µg/dL	micrograms per deciliter
XRF	X-ray fluorescence spectrometer

Summary

Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) is required by Congress to conduct a public health assessment (PHA) at each of the sites on the Environmental Protection Agency's National Priorities List (NPL). In July 2004, the Jacobsville Neighborhood Soil Contamination (JNSC) site was placed on the Environmental Protection Agency's (EPA's) NPL. This document is being conducted as part of ATSDR's requirement to complete a PHA for this NPL site. This document is ATSDR's public comment version of the PHA for this site.

The JNSC site is located in Evansville, Vanderburgh County, Indiana and encompasses approximately 4.5 square miles containing residential properties. EPA determined that residential soils in the JNSC site were contaminated with lead and arsenic due, in part, to air emissions from former foundries and other factories that operated in the area as early as the late 1800s. Other potential sources of lead in residential yards and public spaces (e.g., schools, daycares, playgrounds) may be from paint used for homes and buildings built before 1978, the year lead-based paint was banned from production and lead from leaded gasoline. Although levels of lead in gasoline steadily decreased since 1970s, the United States did not fully phase out leaded gasoline until 1996. Throughout North America and Europe, most leaded gasoline phase-out programs were completed on a policy level within roughly 10-15 years. Another possible source of lead exposure in this community is from lead in drinking water. Historically, city ordinances required the use of lead service lines from city water mains to homes and businesses. In addition, lead was used in household plumbing, which has been phased out in newer home construction but in older homes remains a potential source of lead in drinking water.

EPA's cleanup levels for lead and arsenic in residential soils at the JNSC site are 400 parts per million (ppm) and 30 ppm, respectively. ATSDR evaluated environmental soil data collected by EPA from the site and determined that the lead and arsenic contamination may present a health threat. Limited sediment, surface water and groundwater sampling were conducted at the site. The data results for these media were below levels of health concern.

The Vanderburgh County Health Department (VCHD) is working with the community to help identify and reduce lead exposure. The VCHD has been hosting community health fairs and meetings, and they continue to offer free blood lead screenings to children in this community.

The VCHD and the Indiana State Department of Health have also been working with ATSDR and CDC (Centers for Disease Control and Prevention) to help with the evaluation of blood lead data collected. The results of the evaluation of blood lead data collected in this community point to data gaps including but not limited to the declining number of children in the JNSC community participating in the VCHD blood lead screening program.

While local medical providers have recommended patients participate in VCHD's free blood lead screening program, further efforts are needed to increase participation.

Some of the data gaps or limitations to children's blood lead level (BLL) evaluations include the following:

- Lack of blood lead sampling for children living at many residential properties,
- No information available for the large transient (2–15 weeks) population of residents living at one or more properties for short periods of time,
- For those properties that were not sampled we have no data to correlate with children tested who live at these properties, and
- For those properties sampled there were no children's blood lead levels to correlate with the lead levels detected at the residential properties.

Conclusions

ATSDR evaluated soil data and information for the JNSC site and has determined the site posed a public health threat in the past due to lead and arsenic levels detected in surface soils. The site continues to pose a public health threat in the future for those residential properties that have not yet been remediated. Also, those properties that have denied EPA access pose an indeterminate health hazard. Potential additional sources of lead may be present in older homes (built prior to 1978) from lead based paint and or from lead water lines or lead solder used in water lines of older homes.

Basis for Conclusions

ATSDR evaluated soil data available for the JNSC site. About 40% of the properties sampled by EPA showed lead levels greater than levels of health concern. The exposure route for lead and arsenic contaminated surface soils is from incidental ingestion (eating) of contaminated soil and dust. This exposure route could result in an increase of lead and arsenic in the body.

Next Steps

EPA continues to remove contaminated soil in the JNSC site to reduce the lead and arsenic contamination in the top 18 inches of soil.

Residents, especially children, should participate in yearly blood lead screening and educational programs offered for free by the Vanderburgh County Health Department or that are provided by hospitals or personal health care professionals.

Residents (especially children) entering their homes after working or playing in the yard should follow these steps to help reduce lead exposure:

- Take shoes off before entering the home,
- Use a damp cloth or damp/wet mop to remove dust and dirt from the home,
- Wash hands, wash toys, and wash pets,
- Homeowners with older homes should follow EPA's Lead Renovation, Repair, and Painting Rule (RRP Rule) to lower the risk of lead contamination from home renovation activities. The rule requires that only EPA-certified firms can perform renovation, repair, and painting projects that disturb lead-based paint in homes, child care facilities and pre-schools built before 1978, and that these firms can

only use EPA-trained and certified renovators who know how to follow lead-safe work practices, and

- Residents living in older homes that may still have lead water lines (inside pipes or outside service lines) or lead solder, should have their water tested for lead.

For Further Information

If you have concerns about the JNSC Site, you should contact EPA at 800-621-8431, ext. 31325 and leave a message. This line is operational 24-hours a day.

Background

Purpose and Health Issues

Since 1986, the Agency for Toxic Substances and Disease Registry (ATSDR) has been required by Congress to conduct a public health assessment (PHA) at each of the sites on the Environmental Protection Agency's National Priorities List (NPL). In July 2004, the Jacobsville Neighborhood Soil Contamination (JNSC) site was placed on EPA's NPL. ATSDR's goal for this PHA is to reduce blood lead levels (BLLs) in children and other residents near the Evansville, Indiana, JNSC site. Recommendations included in this PHA seek to help individuals, families, and agencies reduce or stop altogether lead and arsenic exposures at the JNSC site. By publishing this *public comment draft PHA,* we invite your thoughts on the accuracy of the information presented in the assessment, and we seek to ensure that our recommendations address community concerns and help reduce current and future exposures. ATSDR also hopes to increase community participation in the blood lead screening and community health educational programs offered by the Vanderburgh County Health Department (VCHD).

Site Description

The JNSC site (Appendix A: Figures 1 & 2) is in a mixed residential, industrial, and commercial area in Evansville, Vanderburgh County, Indiana, where environmental justice issues and health disparities are a concern [EPA 2011; EPA 2012a; EPA 2012b; EPA 2012c]. Health disparities result from multiple factors, including poverty, environmental threats, inadequate access to health care, individual and behavioral factors, and educational inequalities [HHS 2000; Liao 1999; Jemal 2001, 2008; Breese 2007].

The Indiana Department of Environmental Management (IDEM) and EPA named the site the JNSC site because the contamination (lead and arsenic) was initially found in the Jacobsville Neighborhood.[1] After further sampling, however, IDEM and EPA found that soil contamination extended beyond the initial boundaries to other Evansville properties that are now included within the JNSC NPL site [EPA 2008b; EPA 2009].

The JNSC site (3,095^{+} acres) is divided into *two cleanup areas*, or *operable units (OU)*, and encompasses a larger area than Evansville's Jacobsville Neighborhood (Appendix A: Figures 1 & 2). The first operable unit (OU1) is roughly bounded by the Lloyd Expressway to the south, Mary Street to the west, Iowa Street to the north, Elliot Street to the east, and encompasses 141 acres. The second operable unit (OU2) covers approximately 2,954 acres (Appendix A: Figure 1).

EPA identified that residential soils in the JNSC site neighborhoods became contaminated by lead and arsenic due to air emissions from former foundries and other factories in the area [EPA

[1] In Vanderburgh County, lead and arsenic have been used for residential, commercial, and industrial purposes dating back to the 1880s.

2008b; 2009]. Residential soils are being remediated to EPA's cleanup levels of 400 ppm for lead and 30 ppm for arsenic.

EPA undertook a *Superfund Emergency Removal Action* from September 2007 through April 2008. During this action, EPA in consultation with IDEM and with the support of the City of Evansville and the VCHD cleaned and restored 83 residential properties with lead levels in soil above 1,200 ppm (Appendix B: Table 1). Contractors completed cleanup of 263 residential yards in OU1 in 2010 [EPA 2011]. In 2009, soil sampling and design work for the cleanup began. Contractors completed cleanup of 263 residential yards in OU1 in 2010. An additional 20 properties in OU1 underwent cleanup in 2011. As of May 2014, more than 1300 properties have been remediated. Another 600 properties will be sampled and remediated in 2014 and 2015. As of the date of this PHA, EPA continues the cleanup work at OU2.

Demographics

In 2000, the population of the city of Evansville, Indiana was estimated at 121,582, with a metropolitan population of 342,815 (U.S. Census 2000). That Evansville population estimate represents a 3.7 percent decline from the 1990 estimated population of 126,272. The median age of residents was 36. The 2000 census reported 7,835 children ages 0 to 4, and 7,735 children ages 5–9 for all of Evansville including 10,921 children age 6 and under. Using the 2000 census, 5,365 children 6 years and younger were within 1 mile of OU1 and OU2, 2,355 within OU1 and OU2, and 1,771 within 1 mile of OU1.

Evansville has 56,877 homes of which 82 percent were built before 1979. Children under the age of 18 live in 24 percent of the homes, and 15 percent have someone living alone who is 65 years of age or older. For older adults, 7,078 were 75 to 84 years of age, and 2,782 were 85 or older. Homes were 60 percent owner occupied and 40 percent were rented. The median income for a household in Evansville was $34,160; the median income for a family was $41,091. Thirteen percent of families were below the poverty line. The population of Evansville as identified by the 2000 census was 86 percent white and 11 percent African American (black). Appendix A: Figure 3 shows demographics within the JNSC Site boundaries. The age of homes and median income of residents are shown inside and outside the operable units.

Sampling Investigations

Soil Sampling

EPA found that residential soils at the JNSC site were contaminated with lead and arsenic due in part to emissions from former foundries and other factories in the area (Appendix B: Table 1) [EPA 2011, 2009, 2008, 2006; CH2M HILL 2007]. Other sources of lead in residential yards and public spaces (schools yards, daycares, playgrounds, etc.) might include paint chips and dust from buildings and homes built before 1978 (the year lead-based paint was banned), leaded gasoline, and lead water pipes used in water lines and other commercial industrial and residential sources [EPA 2012a]. As stated earlier, the JNSC site is divided into OU1 and OU2. The OU1

parcel of land is within OU2 (Appendix A: Figures 1 & 2). The OU1 area is where the former factories and foundries operated, some as far back as the 1880s. These former factories and foundries are considered industrial contamination sources.

EPA conducted soil sampling and evaluations throughout the JNSC site to estimate the zones with lead contamination above 400 ppm—EPA's site-specific cleanup level. EPA collected XRF (x-ray fluorescence spectrometry) data for about 730 soil samples reported in the 2009 Record of Decision [EPA 2006, 2008b, 2009, 2011; CH2M HILL 2007]. EPA also provided the 2004 and 2006 lead soil results to ATSDR to help evaluate the 1998 to 2006 blood lead level sampling. EPA uses a combination of XRF and laboratory confirmations to adjust XRF results reported in the Records of Decision [EPA 2006, 2009].

The OU1 residential soils averaged 373.5 ppm lead and ranged from 20 to 8,210 ppm lead. The OU1 arsenic levels in soils ranged from non-detect to 92 ppm arsenic and averaged 15.2 ppm. The OU2 residential soils averaged 403.4 ppm lead and ranged from non-detect to 7,900 ppm lead. Arsenic levels in OU2 soils ranged from non-detect to 68.2 ppm arsenic and averaged 23.3 ppm. EPA reports that arsenic—if present above 30 ppm local background levels—is associated with lead contamination approximately 10 % of the time [EPA 2008b, 2009].

Surface Water and Sediment Sampling

Researchers collected sediment and surface water samples from 10 co-located sample locations along tributaries and streams (Pigeon Creek). All samples were within EPA's water standard criteria [EPA 2009]. Pigeon Creek is on the western boundary of the JSNC site and drains nearly 240,000 acres of southwestern Indiana into the Ohio River. Pigeon Creek has a state fish consumption advisory in place for polychlorinated biphenyls (PCBs) and mercury. The watershed has nonpoint-source pollution from agricultural, mining, and other land uses upstream of the JNSC site. Insufficient data, however, are available to determine lead and arsenic levels in Pigeon Creek or its banks.

Researchers collected surface water samples using a peristaltic pump and plastic tubing. Surface water samples were submitted for analysis of total (unfiltered) and dissolved (filtered) inorganics. Sediment samples were collected from 0 to 6 inches below ground using either a gravity corer or a stainless steel bowl and trowel, depending on the proximity to shore. The samples were submitted to an offsite laboratory where they were analyzed for arsenic, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, silver, sodium, vanadium, and zinc [EPA 2006]. In sediments or surface water sampled, lead, arsenic, or any of the metals tested were not at levels of health concern.

Groundwater Sampling

Researchers collected groundwater samples to determine whether arsenic, iron, and lead in groundwater were of concern. The Indiana Department of Natural Resources (Indiana DNR)

conducted a well survey to identify registered drinking wells located within the site. Groundwater samples were collected from two existing wells: one that supplied water to a private residence and one that supplied water to a business during emergencies, such as a water main break. Groundwater samples were submitted to an offsite laboratory for analysis of arsenic, lead, and iron. Four samples were analyzed for arsenic, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, silver, sodium, vanadium, and zinc. The levels of lead, arsenic and other metals detected in the groundwater samples were not above health based comparison values [EPA 2006]. The Indiana DNR Water Well Record Database is available online at http://www.in.gov/dnr/water/4875.htm.

Drinking Water Sampling

The Evansville Water Department (EWD) is a public utility owned and operated by the City of Evansville. To comply with state and federal regulations, the EWD issues an annual report to customers describing the quality of their drinking water. Currently, the EWD monitors for nearly 100 contaminants, including bacteria, metals, and pesticides. Lead is included in the metals tested. The 2012 Annual Drinking Water Quality Report is the latest report available and it indicated that lead levels (2.0 parts per billion (ppb)) were below EPA's action level of 15 ppb. In 2012, 54 samples were collected throughout the city [http://evansvillegov.org/modules/showdocument.aspx?documentid=13340].

Although the EWD is responsible for providing safe drinking water in Evansville, it cannot control the variety of materials used in plumbing components. If your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to two minutes before using water for drinking or cooking.

The EWD is responsible for monitoring, maintaining and repairing water mains throughout its service area. Property owners are responsible for the upkeep and repair of service lines and meter pits on their property, as defined in the Water Rules and Regulations Policy, approved by the Utility's board on April 15, 2008. This includes the point where a customer's service line connects to the Utility's water main, service lines entering buildings on the property, and the meter pit and cover (Water Handbook: http://evansvillegov.org/index.aspx?=2405).If you are concerned about lead in your water, you may want to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the *EPA Safe Drinking Water Hotline at 1-800-426-4791or at http://www.epa.gov/safewater/lead*.

Air Sampling

ATSDR obtained air quality information for Vanderburgh County from EPA web sites and from the VCHD. The Clean Air Act requires EPA to set National Ambient Air Quality Standards for six common air pollutants commonly found across the United States. These air pollutants are ground-level ozone, particulate pollution (often referred to as particle matter), carbon monoxide, sulfur dioxide, nitrogen oxides, and lead. VCHD samples air for criteria pollutants in the

Evansville area. The air samples are collected from building rooftops in downtown Evansville. Evansville regional air lead levels have been below EPA's National Ambient Air Quality Standards [http://www.epa.gov/air/criteria.html]. Although routine air sampling by VCHD does not include samples from the neighborhoods, during cleanup work EPA test air quality for particulates and lead.

Nature and Extent of Known Contamination

Researchers found soil containing lead above EPA's screening level of 400 ppm and arsenic above EPA's screening level of 30 ppm in the residential yards [EPA 2009]. EPA and IDEM continue to remove contaminated soil in the neighborhoods to reduce lead and arsenic contamination in the top 18 inches of soil. Although ATSDR supports this activity, we are concerned that lead-based paint in and on the homes (built before 1978) still represents a significant lead exposure source. Furthermore, because lead-based paint continues to chalk and flake, it's continuously being released and might re-contaminate outside soils. The highest concentrations of lead were detected along home's drip lines (where water runs off the roof of houses). The average level detected along a drip line was 2,789 ppm, while the average lead level detected in yards of the same depth was 604 ppm—a difference of nearly five times. Airborne lead deposited on the roofs and lead-based paint and other lead in houses would increase soil lead levels near drip lines.

Additional data from EPA will be included in the final version of this public health assessment. The OU1 residential soils averaged 373.5 ppm lead and ranged from 20 ppm to 8,210 ppm lead. The OU1 arsenic levels in soils ranged from nondetect to 92 ppm arsenic and averaged 15.2 ppm. The OU2 residential soils averaged 403.4 ppm lead and ranged from nondetect to 7,900 ppm lead. Arsenic levels in OU2 soils ranged from nondetect to 68.2 ppm arsenic and averaged 23.3 ppm. EPA reports that arsenic—if present above 30-ppm local background levels—is associated with lead contamination approximately 10 percent of the time [EPA 2008b, 2009].

Blood Lead Levels – GIS Evaluation

Blood Lead Data for Children

ATSDR worked with the Centers for Disease Control and Prevention (CDC), Indiana State and Vanderburgh County Health Department to obtain blood lead data for children ages 6 and younger for the period 1998 to 2006. The ISHD requires healthcare providers and county health departments to report blood lead sampling data. The combined data are placed in a state database and provided to the CDC in Atlanta.

ATSDR and CDC evaluated 20,051 blood tests collected from 1998 to 2006. The State of Indiana's Blood Lead Poisoning Prevention Program received 18,218 blood samples from health care professionals. To map the geographic distribution of the children tested, children's' home

addresses were geo-coded. To obtain the year the housing was built, the geo-coded addresses were cross-referenced with tax parcel information from theVanderburgh County Assessor's office. Using ArcGIS software, we overlaid the blood lead testing locations with several other geographic layers including streets, rivers, and census block groups. In addition, we incorporated data from historical maps of Evansville that showing manufacturers that likely used lead in their processes.

We used Sat Scan software to find the strongest cluster of higher-than-usual blood lead levels. On average, the housing in the area delineated by Sat Scan was much older than that in other parts of Evansville. This is important because older housing is likely to contain lead-based paint. Fewer than 7 percent of the children tested in the cluster area lived in homes built after 1978, compared with about 15 percent for the children tested outside the cluster area. We also found that block groups within the cluster area had a lower median income (~$26,060) compared with the other parts of Evansville (~$43,605) (US Census 2000).

The statistical and GIS evaluation of the blood lead data identified 9,498 children age 6 or younger with 10,094 blood lead tests over the 8-year period (some of the children were tested twice).

While local medical providers have recommended patients participate in blood lead screening, further efforts are needed to increase participation.

Lead Concerns in Evansville and the United States

Today in at least 4 million households in the United States, children are exposed to lead. Approximately half a million U.S. children 1–5 years of age have BLLs above 5 µg/dL, the reference level at which CDC recommends initiation of public health actions. There is no safe level of lead in blood. Lead exposure can affect nearly every system in the body. Because lead exposure often occurs with no obvious symptoms, it frequently goes unrecognized. CDC's Healthy Homes and Lead Poisoning Prevention Program is committed to the Healthy People 2020 goals of eliminating BLLs ≥ 10 µg/dL and eliminating differences in average risk based on race and social class. The program is part of the National Center for Environmental Health's Division of Emergency and Environmental Health Services [CDC 2012].

Toxicology and Epidemiology

Lead

Lead is highly toxic to people, pets and other animals. It has no known beneficial effects in the body. Any level of lead exposure is currently considered harmful to people. Very low levels of lead that enter the body are believed to have significant health effects, especially to children and

fetuses [ATSDR 2005]. The higher the amount of lead that enters the blood stream, the more severe the effects Evansville median BLLs are declining, but between 2004 and 2006, BLLs remained two times higher than national levels. And as mentioned, currently the percentage is declining of children participating in VCHD's blood lead screening program.

Lead is a naturally occurring, bluish-gray metal found in the earth's crust at the rate of about 15–20 ppm. Industrial use of lead is mostly for lead batteries used in the automobile industry. Other uses of lead include the production of lead alloys, soldering materials, shielding for x-ray machines, and manufacturing corrosion and acid-resistant materials used in the building industry. Today, lead is present in all parts of our environment [ATSDR 2007b].

Lead as a gasoline additive gradually phased out. Its use in paints was banned in 1978. But because lead does not degrade in the environment, human exposure to lead continues. Leaded paint is still prevalent in many older homes in the United States, and peeling or flaking paint contributes to indoor and outdoor dust levels.

Lead can affect almost every organ and system in the body, although the main target for lead toxicity is the nervous system. Exposure to high amounts of lead resulting in blood lead levels (BLLs) of 100–120 µg/dL in adults or 70–100 µg/dL in children can induce encephalopathy, a general term that describes various diseases that affect brain function. Symptoms develop following prolonged exposure. Symptoms can include dullness, irritability, poor attention span, epigastric pain, constipation, vomiting, convulsions, coma, and death [Chisolm 1962, Chisolm 1965, Chisolm and Harrison 1956, Kehoe 1961, Kumar et al. 1987].

Children are more vulnerable to lead poisoning than are adults. A child who swallows large amounts of lead might develop anemia, severe stomach-ache, muscle weakness, and brain damage. Unborn children can be exposed to lead through their mothers. Harmful health effects might include premature births, smaller babies, decreased mental ability, learning difficulties, and reduced growth in young children [ATSDR 2007b]. In general, the level of lead in a person's blood gives a good indication of exposure to lead and correlates well with adverse health effects.

In January 2012, CDC's Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) recommended that CDC adopt the 97.5 percentile for children 1 to 5 years of age as the reference value for designating elevated BLLs in children. The 97.5 percentile currently is 5 µg/dL http://www.cdc.gov/nceh/lead/ACCLPP/Final_Document_011212.pdf. This new value means more children will be identified as having lead exposures earlier and parents, doctors, public health officials, and communities can take action earlier [CDC 2012].

Because some of lead's more sensitive health effects have no clear threshold, no guidelines for a safe dose of lead intake have been established. EPA has no RfD and ATSDR has no MRL to serve as a safe oral dose below which adverse health effects are unlikely to occur.

Arsenic

Arsenic, a naturally occurring element, is widely distributed in the earth's crust, which contains about 3.4 ppm arsenic [Wedepohl 1991]. Most arsenic compounds have no smell or distinctive taste. Although elemental arsenic sometimes occurs naturally, arsenic usually appears in the environment in two forms—inorganic (i.e., arsenic combined with oxygen, chlorine, and sulfur) and organic (i.e., arsenic combined with carbon and hydrogen).

Arsenic is released to the environment through natural sources such as wind-blown soil and volcanic eruptions. But anthropogenic (i.e., human-made) arsenic sources release much higher amounts of arsenic than do natural sources. These anthropogenic sources include nonferrous metal mining and smelting, pesticide application, coal combustion, wood combustion, and waste incineration. The use of arsenic in treated lumber has been phased out through manufacturers voluntarily no longer using arsenic. In the past, arsenic was widely used as a pesticide; in fact, some pesticides still use organic arsenic compounds.

People might be exposed through incidentally ingesting arsenic in soil. Arsenic concentrations for uncontaminated soils generally range from 1–40 ppm, with a mean of 5 ppm [ATSDR 2007a]. Arsenic concentrations in soils from various countries range from 0.1 to 50 ppm and can vary widely among geographic regions. The U.S. Geological Survey (USGS) reports a mean of 7.2 ppm and a range of less than 0.1–97 ppm in the United States [Shacklette and Boerngen 1984]. Higher arsenic levels might occur near arsenic-rich geological deposits, some mining and smelting sites, or agricultural areas where arsenic pesticides were applied in the past. For example, arsenic concentrations up to 27,000 ppm have been reported in soils contaminated with smelter or mine wastes [EPA 1982].

Dermal exposure to arsenic is usually not of concern because only a small amount will pass through skin and into the body (4.5% of inorganic arsenic in soil) [Wester et al. 1993]. The metabolism of inorganic arsenic has been extensively studied in humans and animals. Several studies in humans indicate that arsenic is well absorbed across the gastrointestinal tract (approximately 95% absorption for inorganic arsenic compounds and 75–85% for organic arsenic compounds) [Bettley and O'Shea 1975, Buchet et al. 1981, Marafante et al. 1987, Zheng et al. 2002]. Once in the body, the liver changes (i.e., through methylation) some of the inorganic arsenic to less harmful organic forms that are more readily excreted in urine. Most forms of organic arsenic appear to undergo little metabolism. Both inorganic and organic forms of arsenic leave the body in urine. Some estimates suggest that more than 75% of the absorbed arsenic dose is excreted in urine [Marcus and Rispin 1988]. Studies have shown that 45–85% of arsenic is eliminated within 1 to 3 days [Apostoli et al. 1999, Buchet et al. 1981, Crecelius 1977, Tam et al. 1979]. An upper-dose limit, however, might interfere with this mechanism working successfully to reduce arsenic toxicity [ATSDR 2007a].

As noted above, water-soluble forms of inorganic arsenic are well absorbed. But ingesting less-soluble forms of arsenic can result in reduced arsenic absorption. Studies in laboratory animals show that arsenic in soil is only $^1/_2$ to $^1/_{10}$ as bioavailable as soluble arsenic forms [Casteel et al. 1997; Freeman et al. 1993; Freeman et al. 1995; Groen et al. 1994; Rodriguez et al. 1999]. In one study, approximately 80% of the arsenic from ingested soil was eliminated in the feces compared with 50% of the soluble oral dose [Freeman et al. 1993]. Low solubility and inaccessibility might reduce the bioavailability of arsenic in soil [Davis et al. 1992]. Most of the bioavailable arsenic in water and soil is expected to be present as inorganic arsenic (trivalent arsenic and pentavalent arsenic, specifically) [Health Canada 1993].

ATSDR's arsenic acute oral minimal risk level[2] (MRL) (0.005 milligrams per kilogram per day (mg/kg/day)) is based on a study in which 220 persons in Japan were exposed to arsenic-contaminated soy sauce for a 2–3 week period. The dose was estimated at 0.05 mg/kg/day. This is considered the LOAEL (lowest observed adverse effect level). Facial edema and gastrointestinal symptoms (nausea, vomiting, and diarrhea) were considered the critical effects seen at this dose [Mizuta et al. 1956]. The MRL is further supported by the case of a man and woman in upstate New York who experienced gastrointestinal symptoms after drinking arsenic-tainted water at an estimated dose of 0.05 mg/kg/day [Franzblau and Lilis 1989].

ATSDR's chronic oral MRL (0.0003 mg/kg/day) is based on a study in which a large number of farmers (both male and female) were exposed to high levels of arsenic in well water in Taiwan. EPA's oral reference dose (RfD) is an estimate with uncertainty spanning approximately an order of magnitude of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancerous effects during a lifetime. The RfD is also 0.0003 mg/kg/day [EPA 2008a]. A clear dose-response relationship was observed for characteristic skin lesions. A control group consisting of 17,000 persons was exposed to 0.0008 mg/kg/day and did not experience adverse health effects. This is considered the NOAEL (no observed adverse effect level). Hyperpigmentation and keratosis of the skin were reported in farmers exposed to 0.014 mg/kg/day (less serious lowest observed adverse effect level (LOAEL)). Those exposed to 0.038–0.065 mg/kg/day experienced an increased incidence of dermal lesions [Tseng et al. 1968, Tseng 1977]. The MRL is supported by a number of well-conducted epidemiological studies that identify reliable NOAELs and LOAELs for dermal effects [Borgoño and Greiber 1972; Cebrían et al. 1983; EPA 1981; Guha Mazumder et al. 1988; Haque et al. 2003; Harrington et al. 1978; Valentine et al. 1985; Zaldívar 1974]. Collectively, these studies indicate that the threshold dose for dermal effects (e.g., hyperpigmentation and hyperkeratosis) is approximately 0.002 mg/kg/day.

The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and EPA have all determined that inorganic arsenic is carcinogenic to

[2] The acute oral MRL is considered provisional because it is based on a serious LOAEL; so the safe level is less certain.

humans. Convincing evidence from a large number of epidemiological studies and case reports shows that ingestion of inorganic arsenic increases the risk of skin cancer [Alain et al. 1993, Beane Freeman et al. 2004; Bickley and Papa 1989; Cebrián et al. 1983; Chen et al. 2003; Haupert et al. 1996; Hsueh et al. 1995; Lewis et al. 1999; Lüchtrath 1983; Mitra et al. 2004; Morris et al. 1974; Sommers and McManus 1953; Tay and Seah 1975; Tsai et al. 1998; Tsai et al. 1999; Tseng 1977; Tseng et al. 1968; Zaldívar 1974; Zaldívar et al. 1981]. A report by the National Research Council suggests that the calculated risks based on increases in incidence of lung and bladder cancers could be greater than those calculated risks based on incidences of skin cancer [NRC 2001].

Discussion

Exposure Pathways at the JNSC Site

Using the best available scientific information and evaluated data (Appendix B: Table 1), the JNSC site [3] poses a public health hazard to those who now live on or regularly visit the site and posed a public health hazard to those who lived on or regularly visited the site *before clean up*. Although EPA continues to remediate areas in OU2, ATSDR identified ingestion as the most likely exposure pathway through which people still could contact lead and arsenic at or near the entire JNSC site.

Introduction to Public Health Assessment Methodology

To determine whether people might be exposed to site-related contaminants, investigators evaluate the environmental and human components leading to human exposure. This analysis consists of evaluating the **five elements of an exposure pathway**:

1. Source of contamination,
2. Transport through an environmental medium,
3. Point of exposure,
4. Route through which the contaminant can enter the body, and
5. Receptor population.

Exposure to contaminants does not always result in adverse health effects. The factors that influence whether exposure to a contaminant might result in adverse health effects include

- Toxicological properties of the contaminant,
- How much of the contaminant the individual is exposed to,
- How often and/or how long the exposure occurs,

[3] Especially including the residential properties not yet sampled and the properties to which EPA cannot gain access.

- The manner in which the contaminant enters or contacts the body (breathing, eating, drinking, or skin/eye contact),
- The number of contaminants to which an individual is exposed (combinations of contaminants),
- Timing of exposure (e.g., early life), and
- Health status of the exposed person.

ATSDR distinguishes three general types of exposure pathways**:** complete, potentially complete, or eliminated. For someone to be exposed to a contaminant, the exposure pathway must be complete. An **exposure pathway** is considered complete when all five elements in the pathway are present and exposure has occurred, is occurring, or will occur in the future. A **potential pathway** is one that is missing at least one or more of the elements, but information is insufficient to eliminate or exclude the element. An **eliminated pathway** is when one or more of the elements are absent. Additionally, even though an exposure pathway is complete or potentially complete does not necessarily mean a public health concern is present [ATSDR 2005].

Completed Exposure Pathway for Lead and Arsenic in Soil

Currently within the operable unit areas, EPA's remediation is reducing exposure to lead and arsenic in soil. IDEM and EPA evaluations and sampling identified the boundaries of the OU areas. And over a 1,000 residential yards with identified levels of lead above 400 ppm have already been remediated.

Primary exposures to lead and arsenic are *direct or indirect soil ingestion* of soil particles or dust. Through ingestion, soil containing lead and arsenic could get on hands and transfer to the mouth. By touching soil and then touching the mouth, food, drinks, and other items—including cigarettes—will allow contaminated soil and dust to enter the body. A portion will enter the body and blood stream. Children naturally put things in their mouths, and some children do this more than others.

Tracking contaminated surface soils into living areas is another lead-exposure route. People and animals might also track or carry contaminated soils and dust on clothes and dust into the house, into vehicles, or into other places they live, work, or play.

Some portions of the soil, especially bare spots, allow easier access to contamination and allow greater potential for exposure. And areas might become recontaminated if, for example: 1) deteriorating lead-based paint continues to chalk and flake and recontaminate outside soils, 2) demolition or remodeling of older homes with lead-based paint and other lead materials redeposit lead on the soil, garden, or other areas of the yard or home, 3) currently buried or covered lead is disturbed and redeposits in surface soil, gardens, or other areas of a yard or home.

ATSDR observed several car batteries and wheel/tire weights in the community. Lead car-tire weights, lead pellets, and lead shot—if present in some yards and if swallowed—could result in acute lead-poisoning events, as could

- Gardening and home grown food and direct and or indirect ingestion from contaminated soil: gardening increases soil contact, resulting in some level of ingestion of soil.
- Root and leafy vegetables—the main concern for gardens in lead contaminated soil given that soil particles can adhere to the edible plant surface.
- Crop ingestion, that is, eating contamination taken into the plant by the roots or leaves or trapped by the plant as it grows and matures.
- Consumption of products from free ranging poultry raised in contaminated areas of a yard could expose people to contamination. VCHD investigated such a blood poisoning case in which they noticed deteriorating lead-based paint on the house and bare soil in the yard.

Lead-contaminated soils are being removed. D*irect or indirect ingestion* of lead containing materials (e.g., lead-based paint, chips and dust, and soil) is the exposure pathway of greatest concern. Lead paint on some homes can contain up to 40% lead or higher [Walker 1945]. Children or pets might eat lead paint chips or dust. Thus, even after soils have been cleaned up, lead based paint could still be a significant source of lead exposure to children.

This public health assessment's focus is the identified JNSC site boundaries. But ATSDR believes lead-based paint dust and chips and lead from plumbing inside and outside homes is a significant contributor to elevated BLLs in the community. Many such homes were built before 1978 (the year lead-based paint was banned). The nature and extent of the contamination at the JNSC site warrants particular concern due to completed exposure pathways and the potential for multiple sources of lead exposure.

Public Health Implications

This section evaluates the estimated exposure doses and the potential noncancerous health effects from exposure to site-related contaminants above health screening values. In these evaluations, ATSDR considered the frequency and duration of the estimated exposures. As discussed above, the most important exposure pathway for this site is the ingestion route. Note, however, that a chemical's presence in the environment will not always result in contact with that chemical, and that contact itself does not always result in the body absorbing that chemical [ATSDR 2005].

If sampling data exceed an existing ATSDR health-based comparison value, the next step is to calculate an exposure dose and compare that dose to ATSDR's MRLs, NOAELs, and LOAELs

(discussed earlier in this health assessment) to determine whether exposure to levels of site-related contaminants could harm people's health. ATSDR also uses EPA's RfD as a comparison value.

Arsenic Exposures

ATSDR evaluated arsenic exposures in JNSC site soils for children (1 to 6 years), adolescents (8 to 17 years) and adults. The exposure factor of 0.71 was derived for children playing in residential soils 5 days a week for 3 months for 9 years (national median time at one residence). The estimated exposure doses calculated for children were then compared with established health guidelines (see Background section for ATSDR's MRLs, EPA's RfD). In addition, ATSDR used EPA's default arsenic bioavailability value of 60%. This means that of the arsenic detected in soil, the human gastrointestinal tract would absorb only 60%.
To calculate a childhood estimated exposure dose (i.e., the most conservative dose compared to adolescents and adults) 16 kilograms was the body weight used with an ingestion rate of 200 milligram per day (mg/day). Arsenic levels in the JNSC site ranged from nondetect to 92 ppm, and the average level was 23 ppm. ATSDR used the average and maximum level of arsenic detected in residential soils to determine a range of exposure doses. The estimated arsenic exposure doses calculated for children at the JNSC site ranged from 0.0001 to 0.0005 mg/kg/day. The estimated dose (0.0005mg/kg/day) for arsenic was above ATSDR's health-based comparison level for chronic (a lifetime) exposure.

Lead Exposures

The toxicity of lead, especially to children and fetuses, has been documented and discussed earlier.

Ways to mitigate or reduce lead exposures in soil and drinking water, particularly in older homes where lead was used in water pipes include

- Residents, especially children, should participate in yearly blood lead screening and educational programs offered for free by the VCHD or that are provided by hospitals or your health care professionals.
- Residents (especially children) entering their homes after working or playing in the yard should follow these steps to help reduce lead exposure: Take shoes off before entering the home, use a damp cloth or wet mop to remove dust and dirt from the home, wash hands, wash toys and wash pets.
- EPA should continue soil remediation in a manner that protects public health.
- Residents should allow EPA access to their property to test for soil contamination.

Homeowners with older homes should follow EPA's Lead Renovation, Repair, and Painting Rule (RRP Rule) to lower the risk of lead contamination from home renovation activities.

The rule requires that only EPA-certified firms can perform renovation, repair, and painting projects that disturb lead-based paint in homes, child care facilities and pre-schools built before 1978, and that these firms can only use EPA-trained and certified renovators who know how to follow lead-safe work practices.

- Homeowners should follow the recommended practices to maintain painted surfaces properly to limit lead exposure [ATSDR 2007a; CDC 2012; EPA 2012a].
- Residents living in older homes that may still have lead water lines (inside pipes or outside service lines) or lead solder, should have their water tested for lead.

Community Health Concerns

In the final version of this PHA, after we receive and address your public comments, we will add to this section.

Quality Assurance and Quality Control

In researching and writing this PHA, we relied on the information provided in the referenced documents. ATSDR assumes that these site documents were prepared with EPA and IDEM oversight and that adequate quality assurance and control measures were followed with chain-of-custody, laboratory procedures, and data reporting. The validity of the analyses and conclusions drawn in this document depend on the availability and reliability of the referenced information.

Limitations in BLL Study Due to Data Gaps

Data gaps in the BLL study include:

- Lack of blood lead sampling for children living at many different residential properties,
- No information available for the large transient (2–15 weeks) population of residents living at one or more properties for short periods of time,
- For those properties that were not sampled we have no data to correlate with children tested who live at these properties, and
- For those properties sampled there were no children's blood lead levels to correlate with the lead levels detected at the residential properties.

Conclusions

ATSDR evaluated soil data and information for the JNSC site and has determined the site posed a public health threat in the past due to lead and arsenic levels detected in surface soils. The site continues to pose a public health threat in the future for those residential properties that have not yet been remediated. Also, those properties that have denied EPA access pose an indeterminate health hazard. Potential additional sources of lead may be present in older homes (built prior to 1978) from lead based paint and or from lead water lines or lead solder used in water lines of older homes.

Recommendations

Considering our public health evaluation of the JNSC site, ATSDR recommends the following:

1. We recommend children with BLLs of 5 µg/dL or greater be evaluated by a physician.
2. We recommend that children participate in yearly free blood lead screening and educational programs offered by the VCHD, or that are provided by hospitals or health care professionals.
3. We recommend that residents (especially children) entering their homes after working or playing in the yard should follow these steps to help mitigate or reduce lead exposure: Take shoes off before entering the home, use a damp cloth or damp/wet mop to remove dust and dirt from the home, wash hands, wash toys and wash pets.
4. We recommend EPA continue soil remediation in a manner that protects public health.
5. We recommend residents allow EPA access to their property to test for soil contamination.
6. We recommend homeowners with older homes follow EPA's Lead Renovation, Repair, and Painting Rule (RRP Rule) to lower the risk of lead contamination from home renovation activities. The rule requires that firms performing renovation, repair, and painting projects that disturb lead-based paint in homes, child care facilities and pre-schools built before 1978 be certified by EPA and use certified renovators who are trained by EPA-approved training providers to follow lead-safe work practices.
7. We recommend homeowners follow the recommended practices to maintain painted surfaces properly to limit lead exposure [ATSDR 2007a; CDC 2012; EPA 2012a].
8. We recommend residents living in older homes that may still have lead water lines (inside pipes or outside service lines) or lead solder, have their water tested for lead.

Public Health Action Plan (PHAP) for the JNSC Site, Evansville, Indiana

Additional information will be inserted in the PHAP in the final PHA for this site.

The public health action plan (PHAP) for the Jacobsville Neighborhood Soil Contamination (JNSC) site describes key actions taken by ATSDR, EPA, IDH, IDEM and the Vanderburgh County Health Department (VCHD) near the site subsequent to the completion of this public health assessment. The purpose of the PHAP is to ensure that this public health assessment identifies potential and on-going public health hazards, and provides a plan of action designed to prevent adverse human health effects resulting from exposure to hazardous substances in the environment.

The public health actions for the Jacobsville Neighborhood Soil Contamination Site that are completed, ongoing, and planned are

- ATSDR and VCHD worked together on community health education events

- EPA sampling and soil replacement activities
- Public health education programs offered by VCDH
- Blood Lead Screening Program Offered by VCDH
- City and individual (tap water) sampling programs

Following plumbing work ATSDR recommends in homes with lead water lines or lead solder, you:

- Test your drinking water,
- Flush water lines up to 2 minutes before using the water for drinking or cooking, and
- Make sure that lead solder is never used in potable water lines.

Organizations You Can Contact:

For public health information, call VCHD at (812) 435-2400 and/or ATSDR at 1-800-CDC-INFO and ask for information on the Jacobsville Neighborhood Soil Contamination Site, Evansville, Indiana. If you have concerns about the JNSC Site you should contact EPA Region 5 at 800-621-8431, ext. 31325 and leave a message. This line is operational 24-hours a day.

EPA's Lead Renovation, Repair and Painting Rule (RRP Rule): www.epa.gov/lead; www.**epa**.gov/**lead**/rrp/index.htm: Common renovation, repair, and painting activities that disturb lead-based paint (like sanding, cutting, replacing windows, and more) can create hazardous lead dust and chips which can be harmful to adults and children. But with careful work practices and thorough clean up, renovations can be done safely. EPA's Lead Renovation, Repair, and Painting Rule (RRP Rule) lowers the risk of lead contamination from home renovation activities. It requires that firms performing renovation, repair, and painting projects that disturb lead-based paint in homes, child care facilities and pre-schools built before 1978 be certified by EPA and use certified renovators who are trained by EPA-approved training providers to follow lead-safe work practices. Be sure to "Renovate Right"!

Find additional general information about lead at the following EPA web site: www.epa.gov/lead/learn-about-lead.html, answers general questions about lead testing procedures.
Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline 1-800-426-4791 or at http://www.epa.gov/safewater/lead,.
Appendix C has additional information about the JNSC Site Public Health Action Plan.

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References

Alain G, Tousignant J, Rozenfarb E. 1993.Chronic arsenic toxicity. Int J Dermatol 32(12):899-901. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Apostoli P, Bartoli D, Alessio L, et al. 1999. Biological monitoring of occupational exposure to inorganic arsenic. Occup Environ Med 56(12):825-832. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2007a. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services. Available at: http://www.atsdr.cdc.gov/toxprofiles/tp2.html.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2007b. Toxicological profile for lead (update). Atlanta: US Department of Health and Human Services. Available at: http://www.atsdr.cdc.gov/toxprofiles/tp13.html.

[ATSDR]. Agency for Toxic Substances and Disease Registry. 2005. Toxicological profile for lead. Atlanta: US Department of Health and Human Services, Public Health Service.

Beane Freeman LE, Dennis LK, Lynch CF, et al. 2004. Toenail arsenic content and cutaneous melanoma in Iowa. Am J Epidemiol 160(7):679-687. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Bettley FR, O'Shea JA. 1975. The absorption of arsenic and its relation to carcinoma. Br J Dermatol 92:563-568. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Chronic arsenicism with vitiligo, hyperthyroidism, and cancer. 1989. N J Med 86(5):377-380. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Binns HJ, Campbell C, Brown MJ for the Advisory Committee on Childhood Lead Poisoning Prevention. 2007. Interpreting and managing blood lead levels of less than 10 µg/dL in children and reducing childhood exposure to lead: Recommendations of the Centers for Disease Control and Prevention Advisory Committee on Childhood Lead Poisoning Prevention. Pediatrics 120; 1285-98, 2007.

Borgoño JM, Greiber R. 1972. Epidemiological study of arsenicism in the city of Antofagasta. Trace Subst Environ Health 5:13-24. Cited in Agency for Toxic Substances and Disease

Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Buchet JP, Lauwerys R, Roels H. 1981. Comparison of the urinary excretion of arsenic metabolites after a single oral dose of sodium arsenite, monomethylarsonate or dimethylarsinate in man. Int Arch Occup Environ Health 48:71-79. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Casteel SW, Brown LD, Dunsmore ME, Weis CP, Henningsen GM, Hoffman E, Brattin WJ, Hammon TL. 1997. Relative bioavailability of arsenic in mining wastes. Document control number: 4500-88-AORH. Prepared for US Environmental Protection Agency, Region VIII, Denver, Colorodo. Cited in Battelle and Exponent. 2000. Final guide for incorporating bioavailability adjustments into human health and ecological risk assessments at US Navy and Marine Corps Facilities. Part 1: overview of metals bioavailability. Prepared for Naval Facilities Engineering Service Center and Engineering Field Activity West.

[CDC] Centers for Disease Control and Prevention. 2012. CDC Response to the Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) Recommendations on Low Level Lead Exposure and Primary Prevention of Lead Poisoning http://www.nchh.org/Portals/0/Contents/CDC_Response_Lead_Exposure_Recs.pdf. And http://www.nchh.org/Portals/0/Contents/NCHH%20CDC%20ACCLPP%20Response%20Summary%20Chart.pdf.

[CDC] Centers for Disease Control and Prevention. 2005. http://www.cdc.gov/nceh/lead/ACCLPP/Final_Document_011212.pdf. Atlanta: US. Department of Health and Human Services;

Cebrián ME, Albores A, Aguilar M, et al. 1983. Chronic arsenic poisoning in the north of Mexico. Hum Toxicol 2:121-133. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

CH2M HILL. 2007. Ecology and Environmental International, Inc. and Teska Associates Inc. Final Feasibility Study Report, Jacobsville Neighborhood Soil Contamination Site, Evansville, Indiana; January.

Chen YC, Guo YL, Su HJ, et al. 2003. Arsenic methylation and skin cancer risk in southwestern Taiwan. J Occup Environ Med 45(3):241-248. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Chisolm JJ. Chronic lead intoxication in children. 1965. Dev Med Child Neurol 7:529-536. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for lead (update). Atlanta: US Department of Health and Human Services.

Chisolm JJ. 1962. Aminoaciduria as a manifestation of renal tubular injury in lead intoxication and a comparison with patterns of aminoaciduria seen in other diseases. J Pediatr 60:1-17. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for lead (update). Atlanta: US Department of Health and Human Services.

Chisolm JJ, Harrison HE. 1956. The exposure of children to lead. Pediatrics 18:943–58. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for lead (update). Atlanta: US Department of Health and Human Services.

Crecelius EA. 1977. Changes in the chemical speciation of arsenic following ingestion by man. Environ Health Perspect 19:147–50. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Davis A, Ruby MV, Bergstrom PD. 1992. Bioavailability of arsenic and lead in soils from the Butte, Montana, mining district. Environ Sci Technol. 26(3):461–68. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

[EPA] US Environmental Protection Agency. 2012a. Lead: Enforcing Lead Laws and Regulations online at http://www.epa.gov/lead/pubs/enforcement.html. Last accessed October 2, 2012.

[EPA] US Environmental Protection Agency Region 5. 2012b. September 6, 2012. Jacobsville Neighborhood Contamination Gateway Home Page. Available online at http://www.epa.gov/region5/cleanup/jacobsville/.

[EPA] US Environmental Protection Agency Region 5. 2012c. July 2012 Jacobsville Neighborhood Contamination -- Cleanup Site Profile Available online at http://www.epa.gov/R5Super/npl/indiana/INN000508142.html.

[EPA] US Environmental Protection Agency Region 5. 2011. Fact Sheet: Superfund Program Implements the Recovery Act, Jacobsville Neighborhood Contamination, Evansville, Indiana. Available online at http://www.epa.gov/superfund/eparecovery/jacobsville.html.

[EPA] U.S. Environmental Protection Agency Region 5. 2009. Jacobsville Neighborhood Soil Contamination Site, Evansville, Indiana, Vanderburgh County Record of Decision.

[EPA] US Environmental Protection Agency. 2008a. Integrated Risk Information System (IRIS). Arsenic. Available at: http://www.epa.gov/ncea/iris.

[EPA] US Environmental Protection Agency Region 5. 2008b. Jacobsville Neighborhood Soil Contamination Site, Evansville, Indiana, Vanderburgh County Record of Decision.

[EPA] United States Environmental Protection Agency Region 5. 2006. Final Remedial Investigation Report, Jacobsville Neighborhood Soil Contamination Site, Evansville Indiana.

[EPA] US Environmental Protection Agency. 1982. Exposure and risk assessment for arsenic. Washington, DC: US Environmental Protection Agency, Office of Water Regulations and Standards. PB85221711. EPA440485005. 1.14.68. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

[EPA] US Environmental Protection Agency. 1981. Community health associated with arsenic in drinking water in Millard County, Utah. Cincinnati, OH: US Environmental Protection Agency, Health Effects Research Laboratory. EPA600181064. PB82108374. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Franzblau A, Lilis R. 1989. Acute arsenic intoxication from environmental arsenic exposure. Arch Environ Health 44(6):385-390. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Freeman GB, Schoof RA, Ruby MV, et al. 1995. Bioavailability of arsenic in soil and house dust impacted by smelter activities following oral administration in cynomolgus monkeys. Fundam Appl Toxicol. 28(2):215-222. Cited in Battelle and Exponent. 2000. Final guide for incorporating bioavailability adjustments into human health and ecological risk assessments at US Navy and Marine Corps Facilities. Part 1: overview of metals bioavailability. Prepared for Naval Facilities Engineering Service Center and Engineering Field Activity West.

Freeman GB, Johnson JD, Killinger JM, et al. 1993. Bioavailability of arsenic in soil impacted by smelter activities following oral administration in rabbits. Fundam Appl Toxicol. 21(1):83-88. Cited in Battelle and Exponent. 2000. Final guide for incorporating bioavailability adjustments into human health and ecological risk assessments at US Navy and Marine Corps Facilities. Part 1: overview of metals bioavailability. Prepared for Naval Facilities Engineering Service Center and Engineering Field Activity West.

Groen K, Vaessen H, Kliest JJG, et al. 1994. Bioavailability of Inorganic Arsenic from Bog Ore-Containing Soil in the Dog. Environ. Health Perspect., 102(2): 182–84. Cited in Battelle and Exponent. 2000. Final guide for incorporating bioavailability adjustments into human health and ecological risk assessments at US Navy and Marine Corps Facilities. Part 1: overview of metals bioavailability. Prepared for Naval Facilities Engineering Service Center and Engineering Field Activity West.

Guha Mazumder DN, Chakraborty AK, Ghose A, et al. 1988. Chronic arsenic toxicity from drinking tubewell water in rural west Bengal. Bull WHO 66(4):499-506. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Haupert TA, Wiersma JH, Goldring JM. 1996. Health effects of ingesting arsenic-contaminated groundwater. Wis Med J 95(2):100-104. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

[Health Canada]. Canadian Environmental Protection Act. 1993. Priority substances list assessment report: arsenic and its compounds. Government of Canada, Environment Canada. Available at: http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl1-lsp1/arsenic_comp/index_e.html.

Hsueh YM, Cheng GS, Wu MM, et al. 1995. Multiple risk factors associated with arsenic-induced skin cancer: Effects of chronic liver disease and malnutritional status. Br J Cancer 71(1):109-14. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Haque R, Mazumder DN, Samanta S, et al. 2003. Arsenic in drinking water and skin lesions: Dose-response data from West Bengal, India. Epidemiology 14(2):174-182. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Harrington JM, Middaugh JP, Morse DL, et al. 1978. A survey of a population exposed to high concentrations of arsenic in well water in Fairbanks, Alaska. Am J Epidemiol 108(5):377-385. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Kehoe RA. 1961. The metabolism of lead in man in health and disease: Present hygienic problems relating to the absorption of lead: The Harben lectures, 1960. J R Inst Public Health Hyg 24:177-203. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for lead (update). Atlanta: US Department of Health and Human Services.

Lewis DR, Southwick JW, Ouellet-Hellstrom R, et al. 1999. Drinking water in Utah: A cohort mortality study. Environ Health Perspect 107(5):359-365. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Lüchtrath H. 1983.The consequences of chronic arsenic poisoning among Moselle wine growers: Pathoanatomical investigations of post-mortem examinations performed between 1960 and 1977. J Cancer Res Clin Oncol 105:173-182. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Marcus WL, Rispin AS. 1988. Threshold carcinogenicity using arsenic as an example. In: Cothern CR, Mehlman MA, Marcus WL, eds. Advances in modern environmental toxicology. Vol. XV: Risk assessment and risk management of industrial and environmental chemicals. Princeton, NJ: Princeton Scientific Publishing Co., 133-158. Cited in Agency for Toxic

Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Marafante E, Vahter M, Norin H, et al. 1987. Biotransformation of dimethylarsinic acid in mouse, hamster and man. J Appl Toxicol 7(2):111-117. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

McKinney J and Rogers R. 1992. Metal bioavailability: Environmental Science and Technology, v. 26, p. 1298-1299.

Mitra SR, Mazumder DN, Basu A, et al. 2004. Nutritional factors and susceptibility to arsenic-caused skin lesions in West Bengal, India. Environ Health Perspect 112(10):1104-1109. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Mizuta N, Mizuta M, Ito F, et al. 1956. An outbreak of acute arsenic poisoning caused by arsenic-contaminated soy-sauce (shōyu): A clinical report of 220 cases. Bull Yamaguchi Med Sch 4(2-3):131-149. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services

Morris JS, Schmid M, Newman S, et al. 1974. Arsenic and noncirrhotic portal hypertension. Gastroenterology 66(1):86-94. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

[NRC 2001] National Research Council. 2001. Arsenic in drinking water. Update. Washington, DC: National Academy Press. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Rodriguez RR, Basta NT, Casteel SW, et al. 2000. An In Vitro Gastrointestinal Method to Estimate Bioavailable Arsenic in Contaminated Soils and Solid Media. Environ. Sci. Technol., 33(4): 642-649. Cited in Battelle and Exponent. 2000. Final guide for incorporating bioavailability adjustments into human health and ecological risk assessments at US Navy and Marine Corps Facilities. Part 1: overview of metals bioavailability. Prepared for Naval Facilities Engineering Service Center and Engineering Field Activity West.

Shacklette HT and Boerngen JG. 1984. Element concentrations in soils and surficial materials of the conterminous United States. US Geological Survey Professional Paper 1270. US Government Printing Office: Washington.

Sommers SC, McManus RG. 1953. Multiple arsenical cancers of the skin and internal organs. Cancer 6:347-359. Cited in Agency for Toxic Substances and Disease Registry. 2007.

Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Tam GKH, Charbonneau SM, Bryce F, et al. 1979. Metabolism of inorganic arsenic (^{74}As) in humans following oral ingestion. Toxicol Appl Pharmacol 50:319-322. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Tay C, Seah C. 1975. Arsenic poisoning from anti-asthmatic herbal preparations. Med J Aust 2:424428. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Tsai SM, Wang TN, Ko YC. 1999. Mortality for certain diseases in areas with high levels of arsenic in drinking water. Arch Environ Health 54(3):186-193. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Tsai M, Chien R, Hsieh S, et al. 1998. Primary hepatic angiosarcoma: Report of a case involving environmental arsenic exposure. Chang Keng I Hsueh Tsa Chih 21(4):469-474. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Tseng WP. 1977. Effects and dose-response relationships of cancer and Blackfoot disease with arsenic. Environ Health Perspect 19:109-119. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Tseng, WP, Chu HM, How SW, et al. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. J Natl Cancer Inst 40:453-463. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Valentine JL, Reisbord LS, Kang HK, et al.1985. Arsenic effects on population health histories. In: Mills CF, Bremner I, Chesters JK, eds. Trace elements in man and animals - TEMA 5: Proceedings of the Fifth International Symposium on Trace Elements in Man and Animals. Slough, UK: Commonwealth Agricultural Bureaux, 289-294. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Wedepohl KH. 1991.The composition of the upper earth's crust and the natural cycles of selected metals. Metals in natural raw materials. Natural resources. In: Merian E, ed. Metals and their compounds in the environment. Occurrence, analysis, and biological relevance. New York, NY: VCH, 3-17. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Wester RC, Maibach HI, Sedik L, et al.1993. *In vivo* and *in vitro* percutaneous absorption and skin decontamination of arsenic from water and soil. Fundam Appl Toxicol 20(3):336-340. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Zaldívar R. Arsenic contamination of drinking water and foodstuffs causing endemic chronic poisoning.1974. Beitr Pathol 151:384-400. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Zheng Y, Wu J, Ng JC, et al. 2002.The absorption and excretion of fluoride and arsenic in humans. Toxicol Lett 133(1):77-82. Cited in Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services.

Appendix A. Figures 1–3

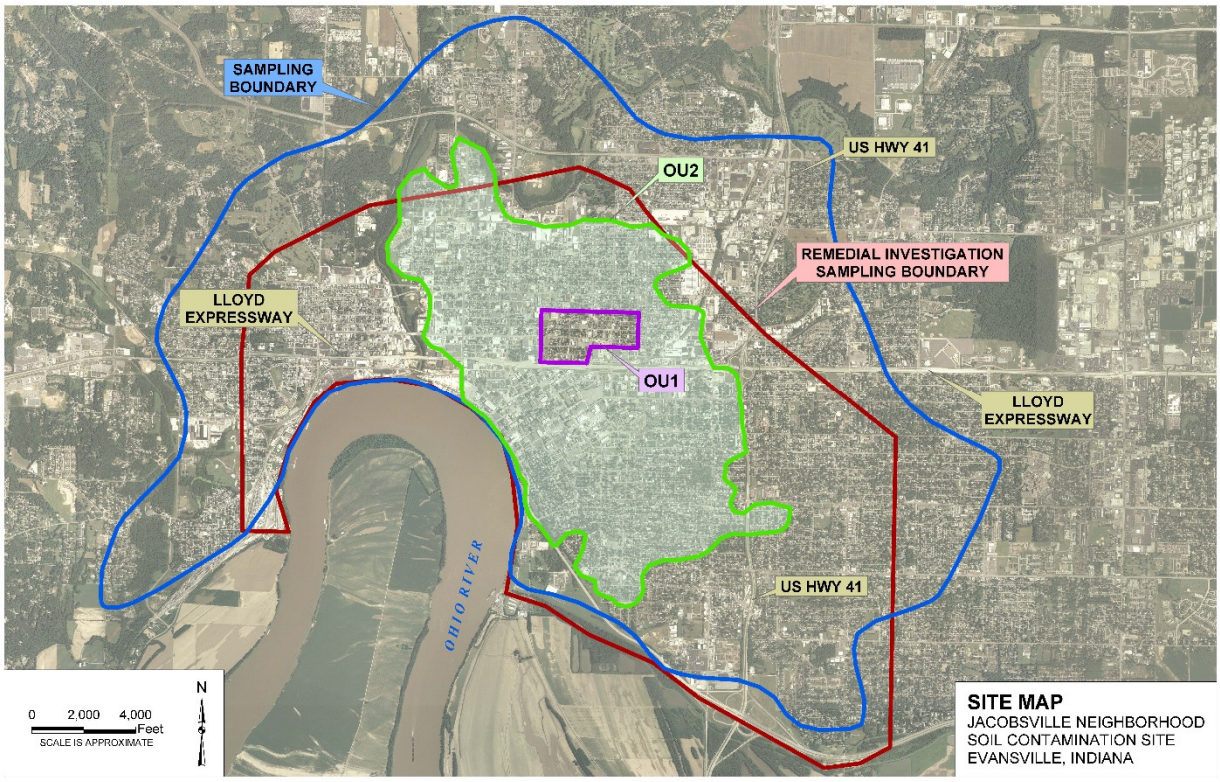

Figure 1: Jacobsville Neighborhood Soil Contamination Site, Evansville, Indiana. Map shows Operable Units 1 & 2.

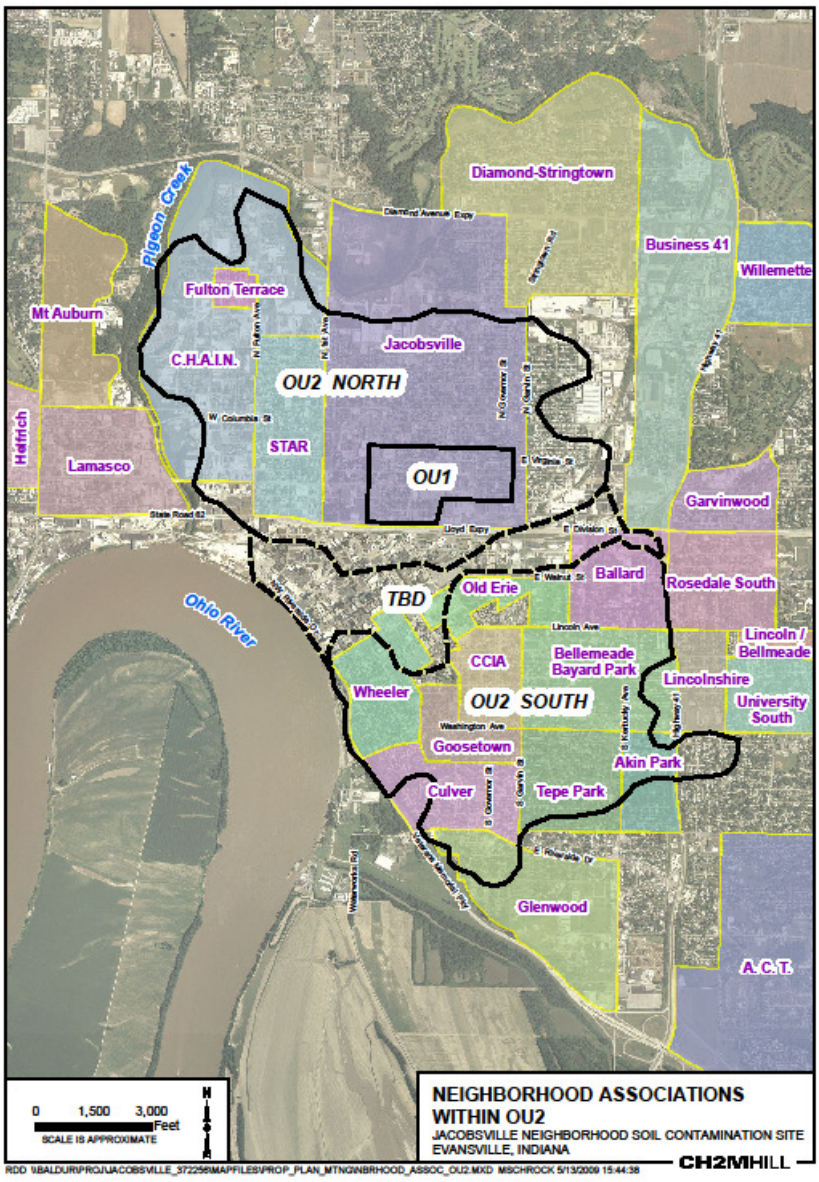

Figure 2: Neighborhood Associations within OU1 and OU2, Jacobsville Neighborhood Soil Contamination, Evansville, Indiana.

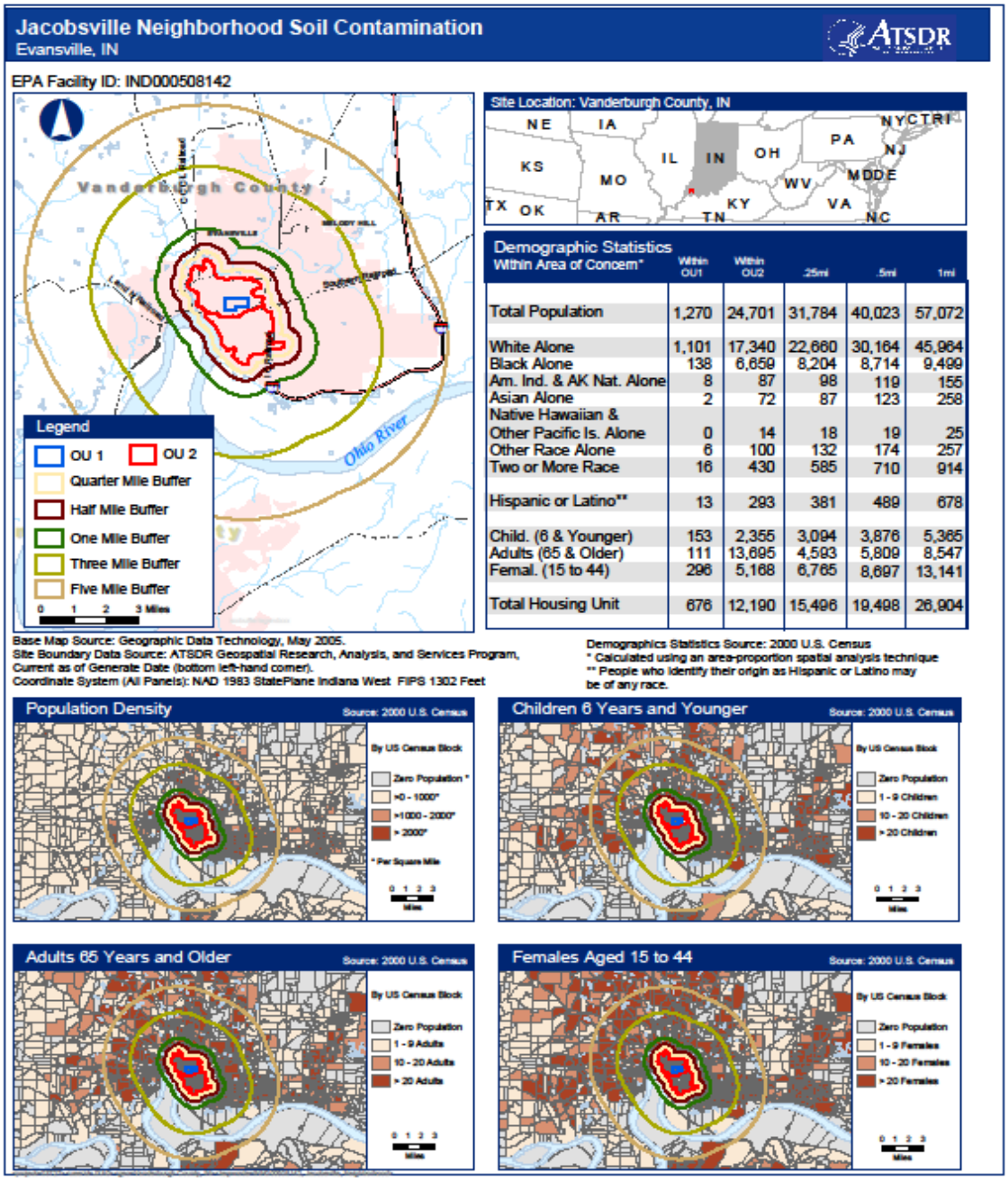

Figure 3: Jacobsville Neighborhood Soil Contamination Site, Evansville, Indiana.

Appendix B. Table 1

Table 1: Lead and Arsenic in Residential and High Access Areas in Surface Soil at the Jacobsville Neighborhood Soil Contamination Site, Evansville, Indiana.

Contaminant and Sample Location	*Exceedances/ (# of Samples)1*	*Range of Results (ppm) (Average)[2]*	*JNSC Site Cleanup Standard (ppm)*
Residential Yards			
Lead (0 to 2 inches) Drip Zone	25/26	20 - 8210 (2789)	400
Lead (0 to 2 inches)	20/28	136 - 1900 (604)	400
Lead (0 to 6 inches)	19/28	88 - 1070	400
Lead (6 to 12 inches)	8/28	49.8 - 2040	400
Lead (12 to 18 inches)	0/28	29.9 - 371	400
Arsenic (0 to 2 inches)	1/28	3.9 - 31.2 (10.7)	30
Arsenic (0 to 6 inches)	1/28	2.5 - 31.8	30
Arsenic (6 to 12 inches)	2/28	7 - 37	30
High Access Areas (Day Cares and Other Areas (Parks, Playgrounds, Schools, Ball Fields) Surface Soil (0 to 2 inches) Results			
Day Care Lead	7/7	23.4 - 145	400
Day Care Arsenic	7/7	9.6 - 13.4	30
Lead	70/70	9.3 - 1520	400
Arsenic	70/70	4.1- 18.2	30

Source: EPA 2006 Remedial Investigation, EPA 2008 Record of Decision

Notes: Only contaminants that exceed their respective EPA Cleanup values are presented in the table.

[1] Exceedances/Detects represents the number of times a contaminant level exceeds its respective screening value over the total number of samples.

2 Numbers in parentheses represent arithmetic mean (average) concentration for detected values.

Table 1 Continued —— Lead Concentrations in ppm; Lead Summary for Selected Data Reported in Jacobsville Soil Contamination Site, Combined XRF and Laboratory Results [EPA 2008; EPA 2009].

Area	Residential	Daycare	Park	Play Ground	Commercial /Industrial
OU1 per property basis	Range 20-8,210 Average 373	Range NA Average NA	Range 217 Average 217	Range 63-411 Average 192	Range 50-606 Average 297
OU2 per property basis	Range ND-7,910 Average 403.4	Range 23.4-145 Average 85.2	Range 56.9-182.8 Average 99.4	Range 30-532 Average 140	Range NA Average NA
GAP TBD area per property basis	Range NA Average NA	Range NA Average NA	Range 42 Average 42	Range NA Average NA	Range 106.12-118.13 Average 110

Table 1 continued —— Arsenic Concentrations in ppm; Arsenic Summary for Selected Data Reported in Jacobsville Soil Contamination Site, Combined XRF and Laboratory Results for Composite Samples. Arsenic results will measure lower than present because lead levels are above 10 ppm for XRF samples.

Area	Residential	Daycare	Park	Play Ground	Commercial /Industrial
OU1 per property basis	Range ND-92 Average 15.2	Range NA Average NA	Range NA Average NA	Range ND-45 Average 15.7	Range ND Average ND
OU2 per property basis	Range ND-68.2 Average 23.3	Range 10.6-13 Average 11.3	Range ND-29.3 Average 13.6	Range 4.1-18.2 Average 9.9	Range NA Average NA
GAP TBD area per property basis	Range NA Average NA	Range NA Average NA	Range ND Average ND	Range NA Average NA	Range ND-25.7 Average 5.5

Appendix C. Public Health Action Plan for the Jacobsville Neighborhood Soil Contamination Site

The public health action plan (PHAP) for the Jacobsville Neighborhood Soil Contamination (JNSC) site describes key actions taken by ATSDR, EPA, IDH, IDEM, and the Vanderburgh County Health Department (VCHD) near the site subsequent to the completion of this public health assessment. The purpose of the PHAP is to ensure that this public health assessment identifies potential and ongoing public health hazards and provides a plan of action to prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Completed, ongoing, or planned public health actions for the Jacobsville Neighborhood Soil Contamination Site include

- Public Health Education Programs Offered by VCDH
- Blood Lead Screening Programs Offered by VCDH
- City and Individual (tap water) Sampling Programs

Completed, Ongoing, and Planned Public Health Actions:

- The official information repository for documents and other site materials is the Evansville Vanderburgh Public Library and the Central Branch-Public Comment Shelf.
- In July 2004, the JNSC site was listed on the Environmental Protection Agency's (EPA) National Priority List (NPL). EPA undertook a *Superfund Emergency Removal Action* for the JNSC site from September 2007 through April 2008. During this action EPA, in consultation with the Indiana Department of Environmental Management (IDEM) and the support of the City of Evansville and the Vanderburgh County Health Department (VCHD), cleaned and restored 83 residential properties with lead levels in the soil above 1,200 ppm. EPA completed the cleanup of 263 residential yards in the first operable unit (OU1) in October 2010 [EPA 2011].
- In 2010, the soil sampling and design work for the cleanup began. An additional 20 properties in OU1 were cleaned up in 2011. As of October 2013, more than a 1000 properties have been remediated. Currently, EPA continues the cleanup work of OU2.
- The VCHD will continue to work with the JNSC community to help identify and reduce lead exposure. The VCHD will continue hosting community health fairs and meetings to bring public health education programs about lead to residents. The VCHD will also continue offering *free blood lead screenings*. The VCHD and the Indiana State Department of Health (IDH) worked with ATSDR and CDC to help with the statistical evaluation of collected blood lead data.
- Evansville American Water and Sewer Utility is responsible for providing safe drinking water in Evansville, but cannot control the variety of materials used in plumbing components. If you are concerned about lead in your water, you might have your water tested. Information on lead in drinking water, testing methods, and steps you can take to

minimize exposure is available from the EPA Safe Drinking Water Hotline at 1-800-426-4791 *or at* *http://www.epa.gov/safewater/lead*.

- EPA provides information on lead in drinking water, testing methods, and steps you can take to minimize exposure at *http://www.epa.gov/safewater/lead*. If you have any doubts about your drinking water you should consider the following actions: 1) *Following* plumbing work in older housing, test your drinking water, 2) inspect faucet aerators, 3) remove any debris and flushing water lines up to 2 minutes before using the water for drinking or cooking, and 4) check to make sure that lead solder is never used in potable water lines.
- ATSDR has reviewed and evaluated soil samples collected by EPA at the JNSC site and, if requested by EPA, will continue to do so in the future.
- EPA aintains a toll-free telephone number that residents with health concerns related to the JNSC site can call 24 hours a day Call 800-621-8431, ext. 31325 and leave a message.
- EPA's community involvement coordinator and remedial project manager will respond to inquiries from those interested in the site throughout the cleanup (Call EPA's toll-free number 1-800-621-8431, ext.31325).
- EPA will mail out fact sheets to those on the site's mailing list as a way to give updates on the site and its activities. EPA will mail the fact sheets periodically to inform the public about upcoming meetings and important technical information.
- EPA will maintain and regularly update a web site for the JNSC Superfund Site, which will contain information about the site, its activities, and upcoming meetings. See http://www.epa .gov/superfund/sites/npl/nar1711.htm. EPA also has a web site to educate parents on how they can protect their families against lead exposure. See www.epa.gov/lead/parents.html.
- EPA will hold community meetings at key milestones. The meetings will be announced via newspaper notices, e-mail messages, and fact sheets.
- CDC provides information about childhood lead poisoning prevention activities within CDC and links to federal agency programs, state and local lead programs and links to nonfederal organizations on the Web at www.cdc.gov/nceh/lead/partners.com.
- The CDC's National Center for Health Statistics monitors blood lead levels in the United States. CDC also provides information on the number of children with elevated blood lead levels, and number and percentage of children tested for lead in your area.
- EPA uses and will continue to use the CDC data to show trends on blood lead levels in children in America's Children and the Environment.

- ATSDR will consult with other agencies and communicate recommended actions that residents and stakeholders should take to protect their health.

Greetings,

You are receiving a document from the Agency for Toxic Substances and Disease Registry (ATSDR). We are very interested in your opinions about the document you received. We ask that you please take a moment now to complete the following ten question survey. You can access the survey by clicking on the link below.

Completing the survey should take less than 5 minutes of your time. If possible, please provide your responses within the next two weeks. All information that you provide will remain confidential.

The responses to the survey will help ATSDR determine if we are providing useful and meaningful information to you. ATSDR greatly appreciates your assistance as it is vital to our ability to provide optimal public health information.

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