Health Consultation

SOIL DATA REVIEW FOR FORMER NEODESHA SMELTER AREA
AT THE FORMER NEODESHA OLD REFINERY SITE

NEODESHA, WILSON COUNTY, KANSAS

OCTOBER 30, 2007

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation 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.

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HEALTH CONSULTATION

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NEODESHA, WILSON COUNTY, KANSAS

Prepared By:

The U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Summary and Statement of Issues

In response to a petition by the community member of Neodesha, the Agency for Toxic Substances and Disease Registry (ATSDR) released a Health Consultation titled "Neodesha Refinery (former Amoco Refinery)" for public comment in October 2003 that evaluated potential exposures to environmental contaminants. During the public comment period, numerous comments were received from community members, Kansas Department of Health and Environment (KDHE), city officials, and personnel of BP Products North American Inc. (BP).

Since the release of the document for "Public Comment", additional investigations have been conducted at the site and additional environmental data were available for review. As a result ATSDR has chosen to produce a series of documents that focus on: 1) lead levels at the New Beginnings facility, 2) metals in soil in other areas of the former refinery site 3) metals in soil at the smelter site, and 4) volatile organic compounds in ground water, soil vapor, and ambient and indoor air at the former refinery site. ATSDR released two health consultations regarding the lead levels at the New Beginnings facility and metals in soil in other areas of the former refinery site in April 2006 and June 2007, respectively.

This is the third document in the series and addresses the soil metals contamination at the former Neodesha smelter area. Environmental data evaluation and analysis indicated that

- It is unlikely that adults and children at any of the properties at the area would experience non-cancerous harmful effects from exposure to arsenic in soil.
- The risk of developing cancer among exposed individuals is minimal because the levels of arsenic (average 10 mg/kg) found in the soil are relatively low.
- Exposures to lead-contaminated soil at commercial, industrial and open land portions of the former smelter are not likely to result in adverse health effects in workers.
- Exposures to lead in the soils at the area would not cause additional cancers among workers because of occasional exposure frequency and small doses of daily intake of lead.
- Surface soil data for residential areas is insufficient to fully characterize the soil contamination and to evaluate exposures.

ATSDR has categorized this site as constituting an "Indeterminate Public Health Hazard" because soil contamination characterization in the residential area is limited and additional soil sampling was recommended to fully characterize the soil contamination.

Background

The Agency for Toxic Substances and Disease Registry (ATSDR) responded to a petition by the community member of Neodesha, and released a Health Consultation titled “Neodesha Refinery (former Amoco Refinery)” for public comment in October 2003 [1]. Since the release of the document for “Public Comment”, additional investigations were conducted at the site and additional environmental data were available for review. As a result ATSDR has chosen to produce a series of documents that focus on: 1) lead levels at the New Beginnings facility, 2) metals in soil in other areas of the former refinery site 3) metals in soil at the smelter site, and 4) volatile organic compounds in ground water, soil vapor, and ambient and indoor air at the former refinery site.

In April 2006, ATSDR released a health consultation that addressed the New Beginnings facility lead contamination. Lead levels in the surface soil samples collected on and near the New Beginnings facility ranged from 15.6 to 181 mg/kg of soil which are below health-based comparison values and are not likely to result in adverse health effects. ATSDR concluded that the surface soil at New Beginnings facility poses No Apparent Public Health Hazard to people working or visiting the facility [2].

In June 2007, ATSDR released the second health consultation that reviewed available soil metals data in other areas of the former refinery site, and assessed the possible implication of exposures to soil contaminants [3]. ATSDR concluded the area poses No Apparent Public Health Hazard based on the following:

- Adults and children at the site who use the Ballpark area are unlikely to experience non-cancerous adverse effects from exposure to arsenic, lead and mercury in soil.
- ATSDR considers that exposures to lead-contaminated soil lead in the general areas (commercial and industrial businesses) are not likely to result in adverse health effects for adult workers.
- The risk of developing cancer among exposed individuals at the site is minimal because of short exposure duration, infrequent exposure frequency, and small doses of daily intake of contaminants.

This third health consultation will addressing issues related to the former refinery site. The purpose of this health consultation is to review available soil metals data in the former Neodesha smelter area, and to assess the possible public health implications of exposure to these soil contaminants.

The former Neodesha smelter area encompasses approximately 55 acres. It is located in the northwest corner of Neodesha and north of the former oil refinery property. It is surrounded by agricultural or wooded land to the west and north, the former oil refinery property to the south, commercial and residential properties to the southwest, and the Missouri Pacific Railroad to the east (Figure 1).

The former smelter began operation in 1903 and was dismantled in 1918. BP Products North American Inc. (BP) and its predecessor companies deposited solid waste on the former smelter area. Currently, the former smelter area consists of eight tracts of land arranged in roughly 3 columns (Figure 2). The west column has a size of 17 acres and is owned by the City of Neodesha as non-residential open property. The center column is owned by the City of Neodesha as non-residential area and two private industrial and commercial companies. The portion owned by the City includes a 20-acre area capped with geosynthetic clay liner and surrounded by a split rail fence. The cap was installed to address refinery waste and petroleum-impacted soil disposed of in a containment pit by the former refinery. The eastern column has a size of approximately 10 acres and is owned by the city as municipal public works, two light industrial companies, and residents as private residences.

Community Health Concerns

As part of the response to the petition to investigate exposure to soil contamination, ATSDR staff participated in many public meetings, reviewed site documents, received numerous calls from residents, and conducted public availability sessions and public meetings to understand community member's concerns regarding the contamination, investigation, and remediation of the site. Major environmental health issues related to soil contamination include the following:

- Accuracy and adequacy of environmental sample results collected to date,
- Lead exposures at recreational areas,
- Possible exposures to site-related contaminants from ongoing BP work in the community, and
- Mercury contamination at the site.

ATSDR addressed most of the community concerns in the pervious two health consultations and will continue to answer the question related to the accuracy and adequacy of environmental sample results collected to date in this health consultation.

ATSDR's Exposure Pathway Analysis and Evaluation Process

ATSDR provides site-specific public health recommendations on the basis of toxicologic literature, levels of environmental contaminants detected at a site compared to accepted comparison values, an evaluation of potential exposure pathways and duration of exposure, and the characteristics of the exposed population. ATSDR used this approach to determine if contamination in the former smelter area posed a public health hazard.

ATSDR used the following comparison values (CVs) for the screening process to identify contaminants of concern for this document:

- ATSDR Environmental Media Evaluation Guides (EMEGs)
- Reference Dose Media Evaluation Guides (RMEGs)
- Minimum Risk Levels (MRLs)
- Cancer Risk Evaluation Guidelines (CREGs)
- EPA Reference Doses (RfDs)
- EPA Region 9 Preliminary Remediation Goals (PRGs)

When determining what environmental guideline value to use, this health consultation followed ATSDR's general hierarchy and used professional judgment to select CVs that best apply to the site conditions [4]. See Appendix B for more information on CVs and definitions.

Discussion

Available environmental data for the site and data quality evaluation

ATSDR evaluated the available environmental sampling information for potential exposure to contaminants at the former smelter area. Since 2001, soil samples were taken in the former smelter area on four separate investigation events to evaluate the extent of contamination. The information includes soil samples taken by the RETEC Group, Inc. (RETEC) under contract with BP, Maxim Technologies, Inc. (Maxim) under contract with KDHE, ENTACT & Associates, LLC, (ENTACT) under contract with Blue Tee Corporation, and soil samples taken by KDHE. Table 1 is a summary of all data used in this evaluation.

Soil samples were analyzed for metals using portable x-ray fluorescence (XRF) instruments in accordance with US EPA Method 6200 and laboratory analysis. The laboratory analysis methods selected were US EPA SW-846 method 6010B for metals [5-8].

To address community concerns, ATSDR also reviewed information on Quality Assurance (QA)/Quality Control (QC) specifications for field data quality and laboratory data quality to verify the acceptability and adequacy of data. For example, ATSDR reviewed available Chain of Custody sheets, project narratives, and laboratory certifications. The laboratory analysis methods and the QA/AC procedures were appropriate [5-8]. In addition, ATSDR made comparisons of the XRF and laboratory analysis to further understand the quality of the soil data.

Environmental data evaluation and public health implications

Environmental data are grouped into two categories (X-Ray Fluorescence instrument soil samples and laboratory soil samples). Data evaluation and public health implications are discussed in the following sections.

X-Ray Fluorescence (XRF) Instrument Soil Samples

In July and August 2002, Maxim conducted a Focused Former Smelter Assessment (FFSA). The investigation measured metals concentrations in the soil using a Niton Model 722SRW field portable x-ray fluorescence (XRF) instrument with 20% of the samples split for confirmation by laboratory analysis. All of the XRF sampling was conducted on undisturbed soil at the surface (*in situ*) except at one location. Sampling below the soil surface was only conducted if the surface reading exceeded the XRF instrument detection limit to assess the approximate vertical extent of the contaminants (for location NS-13 only). There were 23 XRF measurements for the field verification of 9 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and zinc). Arsenic, cadmium and lead were identified as contaminants of concern for the former smelter area.

In March 2005, ENTACT under contract with Blue Tee Corporation conducted a voluntary cleanup investigation (VCI). The objective was to refine the delineation of contaminants of concern (i.e., arsenic, cadmium and lead) in the former smelter area. The investigation measured arsenic, cadmium and lead concentrations in the soil using a Niton Model 700 field portable x-ray fluorescence (XRF) instrument with 20% of the samples split for confirmation by laboratory analysis. For this sampling event, a coordinate grid system composed of 29 grids was established. Soil samples were collected from the center of each grid. In addition, seven locations outside of the gridded area were sampled to complete the lateral delineation. For lead analysis, three measurements were collected for each sample and the results were averaged to obtain the final concentration for the sample. For arsenic and cadmium, only one measurement was obtained.

Figure 3 shows XRF soil sample locations for the FFSA and VCI sampling events. See Table 2 for all XRF sampling results for the two sampling events.

Laboratory Soil Samples

A total of 48 laboratory samples (Table 1) was collected from the former smelter area in the following investigations:

- In 2001, RETEC conducted a soil investigation for the former refinery area that included 16 surface and subsurface soil samples at the west column of the former smelter area.
- In 2002, Maxim performed the FFSA and sent six soil samples for laboratory analysis.
- In 2003, KDEH conducted a FFSA supplemental assessment and collected 17 soil samples for laboratory analysis.
- In 2005, ENTACT performed the VCI and collected 9 soil samples for laboratory analysis.

Table 3 is a summary of soil sample results from the laboratory analysis. Figure 4 shows soil sample locations for the RETEC, FFSA, FFSA supplemental assessment, and VCI sampling events.

Arsenic was detected in 26 samples with concentrations ranged from non-detect to 34 mg/kg, and with an average of 10.25 mg/kg. Cadmium was detected in 24 samples with concentrations ranged from 0.14 to 87.8 mg/kg, with an average of 10.64 mg/kg. Lead was detected in 34 samples with concentrations ranged from 23.4 to 1,700 mg/kg, and with an average of 400 mg/kg.

Comparison of Laboratory Soil Samples and XRF Instrument Soil Samples

XRF instruments were used for the determination of element concentrations in soil and sediment for many years. EPA has thoroughly investigated using XRF technology at Superfund sites. It is considered as a fast and cost effective technology for site characterization under certain conditions. The accuracy of the XRF instrument in measuring metals in soil is well documented; thus the metal concentrations measured by laboratory analysis should be very close to the metal concentrations measured by XRF [9-10]. ATSDR used soil samples that had detectable levels of lead in both laboratory and XRF analysis to compare the two methods. Table 4 is a summary of soil samples used for the comparison. Figure 5 shows the regression analysis comparing the lead concentration from laboratory analysis with the corresponding XRF lead concentrations. In most of the comparisons, the concentrations of lead from the two methods are similar, with a correlation coefficient of 0.82. Therefore, the lead levels measured by the XRF are valid at this site to make public health decisions. For arsenic and cadmium, ATSDR used the laboratory results only for this evaluation because (1) only one measurement were obtained for arsenic, the detection limits were elevated (ranged from 14 to121mg/kg), (2) cadmium detection limits were elevated (ranged from 16 to 180 mg/kg), and (3) in the VCI sampling event, some soil samples were not analyzed for arsenic and cadmium by the XRF instrument.

Public Health Implications

Soil sampling results indicated that arsenic and lead levels in the area exceeded their respective CVs. The evaluation of arsenic and lead exposures are discussed below.

Current land use in the former smelter area is mostly light industrial, commercial, and vacant open land, along with a few residential properties. The most likely human exposures to arsenic in the area were occasional ingestion or infrequent dermal contact with contaminated surface soil by workers and residents. This exposure occurs when people have direct contact with soils in their environment. For instance, when children play outside or crawl on floors, or when adults work in yards and gardens, contaminated soil or dust particles cling to their hands. People can then accidentally swallow the contaminants when they put their hands on or into their mouths, as children often do. Since both people and pets track contaminated soils from outdoors into their homes, exposures can occur while people are in their homes and in their yards. Factors that affect whether or not people have contact with contaminated soil include the amount of grass cover, weather conditions, the amount of time spent outside, and personal habits. While dermal and inhalation exposure can sometimes be a concern for soil and dust, the primary pathway of concern is ingestion.

To determine whether harmful effects might be possible, ATSDR reviewed the findings from numerous studies that have documented the effects of acute and chronic exposures to arsenic on humans. The several factors that should be considered when evaluating the health hazard associated with arsenic in soil include bioavailability of arsenic in soil, pica-like behavior in children, and carcinogenic effect. Children and children with soil-pica behavior are a special concern for acute exposures because ingesting high amounts of soil could lead to significant arsenic exposure.

ATSDR has developed a provisional acute and chronic oral MRL for arsenic of 0.005 mg/kg/day and 0.0003 mg/kg/day, respectively. MRL is an exposure level below which non-cancerous harmful effects are unlikely. The acute MRL is based on several transient (i.e., temporary) effects including nausea, vomiting, and diarrhea. When an estimated acute dose of arsenic is below 0.005 mg/kg/day, non-cancerous harmful effects are unlikely. It should be noted that 1) the acute MRL is 10 times below the levels that are known to cause harmful effects in humans, 2) the acute MRL is based on people being exposed to arsenic dissolved in water instead of arsenic in soil — a fact that might influence how much arsenic can be absorbed, and 3) the MRL applies to non-cancerous effects only and is not used to determine whether people could develop cancer [11]. ATSDR used the maximum surface soil arsenic concentration of 34 mg/kg to estimate site specific exposure (Appendix A). Based on this conservative exposure, ATSDR determined it is unlikely that adults and children (include children with pica- like behavior) at any of the properties at the area would experience non-cancerous harmful effects from exposure to arsenic in soil.

For cancer effects, the Department of Health and Human Services, the International Agency for Research on Cancer, and EPA have all determined that arsenic is carcinogenic to humans. This is based on evidence from many studies of people who were exposed to arsenic-contaminated drinking water, arsenical medications, or arsenic-contaminated air in the workplace for exposure durations ranging from a few years to an entire lifetime [11]. For the smelter area, ATSDR considers the risk of developing cancer among exposed individuals to be minimal because of the relatively low levels of arsenic (average 10 mg/kg) found in the soil.

Lead concentrations in soil samples ranged from non-detect to 1911.33 mg/kg in XRF samples, and from 23.4 -1,700 mg/kg in laboratory samples. The KDHE Tier 2 risk-based standard for lead is 1000 mg/kg for non-residential areas. ATSDR considers residential soil levels above 400 mg/kg as needing further evaluation on the basis of children's unique susceptibility [12], and the KDHE Tier 2 risk-based standards and the EPA Region 9 Preliminary Remediation Goals (PRGs) for lead in residential soils are also 400 mg/kg [13-14].

In the commercial, industrial and open land portions of the former smelter, the most likely human exposures to lead are occasional ingestion or infrequent dermal contact with contaminated surface soil by workers. Children would be excluded from exposure because of the current deed restriction for non-residential use. Based on many studies on the toxicity of lead and the site specific exposure scenario, ATSDR considers that exposures to lead-contaminated soil at those areas are not likely to result in adverse health effects.

U.S. DHHS classifies lead and lead compounds as reasonably anticipated to be a carcinogen. This classification is primarily based on occupational epidemiology studies which were limited by poor exposure assessment methods and did not control for confounding exposures [15]. Further, the many studies on lead toxicity have shown that children are most susceptible to adverse health effects following exposures, and environmental exposures among adults generally do not results in as serious effects as those in children. ATSDR considers that exposures to lead in the soils at the area would not cause additional cancers among workers because of occasional exposure frequency and small doses of daily intake of lead.

There are a few residential properties on the former smelter property and the adjacent properties. Residents, especially young children, can be exposed to lead in soil by hand to mouth activities. For example, when children place objects like toys, food, or their hands, in their mouths they can be exposed if the objects have soil on them. The Centers for Disease Control and Prevention (CDC) and ATSDR reported that blood levels in young children have been raised, on average, 5 micrograms per deciliter of blood for every 1,000 mg/kg of lead in residential soil or dust [16-17]. The lead contamination in the residential area is not fully characterized. Additional soil sampling data is needed to make sound public health decisions. For example, there were only 2 XRF samples and 3 laboratory samples available for the residential area at the northeast corner of the former smelter area (Figure 3 and 4).

Child Health Considerations

ATSDR considers children in its evaluations of all exposures, and we use health guidelines that are protective of children. In general, ATSDR assumes that children are more susceptible to chemical exposures than are adults. For the site-specific exposure scenarios, ATSDR considered that children can be exposed to lead in soil when they play in the residential properties on the former smelter property and the adjacent properties. ATSDR has taken into account that children are at a greater risk for exposure than are adolescents or adults because

- The normal behavior of children might result in higher rates of ingestion of contaminated soil and dust,
- Children might also receive a higher dose of contaminants because they have lower body weights than do adults, and
- Some children might eat soil excessively (called soil-pica behavior) and therefore have a higher exposure dose to contaminants in soil.

ATSDR has considered these factors in the development of its conclusions for this site. The CVs used in this health consultation are developed to be protective of susceptible populations such as children.

Conclusions

On the basis of the available environmental data, ATSDR determined that the primary route of potential human exposure is ingestion of soil and dust for workers and residents in the area. Environmental data evaluation and analysis indicated that

- It is unlikely that adults and children at any of the properties at the area would experience non-cancerous harmful effects from exposure to arsenic in soil.
- The risk of developing cancer among exposed individuals is minimal because the levels of arsenic (average 10 mg/kg) found in the soil are relatively low.
- Exposures to lead-contaminated soil at commercial, industrial and open land portions of the former smelter are not likely to result in adverse health effects in workers.
- Exposures to lead in the soils at the area would not cause additional cancers among workers because of occasional exposure frequency and small doses of daily intake of lead.
- Surface soil data for residential areas is insufficient to fully characterize the soil contamination and to evaluate exposures.

ATSDR has categorized this site as an “Indeterminate Public Health Hazard” because the soil contamination in the residential area has not been fully characterized. Therefore the level of health hazard cannot be determined. See Appendix C for more information on the ATSDR public health hazard categories.

Recommendations

Take additional surface soil samples in the residential area to fully characterize the soil contamination.

Implement administrative controls to prevent and minimize potential exposures to soil at the site. For example, notify residents of activities, restrict access to worksite, and implement work health and safety plan for workers for activities involve generating excess dust for prolonged duration.

Public Health Action Plan

The Public Health Action Plan for the site contains a description of actions that have been or will be taken by ATSDR and/or other government agencies at the site. The purpose of the Public Health Action Plan is to ensure that this public health consultation not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR to follow up on this plan to ensure its implementation.

Actions Taken:

ATSDR conducted site visits in June, July and September, 2002, March 2003, and April 2006.
ATSDR released a health consultation for the former refinery site for public comment and held a public meeting in October and November 2003.
KDHE completed site reconnaissance and evaluation for the Johnson property site. 2003.
KDHE completed site reconnaissance and evaluation for the Neodesha pond site. 2003.
KDHE completed site reconnaissance and evaluation) a preCERCLIS survey for West Indiana Street site. 2006.
KDHE completed Unified Focused Assessment for Former Twin Rivers Plating in May 2006.
BP completed corrective action study revision 1 in February 2005.
City of Neodesha closed the Ballpark area for public assess in 2005.
ATSDR is reviewing additional information as it becomes available.
BP is operating their Phase 2 Interim Remedial Measures in the Neodesha community.

Actions Planned:

ATSDR will continue to work with the community, KDHE and BP to respond to public health questions and concerns about the site.

ATSDR will provide a fact sheet to the community on the soil contamination at the site based on the three final health consultations.

Authors, Technical Advisors

Jane Zhu

Environmental Health Scientist
Consultation Section
Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry (ATSDR)

Reviewers

Susan Moore

Chief, Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry (ATSDR)

Peter Kowalski, MPH, CIH

Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry (ATSDR)

Youlanda Outin
Health Communications Specialist
Division of Health Assessment and Consultation

Denise Jordan-Izaguirre
Public Health Advisor
Office of Regional Operations, Region 7, Kansas City Office

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Figure 1. Former Neodesha Smelter Area Vicinity Map

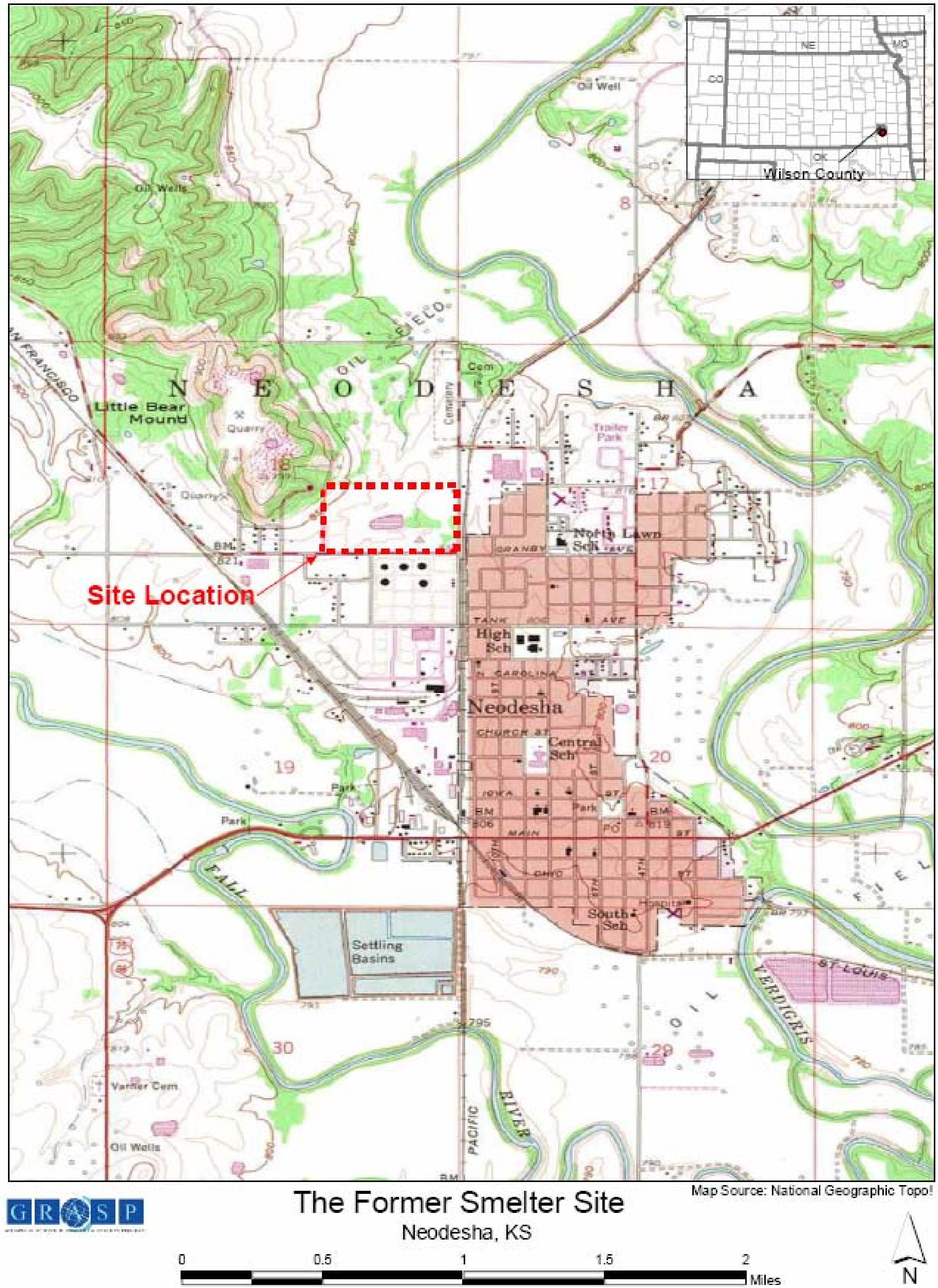


Figure 2. Current Property Ownership and land Use of Former Neodesha Smelter Area

Adopted from the Former Neodesha Smelter Voluntary Cleanup Investigation Report & Proposal for Remediation –Figure 4.

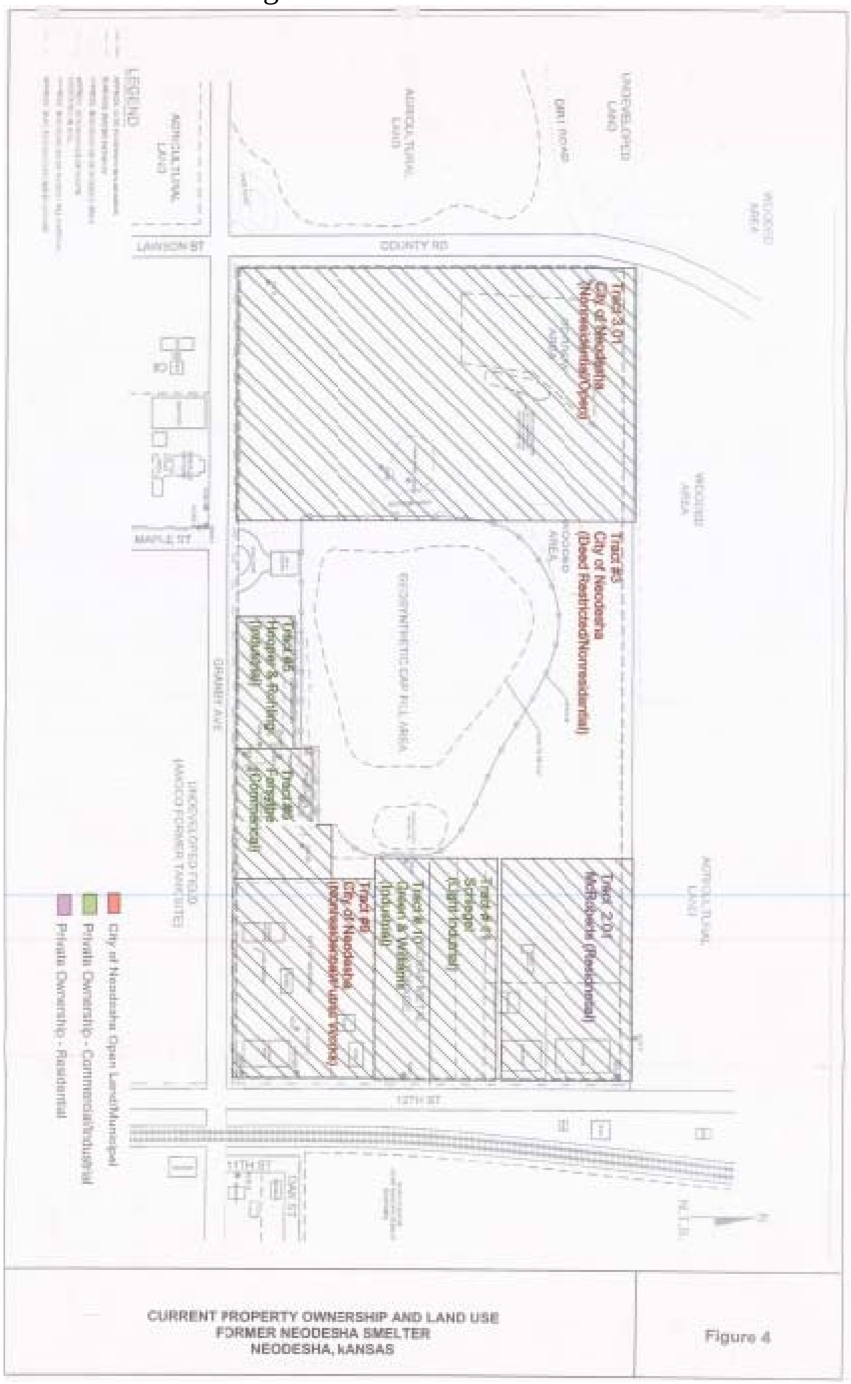
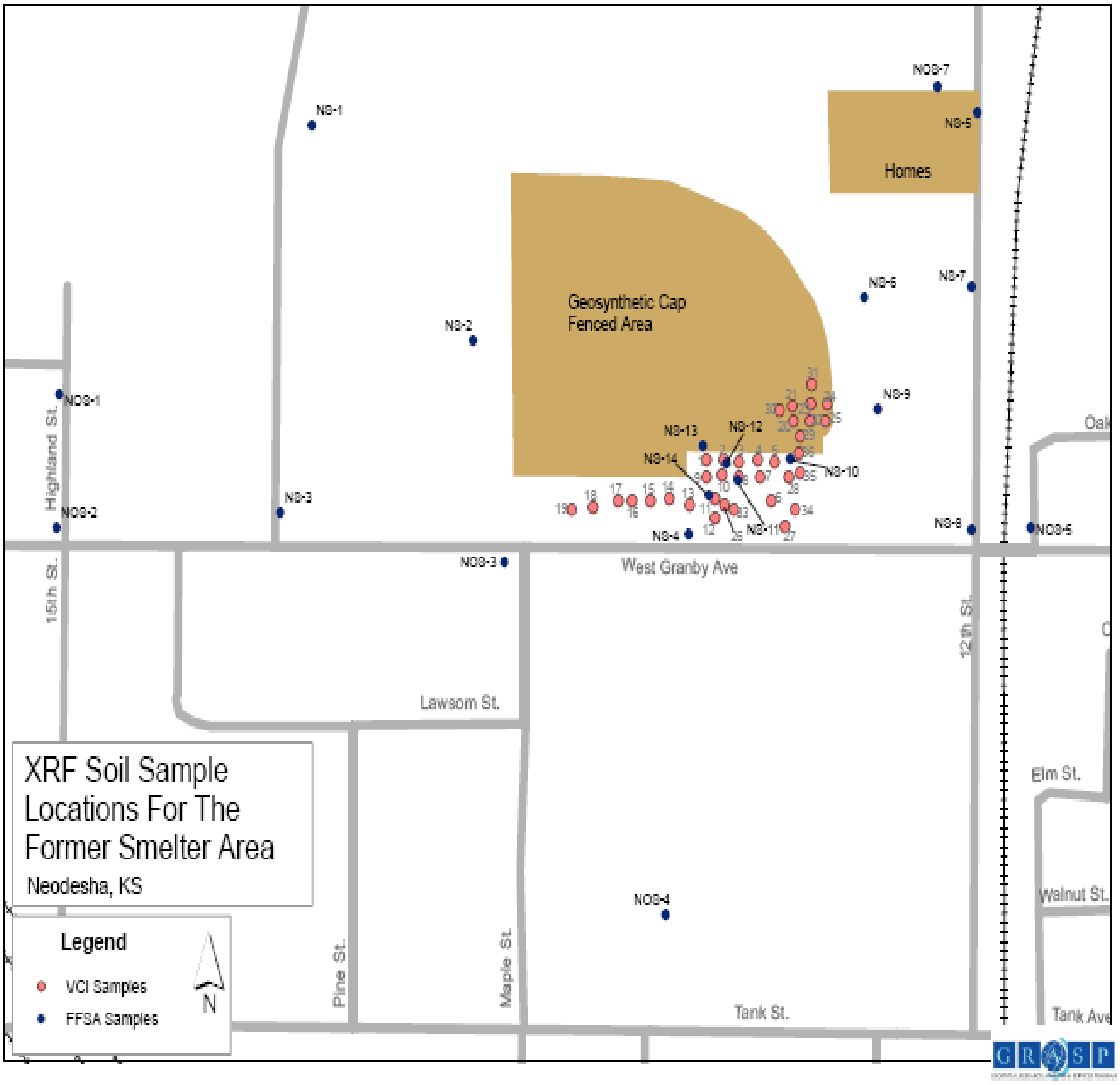
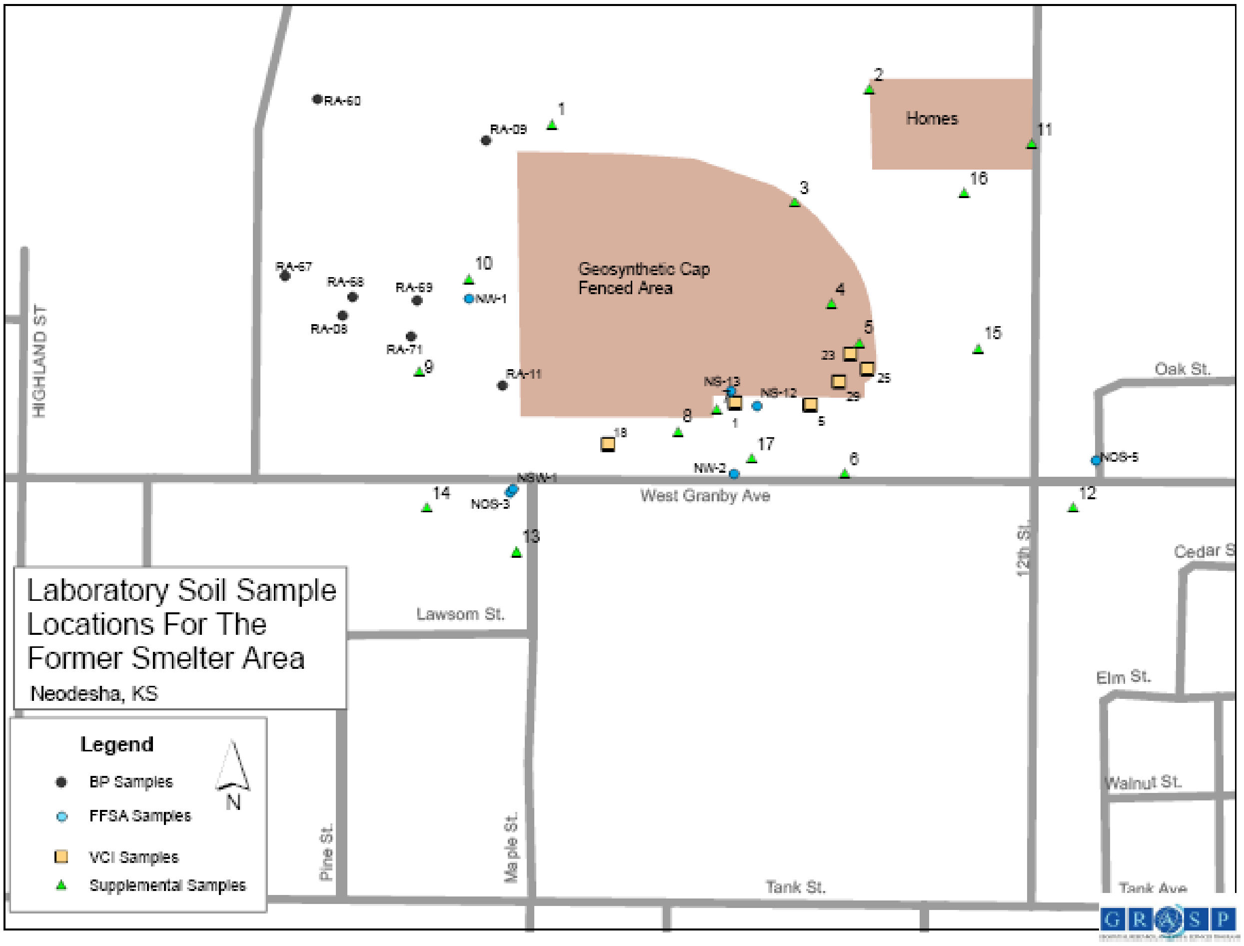


Figure 3. X -ray Fluorescence (XRF) Instrument Soil Sample Locations for the Former Neodesha Smelter Area



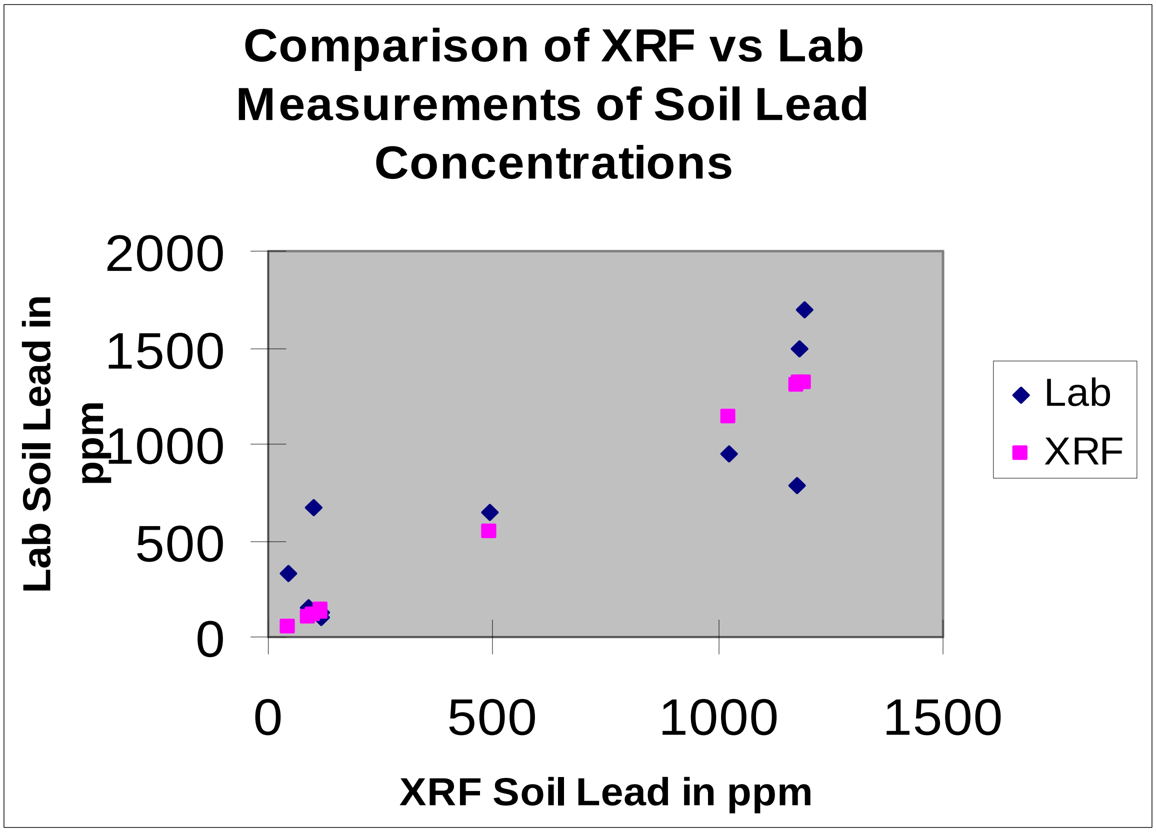
Note:
VCI - Voluntary Cleanup Investigation
FFSA - Focused Former Smelter Assessment

Figure 4. Laboratory Soil Sample Locations for the Former Neodesha Smelter Area



Note:
BP - BP Products North American Inc.
VCI - Voluntary Cleanup Investigation
FFSA - Focused Former Smelter Assessment
Supplemental - FFSA Supplemental Assessment

Figure 5. Comparison of XRF vs Laboratory Measurements of Soil lead concentrations for the Former Neodesha Smelter Area



Lab: Laboratory samples
XRF: x-ray fluorescence instrument samples

Table 1—Summary of Soil Investigation Events for the Former Smelter Area

Investigation Event	Date	Investigation Company	Sample Type	Sample Number	
				Lab	XRF
Risk Assessment	June 2001	RETEC	Lab	16	0
FFSA	June 2002	Maxim	Lab & XRF	6	24
FFSASA	March 2003	KDHE	Lab	17	0
VCI	March 2005	ENTACT	Lab & XRF	9	39
Total				48	63

Risk Assessment - BP Products North American Inc. Risk Assessment Report
VCI - Voluntary Cleanup Investigation
FFSA - Focused Former Smelter Assessment
FFSASA - FFSA Supplemental Assessment
Lab: Laboratory samples
XRF: x-ray fluorescence instrument samples

Table 2 — Summary of XRF Soil Samples Results for the Former Smelter Area (mg/kg)

Sample ID	Sampling Date	Arsenic	Cadmium	Lead
NS-1	June 2002	<30	<85	<34
NS-2	June 2002	<41	<39	294
NS-3	June 2002	<42	NA	<56
NS-4	June 2002	<38	<39	<48
NS-5	June 2002	<48	<81	<62
NS-6	June 2002	<92	<180	786
NS-7	June 2002	<46	<83	<53
NS-8	June 2002	<48	<69	70
NS-9	June 2002	<60	<16	<80
NS-10	June 2002	<39	<37	51
NS-11	June 2002	<121	<63	374
NS-12	June 2002	<80	<165	270
NS-13	June 2002	<42	<22	392
NS-13a	June 2002	<65	<38	102
NS-14	June 2002	<97	<26	159
NOS-1	June 2002	<28	<56	60
NOS-2	June 2002	<28	<70	47
NOS-3	June 2002	<35	NA	87.6
NOS-4	June 2002	<28	<87	42.7
NOS-5	June 2002	<36	<89	<44
NOS-6	June 2002	<58	<73	<86
NOS-7	June 2002	<30	<39	51
NOSS-1	June 2002	<75	<26	<97
SB.01.1.0	March 2005	<62	<74	1024
SB.02.1.0	March 2005	<53	76.9	766.33
SB.03.1.0A	March 2005	<41	<65	488.67
SB.03.1.0B	March 2005	<32	<69	257.67
SB.04.1.0	March 2005	602	<57	287.67
SB.05.1.0	March 2005	<83	<60	1173.33
SB.06.1.0	March 2005	<22	<61	30.23
SB.07.1.0	March 2005	<63	<55	162.80
SB.08.1.0	March 2005	<26	77.4	62.00
SB.09.1.0	March 2005	<24	<46	63.67
SB.10.1.0	March 2005	<15	<71	98.03
SB.11.1.0	March 2005	<55	85.6	1806.67
SB.12.1.0	March 2005	<42	<100	268.67
SB.13.1.0	March 2005	<15	<57	<15
SB.14.1.0	March 2005	<25	<63	45.40
SB.15.1.0	March 2005	<14	<53	20.37
SB.16.1.0	March 2005	<23	<69	123.67
SB.17.1.0	March 2005	<18	<55	297.33

Sample ID	Sampling Date	Arsenic	Cadmium	Lead
SB.18.1.0	March 2005	<80	<59	1183.33
SB.19.1.0	March 2005	<23	<46	14.23
SB.20.1.0	March 2005	NA	NA	325.00
SB.21.1.0	March 2005	NA	NA	696.40
SB.22.1.0	March 2005	NA	NA	1434.67
SB.23.0.5	March 2005	NA	NA	1911.33
SB.24.1.0	March 2005	NA	NA	835.67
SB.25.0.5	March 2005	NA	NA	120.07
SB.26.1.0	March 2005	NA	NA	79.75
SB.26.1.75	March 2005	NA	NA	27.65
SB.27.1.0	March 2005	NA	NA	127.17
SB.28.1.0	March 2005	NA	NA	122.57
SB.29.1.0	March 2005	NA	NA	118.33
SB.30.1.0	March 2005	NA	NA	129.87
SB.31.1.0	March 2005	NA	NA	231.33
SB.32.1.0	March 2005	<90	<57	495.00
SB.33.1.0	March 2005	<59	81.1	1059.39
SB.34.1.0	March 2005	<37	480	439.67
SB.35.1.0	March 2005	<52	53.8	569.67
SB.36.1.0	March 2005	<45	108	448.33

mg/kg - milligram per kilogram
NA - not available
< - less than

Table 3— Summary of Laboratory Soil Samples Results for the Former Smelter Area (mg/kg)

Sample ID	Sampling Date	Arsenic	Cadmium	Lead
RA-08	June 2001	8.3	4.9	107
RA-09	June 2001	7.7	0.14	34.6
RA-11	June 2001	14.9	26.9	1,030
RA-60	June 2001	10.3	<0.66	23.4
RA-67	June 2001	NA	NA	NA
RA-68	June 2001	NA	NA	NA
RA-69	June 2001	NA	NA	NA
RA-71	June 2001	NA	NA	NA
NS-12	June 2002	7.99	15.9	334
NS-13*	June 2002	11.75	30	674
NOS-3	June 2002	5.84	8.19	154
NOS-5	June 2002	7.99	15.9	334
NW-1	June 2002	7.08	13.6	876
NW-2	June 2002	10.2	23.1	265
N-SUP-1	March 2003	<5.29	NA	76.9
N-SUP-2	March 2003	<2.13	NA	NA
N-SUP-3	March 2003	<5.15	NA	69.8
N-SUP-4	March 2003	34.0	20.3	890
N-SUP-5	March 2003	5.18	49.7	1,060
N-SUP-6	March 2003	<4.29	NA	NA
N-SUP-7	March 2003	<3.16	2.19	40.7
N-SUP-8	March 2003	<3.6	66.7	233
N-SUP-9	March 2003	<4.45	NA	71.2
N-SUP-10	March 2003	<3.75	3.85	124
N-SUP-11	March 2003	<4.48	NA	210
N-SUP-12	March 2003	<4.51	NA	94.6
N-SUP-13	March 2003	5.10	NA	77.6
N-SUP-14	March 2003	2.76	NA	185
N-SUP-15	March 2003	16.3	NA	207
N-SUP-16	March 2003	2.08	NA	65.3
N-SUP-17	March 2003	5.00	87.8	343
SB.01.1.0	March 2005	29	45	950
SB.05.1.0	March 2005	12	20	790
SB.18.1.0*	March 2005	21	26	1,500
SB.23.0.5	March 2005	11	37	1,700
SB.25.0.5	March 2005	5	9	100
SB.29.1.0	March 2005	8.6	4.5	130
SB.32.1.0	March 2005	12	22	640
SB.37.0.5	March 2005	2.5	2.6	24
SB.38.0.5	March 2005	3.1	26	200

mg/kg - milligram per kilogram
NA - not available
< - less than

Table 4 —Comparison of XRF vs Laboratory Measurements of Soil Lead Concentrations for the Former Smelter Area (mg/kg)

Sample ID	Date	XRF Measurement	Laboratory Measurement
NS-12	June 2002	270	334
NS-13	June 2002	102	674
NOS-3	June 2002	87.6	154
NOS-5	June 2002	Less than 44	334
SB.01.1.0	March 2005	1024	950
SB.05.1.0	March 2005	1173.33	790
SB.18.1.0	March 2005	1183.33	1,500
SB.23.0.5	March 2005	1191.33	1,700
SB.25.0.5	March 2005	120.07	100
SB.29.1.0	March 2005	118.33	130
SB.32.1.0	March 2005	495.00	640

mg/kg - milligram per kilogram

Appendix A. Dose Calculation for Estimating Arsenic Exposure Doses

The major exposure pathway by which residents can be exposed to arsenic and mercury at the site is incidental ingestion of contaminated soil. Children and children with soil-pica behavior are a special concern for acute exposures because ingesting high amounts of soil could lead to significant arsenic exposure.

Estimate ingestion exposure dose for arsenic

The following assumptions were made to estimate ingestion exposure dose for arsenic:

(1) a adult resident's body weight is 70 kg,

(2) a adult resident soil ingestion rate is 100 mg/day

(3) a child's body weight is 16 kg,

(4) a child's soil ingestion rate is 200 mg/day,

(5) a soil-pica child's maximum soil ingestion rate is 5,000 mg/day, and a soil-pica frequency of 3 days per week.

The following mathematical formula was used to estimate the daily intake of arsenic:

ID = C x IR x BA x EF x10¯6/BW

Where,

ID=ingestion exposure dose (mg/kg/day)

C=contaminant concentration (mg/kg), the maximum arsenic concentration in surface soil of 34 mg/kg are used to represent the worst case scenario for acute exposures, chronic exposures and soil-pica child exposures.

IR=ingestion rate (mg/day)

BA=bioavailability factor (unitless, conservatively assumed to be 42 %). The bioavailability of arsenic in soil varies depending upon the source of arsenic (e.g., smelters, mines, pesticide applications). Studies have shown soil arsenic bioavailability to range from 5-51 % [11]. There is no bioavailability study for the former smelter site, therefore, ATSDR used the bioavailability factor of 42% for the dose calculation based on an EPA study on soil arsenic bioavailability for a superfund site which located in the same region and have similar arsenic source [18].

EF=exposure factor (unitless, conservatively assumed to be 1.0 for adults and children, and 0.429 for soil-pica children with weekly exposures and 1.0 for soil pica children with 1-day exposure)

BW= body weight (kg)

For adults and children, the following table shows the estimated absorbed doses at acute and chronic exposure durations:

Population	*Estimated Arsenic acute exposure dose (mg/kg/day)*	*Acute MRL (mg/kg/day)*	*Chronic MRL (mg/kg/day)*
Adult	0.00002	0.005	0.0003
Child	0.00018	0.005	0.0003
Pica-child	0.0019	0.005	Not Applicable
Pica-child	0.0045 (1-day exposure)	0.005	Not Applicable

It is unlikely that adults and children at the site experience non-cancerous harmful effects from exposure to arsenic in soil.

Appendix B. ATSDR's comparison values and definitions

ATSDR comparison values (CVs) are media-specific concentrations considered safe under default exposure scenario. ATSDR uses them as screening values to identify contaminants (site-specific substances) that require further evaluation to determine the potential for adverse health effects.

Generally, a chemical at a site requires further evaluation when its maximum concentration in air, water, or soil exceeds one of ATSDR's comparison values. Comparison values are *not*, however, thresholds of toxicity. While concentrations at or below the relevant comparison value may reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a comparison value would be expected to produce adverse health effects. Indeed, the purpose behind these highly conservative, health-based standards and guidelines is to enable health professionals to recognize and resolve potential public health problems *before* they become actual health hazards. The probability that adverse health outcomes will actually occur as a result of exposure to environmental contaminants depends on individual lifestyles and genetic factors and site-specific conditions that affect the route, magnitude, and duration of actual exposure, and not on environmental concentrations alone.

ATSDR derives screening values on the basis of noncancerous effects by dividing a NOAEL (no observed adverse effect level) by LOAELs (lowest observed adverse effect level). These levels stem from animal or human studies and include cumulative safety margins (variously called safety factors, uncertainty factors, or modifying factors) that typically range from 10 to 1,000 or more.

By contrast, cancer-based screening values come from linear extrapolations from animal data obtained at high doses because human cancer incidence data for very low levels of exposure simply do not exist, and probably never will.

Listed below are the comparison values that ATSDR uses to select chemicals for further evaluation, along with the abbreviations for the most common units of measure.

EMEG = environmental media evaluation guides

RMEG = reference dose media evaluation guide

MRLs = minimal risk levels

ppm = parts per million, e.g., mg/L or mg/kg

ppb = parts per billion, e.g., µg/L or µg/kg

kg = kilogram (1,000 gram)

mg = milligram (0.001 gram)

µg = microgram (0.000001 gram)

L = liter

m^3 = cubic meter (= 1,000 liters)

acute exposure: exposure to a chemical for a duration of 14 days or less.

cancer risk evaluation guide (CREG): estimated contaminant concentration in water, soil, or air that would be expected to cause no more than one excess case of cancer in a million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors.

chronic exposure: exposure to a chemical for 365 days or more.

environmental media evaluation guide (EMEG): concentration of a contaminant in water, soil, or air unlikely to produce any appreciable risk of adverse, non-cancer effects over a specified duration of exposure. EMEGs are derived from ATSDR minimal risk levels by factoring in default body weights and ingestion rates. ATSDR computes separate EMEGs for acute (≤14 days), intermediate (15–364 days), and chronic (>365 days) exposures.

intermediate exposure: exposure to a chemical for a duration of 15–364 days.

lowest observed adverse effect level (LOAEL): The lowest exposure level of a chemical in a study or group of studies that produces statistically or biologically significant increase(s) in frequency or severity of adverse health effects between the exposed and control populations.

minimal risk level (MRL): estimate of daily human exposure to a hazardous substance that is not likely to pose an appreciable risk of adverse noncancer health effects over a specified route and duration of exposure.

no observed adverse effect level (NOAEL): The dose of a chemical at which no statistically or biologically significant increases in frequency or severity of adverse health effects were seen between the exposed population and its appropriate control**.** Effects may be produced at this dose, but they are not considered to be adverse.

uncertainty factor (UF): a factor used in deriving the MRL or reference dose or reference concentration from exposure data.

Appendix C. ATSDR's levels of public health hazard

Category A: Urgent Public Health Hazard

This category is used for sites where short-term exposures (<1 year) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.

This determination represents a professional judgment based on critical data that ATSDR has judged sufficient to support a decision. Such a designation does not necessarily mean that the available data are complete; in some cases, additional data may be required to confirm or further support the decision made.

Criteria:

Evaluation of available relevant information* indicates that site-specific conditions or likely exposures have had, are having, or are likely to have an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards, such as open mine shafts, poorly stored or maintained flammable or explosive substances, or medical devices, which, if ruptured, could release radioactive materials.

Category B: Public Health Hazard

This category is used for sites that pose a public health hazard because of the existence of long-term exposures (>1 yr) to hazardous substances or conditions that could result in adverse health effects.

This determination represents a professional judgment based on critical data that ATSDR has judged sufficient to support a decision. Such a designation does not necessarily mean that the available data are complete; in some cases, additional data may be required to confirm or further support the decision made.

Criteria:

Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical hazards, such as open mine shafts, poorly stored or maintained flammable or explosive substances, or medical devices, which, if ruptured, could release radioactive materials.

Category C: Indeterminate Public Health Hazard

This category indicates that a professional judgment on the level of health hazard cannot be made because information critical to such a decision is lacking.

Criteria:

This category is used for sites for which available *critical* data are insufficient with regard to the extent of exposure and/or toxicological properties at estimated exposure levels. Using professional judgment, the health assessor must determine the importance of such data and the likelihood that the data can and will be obtained in a timely manner. Where some data—even limited data—are available, health assessors should, to the extent possible, select other hazard categories and support their decision with a clear narrative that explains the limits of the data and the rationale for the decision.

Category D: No Apparent Public Health Hazard

This category designates sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.

This determination represents a professional judgment based on critical data that ATSDR has judged sufficient to support a decision. Such a designation does not necessarily mean that the available data are complete; in some cases, additional data may be required to confirm or further support the decision made.

Criteria:

Available relevant information* indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in adverse impact on human health.

Category E: No Public Health Hazard

This category is used for sites that, because of the absence of exposure, do *not* pose a public health hazard.

Criteria:

Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are occurring, and none are likely to occur in the future.

* *Examples include environmental, demographic, health outcome, exposure, toxicological, medical, or epidemiologic data, as well as community health concerns information.*