Appendix E

ATSDR Health Consultations

Don Bakalian

Health Consultation

OMAHA LEAD
(a/k/a OMAHA LEAD REFINING)

OMAHA, DOUGLAS COUNTY, NEBRASKA

MARCH 21, 2000

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.

You May Contact ATSDR TOLL FREE at
1-888-42ATSDR
or
Visit our Home Page at: http://atsdr1.atsdr.cdc.gov:8080/

HEALTH CONSULTATION

OMAHA LEAD
(a/k/a OMAHA LEAD REFINING)

OMAHA, DOUGLAS COUNTY, NEBRASKA

Prepared by:

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

Background and Statement of Issues

The U.S. Environmental Protection Agency (EPA) requested the Agency for Toxic Substances and Disease Registry (ATSDR) review an Action Memorandum for a time critical removal at the Omaha Lead site, and determine (1) if the proposed soil clean-up levels would reduce the public health threat from lead exposure, and (2) if the removal actions likely to result in reduced blood lead levels in the exposed population [1].

The Omaha Lead site is located near the former ASARCO lead refinery facility, and the Gould Incorporated lead battery recycling plant The site encompasses eastern Omaha, Nebraska and Council Bluffs, Iowa (see attached map) [2]. The ASARCO facility operated from the 1870s to 1997. Airborne emissions of lead occurred during the operation of the ASARCO facility. Lead was also emitted from the blast furnace at the Gould recycling plant until its closure in 1982. In addition, several other businesses in the area used lead in the manufacturing process contributing to area lead contamination [2].

The Douglas County Health Department has conducted ambient air monitoring since 1984 at several locations around the ASARCO lead refinery facility[2]. The EPA National Ambient Air Quality Standard (NAAQS) for lead of 1.5 micrograms per cubic meter ($\mu g/m^3$) [averaged over a calendar quarter] was exceeded on a frequent basis. The highest quarterly average was measured immediately northwest of the ASARCO facility at 6.57 $\mu g/m^3$ [2].

Blood lead screening by the Douglas County Health Department (DCHD) in the greater Omaha area has shown elevated blood lead levels in children[2]. Children residing in zip codes located in whole, or in part, east of 42nd Street in Omaha were elevated on a greater frequency (see attached map). A 1998 DCHD press release stated that within these zip codes, 20.6% to 42.8% of the children exceeded the Centers for Disease Control's (CDC) blood lead guideline of 10 µg/dl [2]. This area is northwest of the ASARCO site, and along the path of the prevailing winds from the ASARCO facility [2].

The DCHD began collecting surface soil samples from residences located in east Omaha to identify potential sources of lead exposure. Soil samples were collected in the Fall of 1996 from 84 residences. Lead concentrations at 20 of the 84 residences exceeded the 400 milligram per kilogram (mg/kg) screening value established for the site. Additional sampling in the east Omaha area was conducted by DCHD in the Fall of 1998. The sampling of the residential properties was more comprehensive and included a sample from the foundation area of the homes to account for lead paint as a confounding factor. Soil lead levels from 22 of the 66 yards exceeded the 400 mg/kg screening level.

In May 1998, the President of the Omaha City Council requested assistance from EPA in addressing lead contamination in the Omaha area. In March 1999, EPA conducted sampling at 153 child care facilities located throughout the greater Omaha area (see attached map). Soil samples were also collected at selected residential properties located along the path of the prevailing wind direction from downtown Omaha. Of the 153 child care facilities, 39 had soil lead concentrations (samples collected near the foundation were not included) exceeding 400 mg/kg. Those child care facilities exceeding the 400 mg/kg level were primarily located along the path that runs north-northwest from downtown Omaha. Preliminary results for the residential sampling has shown 200 of the first 348 residences have exceeded 400 mg/kg. EPA continues to conduct soil sampling at residential properties targeting locations where blood lead levels for children under 7 years old exceeded 15µg/dl.

In the EPA Action Memorandum for the site, it is proposed that soil removal actions be performed at child care facilities were the soil lead levels exceed 400 mg/kg. Included in the proposed action are residential properties where a child under 7 years old has tested greater than 15 µg/dl for blood lead.

Discussion

Blood lead screening by the Douglas County Health Department (DCHD) showed levels exceeding the Centers for Disease Control's (CDC) blood lead guideline of 10 µg/dl in 20.6% to 42.8% of the children in some locations down wind from ASARCO and other potential sources of lead. At blood lead levels as low as 10 µg/dl, some studies have suggested that neurologic effects such as impaired intelligence quotient (IQ), behavioral functioning, and speech and language processing may occur in children [3,4]. The high percentage of elevated blood leads in this population is unusual, since blood lead levels throughout the country have steadily declined over the last two decades due to curtailments on leaded gasoline and other sources of lead. However, lead exposure does continue to occur in some areas, especially older urban areas where lead paint was used, or in areas with high concentrations of lead in the soil.

The degree of risk posed by lead -contaminated soil is dependent on factors such as the location, the concentration in the soil, the species of the lead, the activity of the exposed population, and the age and nutritional status of the exposed group. Soil ingestion rates also vary with seasonal changes, socioeconomic and cultural factors, and the degree of exposed versus covered soils [4].

In general, the CDC has estimated that blood levels in young children may be raised, on average, about 5 ug/dL for every 1,000 mg lead/kg of soil or dust, and may increase 3 to 5 times higher than the mean response depending on play habits and mouthing behavior. Even lower soil levels of lead (150 to 250 mg/kg) have been suggested as contributing to excessive blood lead levels in some children [3,4]. However, the source of the lead in the soil can be an important factor in determining whether exposure will result in elevated blood lead levels. For example, mining site studies have shown very low increases in blood lead in relation to levels found in the soil. However, exposures to smelter-generated lead deposited on soils have resulted in higher blood lead levels [5]. For this site, EPA has used a biokinetic model. The assumptions in this model have been validated largely on smelter studies [5]. Therefore, one could argue that the 400 mg/kg cleanup level proposed by EPA is valid for this site. However, as pointed out by Bornschein [5], blood lead studies, where they are comprehensive and well conducted, are the best measure of risk. With the blood data indicating undesirable levels of lead, and the biokinetic model supporting this position, it would be prudent to assume that the proposed action by EPA would result in blood lead reductions in the affected communities. This of course assumes that lead paint and other sources of lead are accounted for.

The proposed cleanup level for child care facilities and residential properties is 400 mg/kg. This level is consistent with, or lower than, cleanup levels used throughout the country, and is considered protective of public health. However, the plan does not account for residential properties where there are no children with elevated blood lead, but the soil screening value is exceeded. A child may not have been exposed at the time of the blood test, or there may not be a child at the residence at this time. In either case, the situation could change putting a child at risk in the future if the soil lead concentrations are elevated. If not already in place, continued monitoring of blood leads for children in the area after remediation may be required to identify children at risk.

ATSDR Child Health Initiative

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of environmental media. As part of the ATSDR initiative, ATSDR health consultations must consider children in their evaluations where indicated. Children have developing nervous systems that are vulnerable to the deleterious affects of lead. In addition, children are more likely to ingest contaminated soil or dust due to frequent hand to mouth activity, and can receive larger doses relative to body weight. Blood lead levels of 10 ug/dL and above have been associated with adverse health effects such as developmental and hearing impairment in children [3,4]. Since children are especially vulnerable to the deleterious effects of lead, ATSDR considered this sensitive population in the evaluation of this site, and has concurred with EPA's proposed actions to reduce exposures to the lead-contaminated soil.

Based on the information provided, ATSDR concludes the following:

Conclusions

The proposal outlined in EPA's Action Memorandum to remediate lead in soils at childcare centers and residential properties are likely to result in reduced blood leads in the exposed population.

2. Lead paint and other potential sources of lead may be responsible for increased blood lead concentrations in the population.

3. There does not appear to be a contingency plan in the action memorandum to address residential properties where the 400 mg/kg cleanup level is exceeded, but no child is present with elevated blood leads. Therefore, children residing on these properties in the future may be at risk, unless some type of long-term blood testing plan is in place for the community.

Recommendations

Ensure that a comprehensive assessment of potential lead sources (e.g.) lead-based paint is conducted at each of the properties to be remediated.

2. Develop a protocol to monitor blood lead levels in children in areas where there is not currently an elevated blood lead, but where soil lead concentrations have exceeded the cleanup level.

Preparer of report:

Timothy Walker, MS
Environmental Health Specialist
ATSDR/DHAC/EICB

Reviewers of Report:

Susan Moore
Section Chief
ATSDR/DHAC/EICB

John E. Abraham, PhD
Branch Chief
ATSDR/DHAC/EICB

REFERENCES

1 Health consultation request from Don Bahnke, EPA Region VII November 12, 1999.

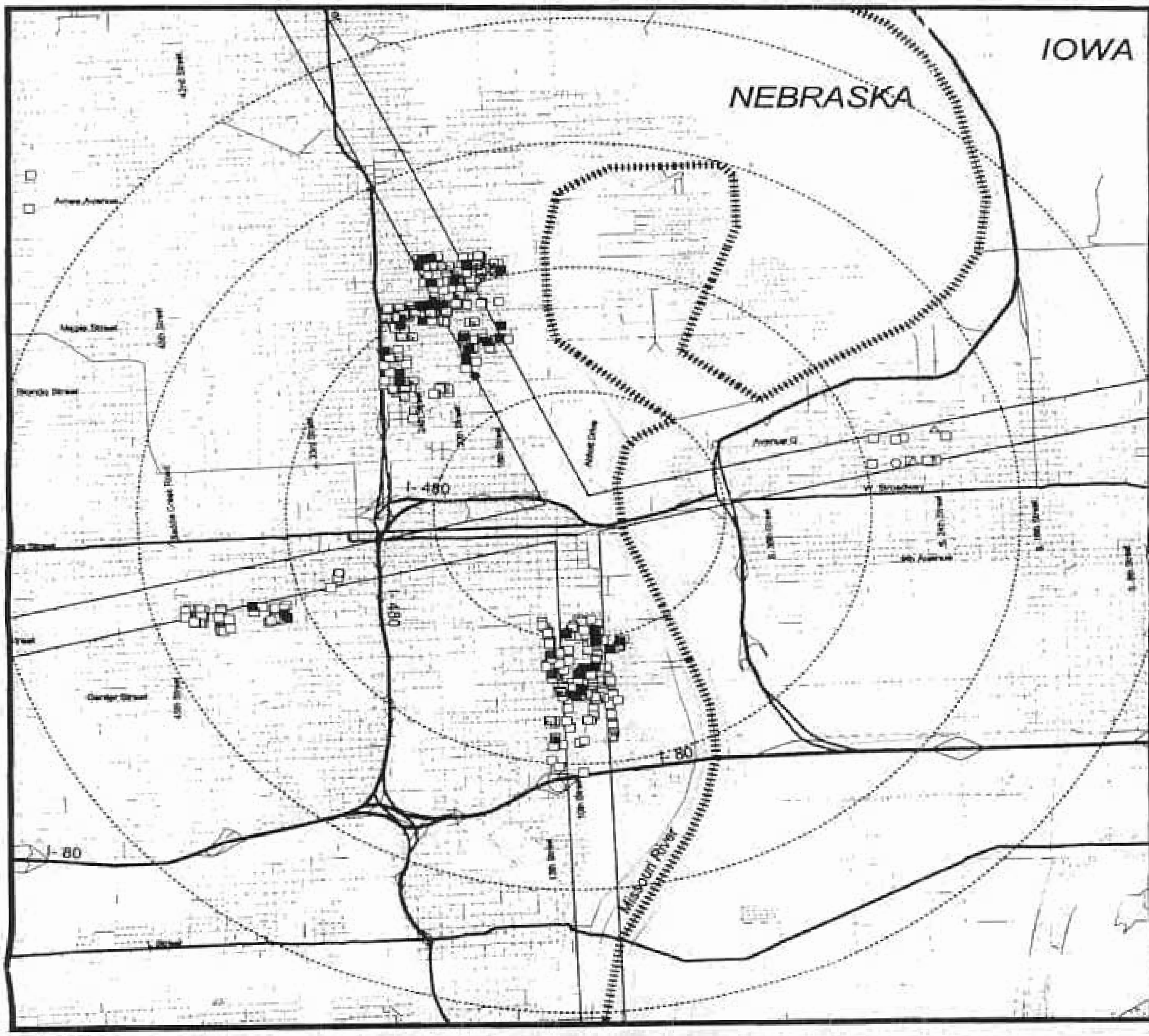
2. U.S. EPA Action Memorandum for the Omaha Lead site, Omaha, Nebraska, August 2, 1999.

3 Preventing Lead Poisoning in Young Children, A Statement by the Centers for Disease Control - October 1991, U.S. Department of Health and Human Services, Public Health Service.

4 Toxicological Profile for Lead, Update, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, April 1993.

5. Robert L. Bornschein Department of Environmental Health, University of Cincinnati, EPA Science Advisory Board, November 7, 1991.

Omaha Lead Site Investigation
Residences - Overall
XRF Lead Concentrations in Soil*



LEGEND

*Samples shown represent the highest nonfoundation lead concentration detected among quadrants, play areas and gardens at each property.

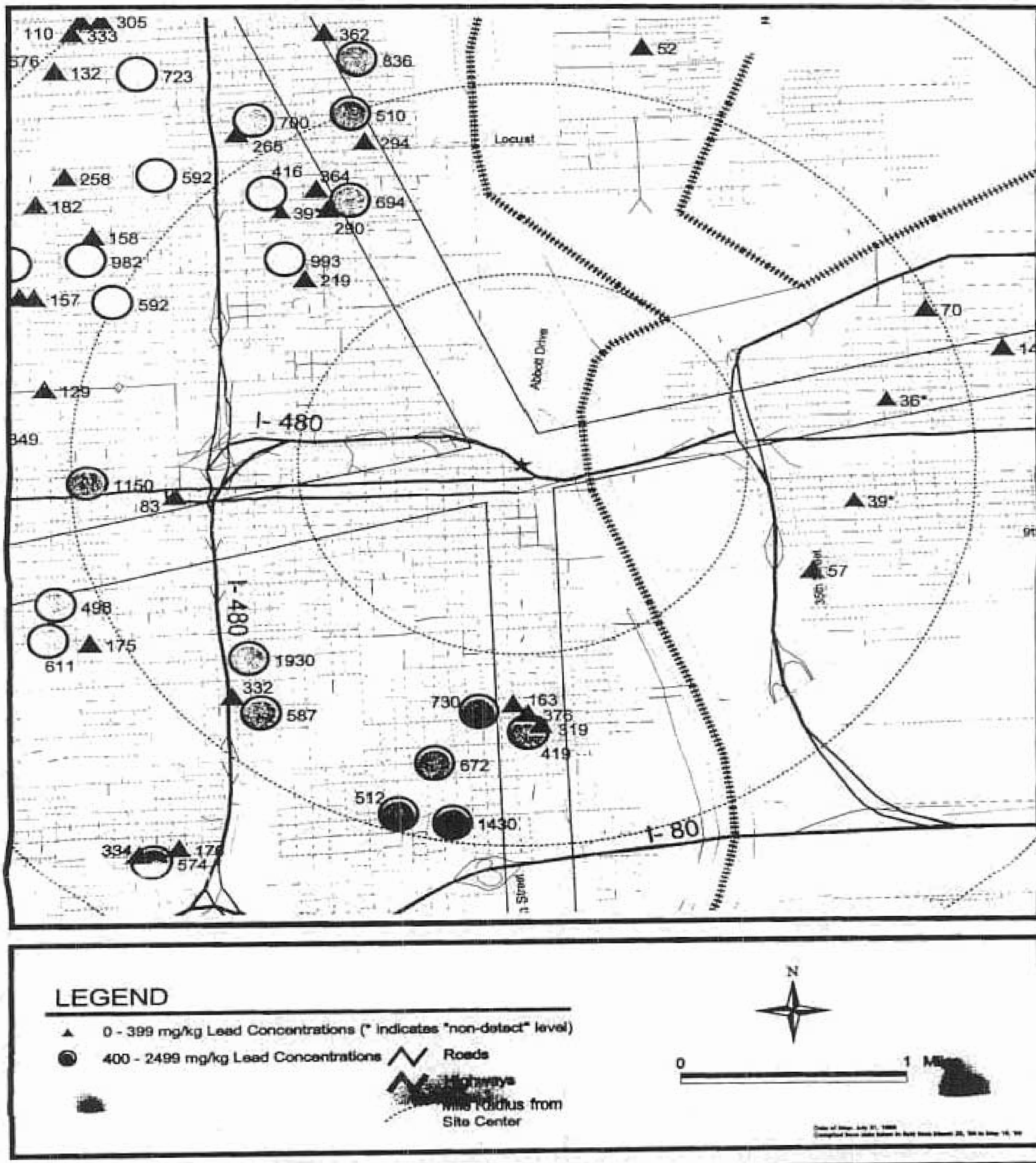
- 0 - 399 mg/Kg Lead Concentrations
- 400 - 799 mg/Kg Lead Concentrations
- 800 - 1199 mg/Kg Lead Concentrations
- 1200 + mg/Kg Lead Concentrations

- Roads
- Highways
- State Line
- Mile Radius from Site Center

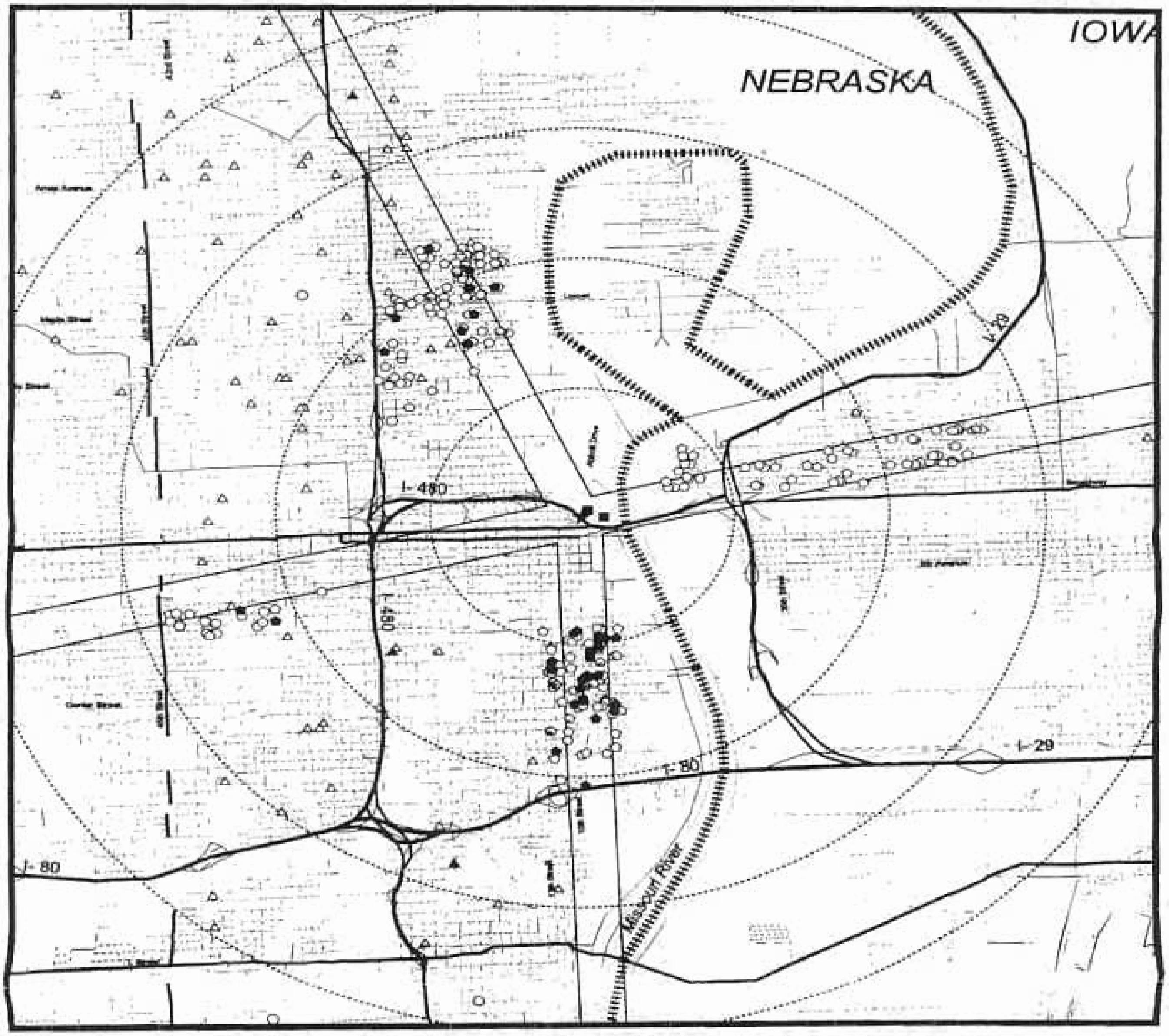
N

0 — 1 Miles

Omaha Lead Site Investigation
Child Care Centers
Lead Concentration in Soil (Quadrant Samples)



Omaha Lead Site Investigation
All Property Types
Confirmatory Sample Data for Lead



LEGEND

- 0 - 399 mg/Kg Lead Concentrations
- 400 - 799 mg/Kg Lead Concentrations
- 800 - 1199 mg/Kg Lead Concentrations
- 1200 - 2499 mg/Kg Lead Concentrations
- 2500 + mg/Kg Lead Concentrations

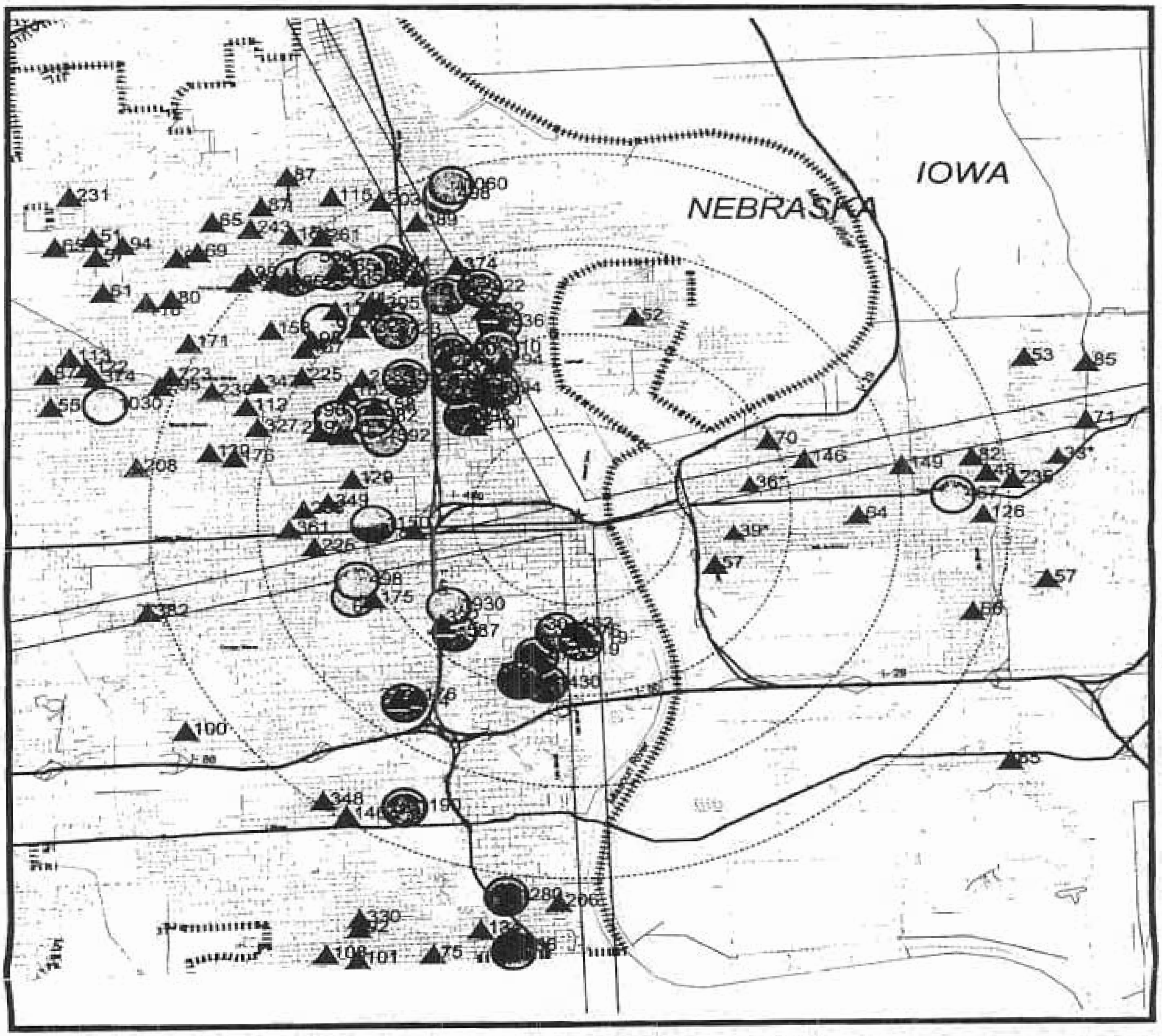
- Roads
- Highways
- State Line
- Mile Radius from Site Center

Results shown are based on highest nonfoundation lead concentration at each property.

N

0 1 Miles

Omaha Lead Site Investigation
Child Care Centers
Lead Concentration in Soil (Quadrant Samples)



LEGEND

- ▲ 0 - 399 mg/kg Lead Concentrations (* indicates "non-detect" level)
- ⊕ 400 - 2499 mg/kg Lead Concentrations
- Roads
- Highways
- Mile Radius from Site Center

N

0 — 1 Miles

Health Consultation

Evaluation of the U.S. Environmental Protection Agency
Proposed Soil Excavation Plan for the Omaha Lead Refinery Site

OMAHA LEAD REFINERY

OMAHA, DOUGLAS COUNTY, NEBRASKA

EPA FACILITY ID: NESFN0703481

JUNE 2, 2004

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.

You May Contact ATSDR TOLL FREE at
1-888-42ATSDR
or
Visit our Home Page at: http://www.atsdr.cdc.gov

HEALTH CONSULTATION

Evaluation of the U.S. Environmental Protection Agency
Proposed Soil Excavation Plan for the Omaha Lead Refinery Site

OMAHA LEAD REFINERY

OMAHA, DOUGLAS COUNTY, NEBRASKA

EPA FACILITY ID: NESFN0703481

Prepared by:

Superfund Site Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Statement of Issues and Finding

Region 7 of the U.S. Environmental Protection Agency (EPA) has requested the written concurrence of the Agency for Toxic Substances and Disease Registry (ATSDR) on their proposed soil excavation plan for the Omaha Lead Refinery National Priorities List (NPL) site in Omaha, Nebraska. ATSDR does not approve remediation actions for a contaminated site; however, given site-specific information, we will indicate whether we conclude that a proposed site-specific remedial action would be protective of public health. This decision is specific for the Omaha Lead site and is not applicable to other sites. EPA's proposed excavation actions include the following:

1. Establish a surface soil action and cleanup level of 400 parts per million (ppm) lead. All portions of a yard exceeding 400 ppm would be excavated to a maximum depth of 12 inches.
2. If the lead concentrations at 12 inches below the surface are less than 1,200 ppm the excavated will be covered with 12 inches of clean soil.
3. If the soil lead level at 12 inches below the surface is 1,200 ppm and **or** greater, heavy plastic construction fencing would be placed in the bottom of the excavation then covered with 12 inches of fill.
4. Contaminated vacant lots, parks, school yards, green spaces, etc. would follow the same rules as above, except each property where a barrier is placed would be reported to the City of Omaha for inclusion in an institutional controls program.
5. Areas of existing vegetable gardens with surface soil greater than 400 ppm would be excavated until soil lead levels are below 400 ppm or to a maximum depth of 24 inches. An alternative to this, would involve excavating the garden area to 12 inches, then constructing a 12 inch raised bed in the garden, for a total of 24 inches of clean soil.

Except for the installation of new gardens or lawns, ATSDR agrees that EPA's proposed soil excavation plan for the Omaha Lead Refinery site would be protective of public health. ATSDR suggests that an easily accessible informational database and an educational program be developed a way to deal with this exception.

Background

The Omaha Lead site includes residential properties, childcare facilities, schools, and other properties in the city of Omaha, Douglas County, Nebraska [1]. Those properties have been contaminated with lead from air emissions from lead refining operations and other sources. The site area covers about 8,840 acres. It roughly extends south from Ames Avenue to L Street and eastward from 45th Street to the Missouri River, excluding the central business district. ATSDR's evaluation of the 2000 Census data indicates that about 86,000 residents live within the identified site area. Nine thousand seven hundred of these are children 6 and younger.

The American Smelting and Refining Company (ASARCO) operated a lead refinery on the west bank of the Missouri River in downtown Omaha from the early 1870s [1,2]. The company closed the 23-acre refinery site in 1997. ASARCO is considered to have been the primary source for the soil contamination in the Omaha Lead initial site investigation area. Other sources of lead contamination may include lead-based paint and lead deposited from automobiles that used leaded gasoline in the past.

EPA started sampling the area potentially affected by the Omaha Lead site in 1999 and through 2003 has sampled 15,191 properties in Omaha and Council Bluffs [3]. At most of these properties, a minimum of five samples were collected [2]. Four of those soil samples were collected far enough from the house to avoid likely contamination by lead-based paint from the house [4]. The fifth soil sample was collected at the drip line, which is soil within 3 feet of the house to evaluate whether there is the lead in soil from peeling lead-based paint on the house. All these samples were analyzed for lead using x-ray fluorescence (XRF). XRF allows samples to be analyzed in the field. Portions of about 10% of the samples underwent laboratory analysis to validate the XRF results. The laboratory analysis used EPA methods 3010 and 6010 [5]. Over 6,800 (42%) of the properties sampled had at least one yard sample with a soil lead level of 400 ppm or greater.

Overview of the Proposed Plan

EPA is finalizing the Feasibility Study for the Omaha Lead Site and preparing the Proposed Plan to document the preferred cleanup action for lead contaminated soils at residential type properties.[1] In sampling over 15,000 properties in or near the site area, EPA has found that lead is located in the top 2 - 12 inches of soil at most properties. However, some properties contain lead at greater depths. The following is a proposal that EPA would like to include in the Proposed Plan for the excavation of soil at the Site. EPA requests written concurrence from ATSDR on this method before finalizing the plan. The excavation actions would include the following:

- Establish a surface soil action and cleanup level of 400 ppm lead. All portions of a yard exceeding 400 ppm would be excavated to a maximum depth of 12 inches. If soil concentrations below 400 ppm are achieved at a depth of less than 400 ppm, the excavation would stop in that area.

[1] This description of EPA's excavation plan was adapted from a email dated 5/18/2004 to Sue Casteel, ATSDR Region 7, from D. Mark Doolan, EPA Region 7 requesting ATSDR's assistance and summarizing the plan.

- Areas of existing vegetable gardens with surface soil greater than 400 ppm would be excavated until soil lead levels are below 400 ppm or to a maximum depth of 24 inches. An alternative option, and one that may be preferred would involve excavating the garden area to 12 inches, then constructing a 12 inch raised bed in the garden, for a total of 24 inches of clean soil.

- Once the yard soil has been excavated to a depth of 12 inches, soil in the bottom of the excavation will be sampled. EPA would consider that any soil containing lead concentrations less than 1,200 ppm (3 times the action level) will not present a significant risk once covered with 12 inches of clean soil, and the yard would simply be backfilled. For reference, EPA Headquarters allow Regions the flexibility to select cleanup levels for lead from 400 ppm to 1,200 ppm without HQ consultation. The IEUBK will predict a 1,200 ppm cleanup level for lead using the least conservative, yet defensible values for each model parameter. Additionally EPA has excepted 1,200 ppm lead in surface soil as a standard trigger level for conducting time-critical removal actions (in other words, lead levels below 1,200 ppm do not warrant a time-critical removal action).

- For areas of the yard exceeding 1,200 ppm lead, heavy plastic construction fencing would be placed in the bottom of the excavation as a visible/physical barrier prior to placing the 12 inches of clean backfill. Drip zones (within 3 feet of a structure) of the yard would be treated the same as the general yard areas. All yards where barriers are placed will be reported to the City of Omaha, where they would be tracked under the building/construction permit system. Residents planning home expansion, or other major yard disturbances/excavation, would be required to safely address contaminated soil.

- Excavated vacant lots, parks, school yards, green spaces, etc. would follow the same rules as above, where heavy plastic construction fence would be placed in the bottom of the excavation if the soil exceeds 1,200 ppm lead. However, each property where barrier is placed would be reported to the City of Omaha for inclusion in the institutional controls program. EPA, through discussion with the City, anticipates that Omaha will track these properties through their building permit system to insure proper development in the future to address the remaining contaminated soil if excavated during construction/development of the property.

Analysis

Here is our analysis of the components of EPA's proposed soil excavation plan for residential area soil in the Omaha Lead site area.

1. *Establish a surface soil action and cleanup level of 400 ppm lead then excavate all portions of a yard where the soil lead exceeds 400 ppm down to a maximum depth of 12 inches.*

   EPA seeks to limit the risk that children will have blood lead concentrations above 10 micrograms per deciliter (µg/dL) [6]. They recommend "that a soil lead concentration be determined so that a typical child or group of children exposed to lead at this level would have an estimated risk of no more than 5% of exceeding a blood lead level of 10 µg/dL" [7]. Using default inputs, the IEUBK model identifies 400 ppm as the soil lead concentration where 5% of the children would have blood lead levels about 10 µg/dL.

Although, the IEUBK model tends to overestimate the association of blood lead levels with respect to soil levels (alone), ATSDR utilizes its results to ensure the protection of children who may have other lead exposures. Therefore, ATSDR considers it prudent to prevent exposures to soil with lead concentrations above 400 ppm

2. *If the lead concentrations at 12 inches below the surface are less than 1,200 ppm the excavated will be covered with 12 inches of clean soil.*

   The underlying premise of this component of EPA's plan is that 12 inches of clean soil on top of soil concentrations of no more than 1,200 ppm would insure that soil lead levels at the surface would never exceed 400 ppm. EPA is, therefore, assuming that any disturbance of the soil would result in no more than 1 part of contaminated soil being mixed with at least 2 parts of clean soil. Disturbances could include installing or repairing water, sewer, or natural gas lines; underground electrical, T.V., or phone cables; fence and mail box posts; basketball poles; and similar activities. It also could include planting trees or shrubs. For these sorts of disturbances, EPA's underlying premise seems reasonable and would be protective of public health.

   However, this premise might not be reasonable if a resident decided to install a new garden or lawn and turned the soil using a power tiller. A possible way to deal with this situation would be to create a database which could be accessed at Omaha city offices or online that would permit residents to discover whether their lot had been tested or cleaned up. This database could be designed so that a resident could be made aware whether there were still elevated soil lead levels below grade. In conjunction with this, an education program should be developed to inform residents about the clean up.

3. *If the soil lead level at 12 inches below the surface is 1,200 ppm and greater, heavy plastic construction fencing would be placed in the bottom of the excavation then covered with 12 inches of fill.*

   This approach would be protective of public health as long as residents had a reasonable way to find out the significance of the barrier. The database suggested in number 2 could be one way to accomplish this.

4. *Contaminated vacant lots, parks, school yards, green spaces, etc. would follow the same rules as above, except each property where a barrier is placed would be reported to the City of Omaha for inclusion in an institutional controls program.*

   This approach would also be protective of public health. It is suggested that information on these properties on the informational database described previously.

5. *Areas of existing vegetable gardens with surface soil greater than 400 ppm would be excavated until soil lead levels are below 400 ppm or to a maximum depth of 24 inches. An alternative to this, would involve excavating the garden area to 12 inches, then constructing a 12 inch raised bed in the garden, for a total of 24 inches of clean soil.*

   Covering an existing garden area with 24 inches of clean fill should be protective of public health.

Assumptions and Limitations

The assumptions and limitations of this health consultation include

- That the soil used as clean fill would have lead levels at or near the background soil lead concentration of 26 ppm [8];
- That determination of the soil lead level at the bottom of an excavated area follow EPA protocol and procedures for determining contaminant levels for a specific area.
- That the 400 and 1,200 ppm concentrations are the 95% confidence levels for those levels not the actual levels.
- That the site area will not undergo any development or building activity in which the soil is graded off in distinct layers without being aware of the presence of lead-contaminated soil below grade.

Conclusion

Except for the installation of new gardens or lawns, ATSDR agrees that EPA's proposed soil excavation plan for the Omaha Lead Refinery site would be protective of public health.

Recommendation

ATSDR recommends that an easily accessible information database and an education program be developed as a way to deal with installation of new gardens or lawns by residents and also as a way to provide information on the excavation and other remediation activities.

Authors:

John R. Crellin, Ph.D.
Senior Environmental Epidemiologist
Superfund Site Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Annmarie DePasquale, MPH
Environmental Health Scientist
Superfund Site Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Regional Representative:

Sue Casteel
ATSDR Region 7
Regional Representative
Division of Regional Operations
Agency for Toxic Substances and Disease Registry

Reviewed by:

Greg Zarus
Strike Team Leader
Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Don Joe, P.E.
Assistant Branch Chief
Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

References

1. US Environmental Protection Agency. Hazard ranking score documentation record, Omaha lead site, Douglas County, Nebraska. Kansas City, Kansas: US Environmental Protection Agency, Region 7. 2002 Jan 16.

2. Black and Veatch Special Projects Corporation. Final preliminary assessment/site investigation report, Omaha Lead, Omaha, Douglas County, Nebraska; prepared for the US Environmental Protection Agency. Kansas City, Missouri. August 2001.

3. Agency for Toxic Substances and Disease Registry. Omaha Lead Refinery Public Health Assessment. Public Comment Release. Atlanta: US Department of Health and Human Services. June 2004.

4. U.S. Environmental Protection Agency. Superfund lead-contaminated residential sites handbook. Washington, DC: U.S. Environmental Protection Agency. 2003 Aug. EPA 9285.7-50. Available at: http://www.epa.gov/superfund/programs/lead/products/handbook.pdf

5. U.S. Environmental Protection Agency. Methods 3010A and 6010B in, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* U.S. Environmental Protection Agency. EPA SW-846 On-Line. Available at: http://www.epa.gov/epaoswer/hazwaste/test/main.htm

6. US Environmental Protection Agency. Overview for the IEUBK model for lead in children. Washington, DC: US Environmental Protection Agency. 2002 Aug. OSWER #9285.7-31. Available at URL: http://www.epa.gov/superfund/programs/lead/products/factsht5.pdf

7. US Environmental Protection Agency. Clarification to the 1994 revised interim soil lead (Pb) guidance for CERCLA sites and RCRA corrective action facilities. Washington, DC: US Environmental Protection Agency. OSWER directive #9200.4-27P. Available at URL: http://www.epa.gov/superfund/programs/lead/products/oswer98.pdf

8. Background summary report, Omaha lead refining site, Omaha, Douglas County, Nebraska. Jacob Federal Operations. January 27, 2000.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

OMAHA LEAD
OMAHA, DOUGLAS COUNTY, NEBRASKA
EPA FACILITY ID: NESFN0703481
MAY 2, 2005

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

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment 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.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

Agency for Toxic Substances & Disease Registry .... Julie L. Gerberding, M.D., M.P.H., Administrator
Thomas Sinks, Ph.D., M.S., Acting Director

Division of Health Assessment and Consultation........ William Cibulas, Jr., Ph.D., Director
Sharon Williams-Fleetwood, Ph.D., Deputy Director

Community Involvement Branch .... Germano E. Pereira, M.P.A., Chief

Exposure Investigations and Consultation Branch .... Donald Joe, M.S., Deputy Branch Chief

Federal Facilities Assessment Branch .... Sandra G. Isaacs, B.S., Chief

Superfund and Program Assessment Branch........ Richard E. Gillig, M.C.P., Chief

Additional copies of this report are available from:
National Technical Information Service, Springfield, Virginia
(703) 605-6000

You May Contact ATSDR TOLL FREE at
1-888-42ATSDR
or
Visit our Home Page at: http://www.atsdr.cdc.gov

PUBLIC HEALTH ASSESSMENT

OMAHA LEAD

OMAHA, DOUGLAS COUNTY, NEBRASKA

EPA FACILITY ID: NESFN0703481

Prepared by:

The U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia

TABLE OF CONTENTS

List of Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
ASARCO	American Smelting and Refining Company
CAG	Citizen Advisory Group
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DCHD	Douglas County Health Department
EBLL	elevated blood lead level
EPA	United States Environmental Protection Agency
HUD	Department of Housing and Urban Development
IARC	International Agency of Research on Cancer
IEUBK	Integrated Exposure Update Biokinetic Model for Lead in Children
ppm	parts per million
MRL	minimal risk level
NCEH	National Center for Environmental Health
NCR	Nebraska Cancer Registry
NDEQ	Nebraska Department of Environmental Quality
NHHSS	Nebraska Health and Human Services System
NPL	National Priority List
OSHA	Occupational Safety and Health Administration
PHA	public health assessment
RfD	reference dose
SDWA	Safe Drinking Water Act
TRI	Toxic Release Inventory
TSCA	Toxic Substabce Control Act
µg/dL	micrograms per deciliter
XRF	x-ray fluorescence

15µg/dL and 44 µg/dL. Four had levels between 45 µg/dL and 69 µg/dL and one child had a level greater than 69 µg/dL. The literature suggests that children with blood lead levels of 10–20 µg/dL are at risk of having decreases in IQ of up to 11 points, and slightly impaired hearing and growth. Those children with levels from 20 µg/dL to 40 µg/dL could experience problems in metabolizing vitamin D, which is important in bone development. Children with levels greater than 40 µg/dL could experience anemia and other blood-related problems. Colic, kidney disease, and diseases of the brain have been observed in children with blood lead levels greater than 60 µg/dL.

From the available information, ATSDR concludes that the ongoing exposure to lead of children 6 years old and younger living in or near the Omaha Lead initial site investigation area is putting them at risk of experiencing lead-related health effects. This exposure is evidenced by the presence of 484 children with blood lead levels of 10 µg/dL or greater in or near the site area during July 2000 through 2003. Given that about 30% of the 6 years and younger children in the area were tested, the number of EBLL children may have been 1,600 or greater for July 2000 through 2003.

ATSDR concludes that the main sources for the lead in children are soil contaminated with lead emitted from the operation of the ASARCO refinery and lead-based paint.

ATSDR recommends that EPA continue to investigate and remove soil contaminated with lead from properties, particularly homes with children 6 years of age and under, homes with children with EBLLs, schools, and daycare facilities. In addition, DCHD, the National Center for Environmental Health (NCEH), Nebraska Health and Human Services (NHHS), and ATSDR should initiate a plan regarding lead hazards. The goals of this plan would be to increase public knowledge regarding lead hazards, promote primary prevention activities, and promote and facilitate yearly blood lead testing for all children 6 years and under living in or near the Omaha Lead initial site investigation area. Aggressive blood lead testing of young children will increase the likelihood of identifying children currently exposed. This will allow timely interventions such as clean up of contaminated soil and mitigation of lead-based paint.

Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR), in Atlanta, Georgia, is one of the agencies of the U.S. Department of Health and Human Services. ATSDR is required to conduct public health assessment (PHA) activities for sites proposed for the U.S. Environmental Protection Agency's (EPA's) National Priorities List (NPL), under authorities provided by the Superfund law (Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [CERCLA]) and its amendments. The Omaha Lead site was proposed for the NPL on February 26, 2002 and listed on April 30, 2003.

In PHAs, ATSDR evaluates exposure to contaminants at hazardous waste sites, and determines whether those exposures have affected health. Based on these findings, ATSDR implements and recommends public health actions. The evaluation may result in activities that are not necessarily part of the evaluation process. The evaluation may include some or all of the following broad categories of public health activities:

- assessing how people might be exposed to contaminants;
- evaluating possible health effects from exposure to contaminants enables health professionals to identify a number of appropriate public health interventions, such as medical testing, health education and health promotion. In addition, ATSDR makes recommendations to site managers and other health professionals. Throughout this process, ATSDR works with the community to help ensure the success of our interventions for a variety of appropriate public health actions;
- recommending medical tests, health education, and health promotion;
- making recommendations to local, state, and federal agencies; and
- involving and working effectively with the community.

Site Background

Site Location

The Omaha Lead site is comprised of residential properties, childcare facilities, and schools in the city of Omaha, Douglas County, Nebraska. These properties have been contaminated with lead due to air emissions from lead refining operations and probably other sources [1]. As indicated on Figure 1, the site area covers approximately 8,840 acres extending from approximately Ames Avenue to L Street and from 45th Street to the west side of the central business district and the west bank of the Missouri River north and south of the central business district. These boundaries represent EPA's initial site investigation area. These boundaries will be adjusted based on the sampling data obtained during the remedial investigation. ATSDR's evaluation of 2000 U. S. Census data indicates that approximately 86,000 residents live within the identified site area. Approximately 9,700 of these are children 6 years old and under.

Site History

ASARCO Facility

The American Smelting and Refining Company (ASARCO) operated a lead refinery on approximately 23 acres on the west bank of the Missouri in downtown Omaha from the 1870s until 1997 [1, 2]. EPA concludes that the refinery is a major contributor of the soil lead contamination in the Omaha Lead initial site investigation area [3].

The Nebraska Department of Environmental Quality (NDEQ) cleaned up the ASARCO facility under the State of Nebraska Remedial Action Plan Monitoring Act Program [2]. NDEQ then turned the site over to the city, which has turned it into a park. The "Lewis and Clark Landing" park also includes a restaurant. EPA and NDEQ do not consider the area where the ASARCO facility was located to be part of the Omaha Lead site.

The investigation and cleanup of the ASARCO facility indicated that area groundwater and the Missouri River had been minimally contaminated by lead and other metals from ASARCO [4-8]. However, there was considerable concern that emissions from the ASARCO refinery had contaminated soil in the Omaha area [2].

Other Sources

EPA conducted several investigations of the potential industrial sources of lead contamination in the Omaha area [2–4, 9]. More than 100 potential sources were identified, but EPA is focusing on ASARCO and a now closed secondary lead smelter, Gould Battery, as the major contributors of soil contamination from industrial sources [3, 9]. Nonindustrial sources of lead contamination may include lead-based paint and lead deposited from automobiles that used leaded gasoline in the past [10].

Soil Contamination

In 1998, the Omaha City Council solicited assistance from the EPA in addressing the problems with lead contamination in the area [11]. EPA started an evaluation of the extent of the soil contamination by modeling the atmospheric deposition patterns around the ASARCO facility [12]. The modeling was performed to get a better understanding of the deposition of lead in emissions from the smoke stack in an attempt to focus soil testing in areas that were likely to be the most heavily impacted by contamination. The model indicated that the highest concentrations of lead were likely to be along the direction of the prevailing winds, which were northerly or southerly.

In March 1999, EPA began collecting soil samples from residential properties in Omaha and in Council Bluffs and Carter Lake, Iowa, in order to characterize the extent of the contamination and to prioritize soil removal actions [2]. Previous soil sampling was also conducted by the

Douglas County Health Department (DCHD), EPA, and other interested parties. As of April 9, 2004, EPA had collected soil samples from over 15,500 properties in the Omaha area[1].

Figure 2 shows results from EPA's soil sampling in the Omaha and Council Bluffs areas. As indicated on this figure, most of the locations where the lead concentration exceeds the EPA screening level of 400 parts of lead per million parts of soil (ppm) lie within or next to the Omaha Lead site focus area. The background soil lead concentration for the Omaha area is 26 ppm, based on soil sampling conducted approximately 8 miles north of the ASARCO facility [11].

Concern about Blood Lead Levels in Children

In 1997, the Centers for Disease Control and Prevention (CDC) recommended that local government analyze the available lead poisoning data and issue targeted screening guidelines [16]. In November 1998, DCHD released the available blood lead screening results. It concluded that blood lead levels in Douglas County exceeded the national average [17]. For example, about 2,850 children were screened for lead poisoning by DCHD from July 1, 1997 to June 30, 1998. The results indicated that nearly 600 children (about 21%) had blood lead levels of 10 micrograms per deciliter (µg/dL) or greater. In comparison, the *1998 Nebraska Surveillance Report on Lead Poisoning Among Children Less Than Age Six*, prepared by Nebraska Health and Human Services System (NHHSS), indicates that 7.1%, 12.0%, and 7.3% of children in Nebraska had elevated blood lead levels (EBLLs or levels of 10 µg/dL or greater) in 1996, 1997, and 1998, respectively [17].

Demographics

Table 1 shows demographic data for the Omaha Lead initial site investigation area identified on Figure 1. Within this site area, there are distinct differences between the portions north and south of Dodge Street (U.S. Highway 6) which roughly divides the site in half. The area north of this highway is 55% African-American while south of it Whites make up 75% of the population. Likewise, the percentage of individuals of Hispanic origin is greater (24%) south of Dodge Street than north of it (7%). Overall, the site investigation area is more diverse racially and culturally than the rest of Omaha. In addition, 63% of the housing in this area was built before 1950, while in all of Omaha only 27% of housing was built before 1950. This information is important in designing public health responses.

1 Conversation with Don Bahnke, EPA RPM for Omaha Lead, on April 9, 2004.

Table 1 – Demographic Characteristics of Omaha Lead Initial Site Investigation Area

Population Parameter	Total Site Area	Area North of Dodge Street	Area South of Dodge Street	City of Omaha
Total	86,826	33,637	53,189	390,007
Whites (%)	52,070 (60%)	11,966 (36%)	40,104 (75%)	305,745 (78%)
African-American (%)	21,388 (25%)	18,405 (55%)	2,983 (6%)	51,917 (13%)
American Indian (%)	1,130 (1%)	434 (1%)	696 (1%)	2,616 (0.7%)
Asian (%)	1,483 (2%)	782 (2%)	701 (1%)	6,773 (2%)
Other & Multiple Race (%)	10,755 (12%)	2,050 (6%)	8,705 (16%)	22,956 (6%)
Hispanic Origin* (%)	14,861 (17%)	2,194 (7%)	12,667 (24%)	29,397 (8%)
Children 6 Years and Younger	9,700 (11%)	3,948 (12%)	5,752 (11%)	40,758 (10%)
Adults 65 Years and Older	9,142 (11%)	3,015 (9%)	6,127 (12%)	47,766 (12%)
Females 15–44 Years	21,659 (25%)	8,901 (26%)	12,758 (24%)	92,625 (24%)
Total housing units	34,060	12,271	21,789	165,731
Percent pre-1950s housing	63%	60%	65%	27%
Mean population density (people per square mile)	6,349	5,629	6,728	5,578

* Hispanic origin is not a racial category in the census so the percent Hispanic cannot be compared to the racial parameters.
Source: 2000 U.S. Census

Land Use and Natural Resource

Land-use within the Omaha Lead site is residential, commercial, and industrial [1, 2]. The Missouri River is the eastern boundary of the site area. The river supports recreational fishing and boating. Surface water runoff from the Omaha Lead site is discharged from the sewer system into the Missouri River. Drinking water within the site area comes from the Omaha city water system, which uses water from wells and surface water from the Missouri River. Information regarding the presence of private wells in this area was unavailable [1].

Discussion

Data Used

The data used in preparing this PHA included two databases on child blood lead levels from DCHD and two databases containing the available soil lead data from EPA.

In 2002, EPA provided ATSDR with a database containing lead measurements for 13,500 samples from about 2,200 locations, including 278 locations in Council Bluff and Carter Lake, Iowa. All other samples were taken in or near Omaha, Nebraska. Most of these were taken within 5 miles of the former ASARCO facility.

In 2004, EPA provided ATSDR with a database with the results for the maximum non-drip line sample taken at the 15,191 locations sampled by EPA in Omaha and Council Bluffs. We display these soil sampling data on Figure 2.

Many of the samples in EPA's database came from the site investigation where a minimum of five samples were collected from each property [2]. Following EPA guidance for remediating lead sites, 4 of those soil samples were collected far enough from the house to avoid likely contamination by lead-based paint from the house [19]. The fifth soil sample was collected at the drip line, which is soil within 3 feet of the house. Because of its proximity to the house, this sample usually identifies lead in soil from peeling lead-based paint on the house. All these samples were analyzed for lead using x-ray fluorescence (XRF). XRF allows samples to be analyzed in the field. Portions of about 10% of the samples underwent laboratory analysis to validate the XRF results. The laboratory analysis used EPA methods 3010 and 6010 [20]. The laboratory also analyzed the samples for molybdenum, zirconium, strontium, rubidium, selenium, arsenic, mercury, zinc, copper, nickel, cobalt, iron, manganese, chromium, barium, antimony, cadmium, and silver. EPA did this to help determine whether these metals should be included in the cleanup [21].

DCHD has collected the results of blood lead testing for children 6 years and younger in Douglas County since 1992. These results are for capillary and venous testing. In 2002, DCHD provided ATSDR with data from more than 44,000 individuals for 1992 through August 2002. From this data set, ATSDR selected 12,754 records from July 2000 through August 2002, corresponding to the period for the initial soil lead data set from EPA. DCHD also provided ATSDR with a second data set with the results of the testing of 9,600 children in 2003.

The blood lead results are reports of tests by private physicians or were obtained at clinics and other efforts of the DCHD Childhood Lead Poisoning Prevention Program [22]. Since July 1997, there has been a state requirement that the results of all blood lead tests in Nebraska be reported to the health department in the county of residence for the person tested. However, DCHD indicated to ATSDR that there was not complete reporting of levels below 10 µg/dL until 2000.

Most of the DCHD data came from voluntary participation in the testing. DCHD recommends annual testing of all children 3 years old and younger [22]. They also recommend annual testing of children

3–6 years old who are at high risk of exposure to lead. DCHD defines "high risk" as children in Douglas County who :

- live or visit east of 72nd Street,
- live or visit a home built before 1978 that needs repair, is being repaired or renovated, or has the original windows and porch, and
- put many things in their mouths including toys, fingers, and soil.

Mandatory testing is required for children at ages 12 and 24 months if they are participating in the Medicaid program [23]. However, it is unclear how many of these children are actually screened.

Contaminant of Concern

The available data indicate that lead is the primary contaminant of concern for the Omaha Lead site. EPA and NHHSS made a similar determination [14,15]. Therefore, this PHA focuses on the potential health effects associated with lead exposure. If additional data reveal the presence of other contaminants at this site at levels of potential concern for human health, ATSDR will evaluate exposure to these contaminants in an separate document.

Lead Overview

As indicated in Figure 2 on page 10, lead is present in the soil of properties in and around the area encompassing the Omaha Lead site focus area. During industrial operations in Omaha, lead was released from emission stacks to the air and settled to the ground in neighboring communities [10, 12]. Lead particles from emissions deposit on the soil, become tightly bound to soil particles, and are retained in the upper portions of the surface soil after deposition. Because lead does not dissipate, biodegrade, or decay, the risk of exposure is long-term.

Other sources of lead in the environment include exhaust from vehicles that burned leaded gasoline (this use was phased out in the 1980s) [24]. Lead from interior and exterior lead-based paint may also be present in houses and soil surrounding houses built before 1978.

Individuals may be exposed to lead in soil on their property through incidental ingestion of soil during activities such as gardening and outdoor play [25]. Individuals may also be exposed to lead from inhaling dust.

The biologic fate of lead is well known [25, 26]. When ingested, 10% to 80% (depending on a variety of factors) is absorbed directly, distributed throughout the body through the bloodstream, and excreted. Lead is primarily distributed to the kidneys, bone marrow, liver, brain, bones, and teeth. Bone and tissue have been found to contain 95% of the total amount of lead stored in the body. Therefore, collecting and analyzing a blood sample for lead accurately measures recent and ongoing exposures but does not measure the amount of lead being stored.

Lead and Health Effects in Children 6 Years and Younger

In residential settings, children ages 6 years and younger are considered to be at greater risk for health effects from lead exposure than are older children and adults [27]. The reasons for children's increased vulnerability include the following:

1) children's developing nervous system;
2) hand-to-mouth behavior exhibited by children which increases the opportunity for soil ingestion or the ingestion of lead-containing dust or paint chips;
3) the efficiency of lead absorption from the gastrointestinal tract is greater for children than adults; and
4) iron and calcium deficiencies, which are prevalent in children, may enhance the absorption and increase the toxic effects of lead [26].

Most children with lead poisoning have no obvious symptoms, and therefore, the condition often remains undiagnosed and untreated [28].

Fetuses are at even greater risk from lead exposure than children [24, 28]. Because lead crosses the placenta, a woman exposed during pregnancy can transmit lead to her fetus. Lead in the bones of women who were exposed before pregnancy may be mobilized because of the physiological stresses of pregnancy resulting in exposure to the fetus.

Studies of lead exposure to children and the developing fetus have demonstrated an association between lead and several health effects [24, 26, 28, 29]. These health effects include physical and mental impairments, hearing difficulties, impaired neurological development, and reduced birth weight and gestational age [24, 30]. They can also include behavioral effects such as impulsivity, aggression, and short attention span when exposure levels are high and distractibility, poor organization, a lack of persistence, and daydreaming when exposure levels are low [31]. The neurotoxicity of lead is a particular concern. Some health effects, such as impaired academic performance and motor skills, may persist as a result of lead exposure, even when blood lead concentrations return to normal levels [32].

Evaluation of Health Effects of Lead

For the evaluation of most chemicals, ATSDR compares the exposure dose to a health guideline established for the individual contaminant. The exposure dose is the amount of a contaminant that gets into a person's body. Health guidelines used by ATSDR usually are ATSDR's minimal risk level (MRLs) or EPA's reference dose (RfD). ATSDR has developed MRLs for many contaminants commonly found at hazardous waste sites. MRLs are estimates of daily exposure to a contaminant below which noncancer adverse health effects are unlikely to occur. Public health effects are not expected to occur at exposure doses below the MRL. MRLs are developed for different routes of exposure, such as ingestion and inhalation. They are also developed for different lengths of exposure, such as acute (less than 14 days), intermediate (15–365 days), and chronic (365 days or more). RfDs are estimates of daily, lifetime exposure of human populations to a possible hazard that is not likely to cause noncancerous health effects.

ATSDR has not derived MRLs for lead exposure nor has EPA developed an RfD for inorganic lead and lead compounds. This is because clear dose-response relationships cannot be established using environmental concentrations of lead [24, 33].

Based primarily on studies in animals, EPA and the International Agency for Research in Cancer (IARC) have identified lead as a probable human carcinogen [24, 33]. Several studies reported an increased incidence of kidney cancer among lab animals who ingested or had direct skin contact with several lead compounds. There is increasing evidence from human studies of lead exposure supporting the findings of animal studies regarding the cancer-causing potential of lead [34, 35]. An IARC working group recently reviewed six studies of workers heavily exposed to lead and found limited evidence linking lead exposure with stomach, kidney, lung, and brain cancer [34].

In addition, the National Institute of Environmental Health Sciences, National Report on Carcinogens Review Committee lists lead and lead compounds as reasonably anticipated to cause cancer in humans. According to the report, exposure to lead has been associated with a small increased risk for lung and stomach cancer in humans, and cancer of the kidney, brain, or lung in studies with laboratory animals [36].

To response to the concerns that ATSDR has received about exposures at the Omaha Lead site and the likelihood of cancer, ATSDR is preparing a Health Consultation. The Health Consultation will be released under separate cover and will provide additional information on the rates of various types of cancer in the vicinity of the Omaha Lead site.

As indicated above, no health guidelines or threshold levels have been established for the health effects resulting from exposure to lead in various environmental media. However, good evidence does link health effects to blood lead levels [24, 26–28]. Levels of 10 to 20 µg/dL, and perhaps even lower, in children's blood have been associated with decreases in IQ and slightly impaired hearing and growth [24, 28, 37]. Concentrations of 20 µg/dL and greater are associated with changes in nerve conduction velocity. Vitamin D metabolism, which is important in bone development, can suffer at concentrations of 30 µg/dL [28]. In children, lead begins to affect hemoglobin synthesis at 40 µg/dL. Colic, anemia, kidney disease, and diseases of the brain occur at blood lead levels between 60 µg/dL and 100 µg/dL. CDC consider blood lead levels of greater than 10 µg/dL in children to be "elevated" and of public health concern [28].

Therefore, in this document we will use blood lead levels or a prediction of blood lead levels to evaluate the possible health consequences of exposure to lead. The next section discusses the relationship of soil lead levels to blood lead levels.

Relationship of Soil Lead Levels to Blood Lead Levels

A great deal of variation has been reported regarding the correlation of soil lead concentrations and blood lead levels. An ATSDR study of several different communities reported that lead soil concentrations greater than 500 ppm were associated with average blood lead levels greater than 10 µg/dL in children [29]. One study reported a correlation between a soil lead concentration of 250 ppm and an estimated blood lead level of 2 µg/dL [38]. CDC reported that, in general, blood lead levels increase 3–7 µg/dL for every 1,000 ppm increase in the soil lead concentration, based on the available scientific literature [28]. The variations reported among studies reflect the different sources and absorptions of lead and lead-containing compounds, different exposure conditions (i.e., ground cover, seasonal variations) and different exposed populations [26]. In addition, health conditions, such as iron deficiencies, can enhance lead absorption and toxicity [24, 28].

Several studies indicate that the increase in blood lead concentration as a function of soil lead concentration is not linear. That is, at higher soil lead concentrations, the rate of increase in blood lead levels is not as great [39]. According to this study, an increase in soil lead concentrations from 100 ppm to 1,000 ppm was linked to a change of the predicted blood lead level from 7.3 µg/dL to 13.0 µg/dL, an increase of 5.7 µg/dL. However, a soil lead concentration of 2,100 ppm was linked to an estimated blood lead level of 15.2 µg/dL, a change of only 2.2 µg/dL.

To deal with this problem of nonlinearity, EPA developed the "Integrated Exposure Uptake Biokinetic Model for Lead in Children" (IEUBK) [40]. The IEUBK model is used to predict the risk of EBLLs in children (under the age of 7 years) that are exposed to environmental lead from many sources. The model also predicts the risk (e.g., probability) that a typical child, exposed to specified media lead concentrations, will have a blood lead level greater than or equal to the level associated with adverse health effects (10 µg/dL). The IEUBK model is EPA's primary tool for identifying clean up levels for lead-contaminated soil.

The following factors are considered in the IEUBK model [40]:

- *Intake of lead in soil, house dust, air, water, and food.* Whenever possible, sampling data on lead in these various media are used to identify site-specific intake rates. Media-specific default intake rates are used in the model if sampling data are not available. These default rates are carefully determined from available research data.
- *Uptake of lead from the contaminated media into the bloodstream.* Only a fraction of the lead that an individual takes in makes it into the bloodstream. Typically, default uptake rates are used in the IEUBK model.
- *Biokinetics of lead within the body.* The biokinetics of lead, or where lead goes within the body and how fast it is eliminated, is also considered in the IEUBK model through default values which are used to calculate a mean blood lead concentration.
- *Distribution of blood lead concentrations within the population of concern.* The mean identified in the biokinetic component is then used to calculate the most probable distribution of blood lead levels within a population using default assumptions on distribution. These assumptions include variability in physiology, behavior, sampling, and analysis. These results are used to determine the probability that a child will have a blood lead concentration above a specific level. The default value for this level is 10 µg/dL.

The validity of IEUBK model was calibrated against two different blood and soil lead community studies [40]. Subsequent comparisons involved well-conducted blood and environmental lead studies of children with adequate exposure characterizations. Those comparisons demonstrate reasonably close agreement between mean observed (measured) and predicted (modeled) blood lead concentrations, and between observed and predicted exceedances of 10 µg/dL. These studies focused on communities with at least 15% of the children having blood lead concentrations greater than 10 μg/dL.

Current Standards, Regulations, and Recommendations for Lead

The following paragraphs briefly detail some of the regulations and standards regarding exposure to lead.

EPA regulates lead under the Clean Air Act and has designated lead as a hazardous air pollutant [24]. Before the Clean Air Act, the amount of lead discharged from industrial sources was not restricted. Contaminants were released to the air from the stacks at industrial facilities, settled out of the air onto nearby soil, and accumulated over time.

In the early 1970s, EPA began to phase-out the use of lead in gasoline because of its effects on the environment from automobile emissions [24]. By 1988, less than 1% of gasoline contained lead as compared to the amount of lead-containing gasoline used in 1970. In 1990, Congress stated that it would be unlawful for automotive gasoline to contain lead or lead additives after December 31, 1995.

The Lead-Based Paint Poisoning Prevention Act became law in 1988. It prohibits the use of lead-based paint in residential structures built or renovated by any federal agency [42]. The Act also gives the Department of Housing and Urban Development (HUD) authority to create regulations focused on the removal of lead from housing built before 1978. In addition to HUD, EPA, the U.S. Department of Health and Human Services, and the Department of Labor's Occupational Safety and Health Administration (OSHA) are the primary federal agencies responsible for promulgating regulations aimed at minimizing lead exposure.

In compliance with the Toxic Substance Control Act (TSCA) §403, EPA published a final rule for dangerous levels of lead in 2001. That rule establishes a soil-lead hazard of 400 ppm for bare soil in play areas and 1,200 ppm for bare soil in non-play areas of the yard [43]. As recognized in the TSCA §403 rule, lead contamination at levels equal to or exceeding the 400 ppm and 1,200 ppm standards may pose serious health risks. The potential risks are site-specific and may warrant timely response actions. However, the soil-lead hazard levels under the TSCA §403 Rule should not be used to modify approaches to addressing brownfields, NPL sites, state Superfund sites, federal CERCLA removal actions, and CERCLA non-NPL facilities.

Exposure Pathway Analysis

ATSDR identifies human exposure pathways by examining environmental and human components that might lead to contact with contaminants of concern [44]. A pathway analysis considers five principal elements:

1) a source of contamination,
2) transport through an environmental medium,
3) a point of exposure,

4) a route of human exposure, and
5) a receptor population.

Completed exposure pathways are those for which the five elements are present and exposure to a contaminant has occurred in the past, is currently occurring, or will occur in the future. ATSDR regards those people who contact contaminants as being exposed. That exposure can occur through breathing airborne contaminants, drinking water known to be contaminated, or playing or digging in contaminated soil. The identification of an exposure pathway does not imply that health effects will occur. Exposures may or may not be substantive. Thus, even if exposure has occurred, human health effects may not necessarily result.

ATSDR reviewed site history, information on site activities, and the available sampling data for the Omaha Lead site. From this review, ATSDR identified numerous exposure pathways that warranted consideration. The primary completed exposure pathway is discussed in the following section. A discussion of the additional pathways that have been considered, but eliminated for further evaluation on the basis of available data, also follows. Each of the pathways identified at the Omaha Lead site are summarized in Appendix A.

Completed Exposure Pathways

Soil

On the basis of EPA's sampling results, locations with soil lead levels above 400 ppm identified in Figure 2 are considered a completed exposure pathway. Exposure to soil lead, which originally came from the ASARCO facility may have been occurring since 1870. However, the sampling results indicate that not every location within this area is contaminated above EPA's soil screening level of 400 ppm [1–3]. Likewise, some of the lead found in the soil in the site area may have come from lead-based paint or other sources not related to the site. In addition, the soil sampling results provided by EPA indicated that the site-related lead contamination extends beyond the site study area identified by EPA when they proposed the Omaha Lead site for the NPL.

Individuals swallow soils as an incidental consequence of typical outdoor activities such as working in the yard, gardening, and playing. They can also be exposed to lead from this source by ingesting house dust that originally came from outside soil. The soil exposure pathway is an especially important pathway for children, who exhibit hand-to-mouth behavior and have consequently higher soil ingestion rates .

Lead-Based Paint

Lead-based paint in homes is not related to the Omaha Lead site, but it is a very important current source of exposure to lead for many children 6 years and younger in the Omaha area. Therefore, this exposure pathway is described here so that readers will be knowledgeable about this source of lead exposure.

Individuals are exposed to lead-based paint through ingestion of dust or soil contaminated with small particles of lead-based paint or through direct ingestion of paint chips. Exposure to lead-based paint occurs in or around homes that were painted inside or out with lead-based paint and where that paint is peeling, chipping, or otherwise deteriorating. Homes most likely to have lead-based paint are those built before 1950, but lead paint was also used in some homes built between 1950 and 1978 [22]. Use of paint containing lead in homes was banned in 1978, so it is unlikely the homes built after 1978 contain lead-based paint. As indicated in Table 1 on page 12, 63% of the housing in the Omaha Lead initial site investigation area was built before 1950, so there is a good chance that a child living in the Omaha Lead initial site investigation area could be exposed to lead from lead-based paint.

ASARCO Refinery Emissions

When the ASARCO Refinery was operating (before 1997), its airborne emissions were likely a significant completed exposure pathway, as indicated by a 1977 investigation of metals levels in children living near operating smelters [45]. The extent of soil contamination displayed in Figure 2 likely represents where exposure to airborne emissions from the ASARCO Refinery occurred. Individuals living or working in this area inhaled lead particulates from the opening of the refinery in 1871 until it ceased operation in 1997.

Ingestion of Homegrown Produce

Some Omaha residents grow fruits and vegetables in their home gardens or in community gardens. Lead can be absorbed from the soil and taken up by plants [24]. In addition, lead-contaminated soil may adhere to plant surfaces, especially potatoes, carrots, and similar "root" vegetables. Thus, consumption of plants grown in lead-contaminated soil could be another source of exposure. Recent research indicates that this pathway would be a concern only for those children who consume large amounts (about a pound a day) of homegrown produce [46]. It does not appear to be a significant pathway for adults.

DCHD developed guidelines for gardening in and around the Omaha Lead site (see Appendix C, page 41) [22]. These guidelines recommend careful trimming and washing of plants grown in soil with lead levels less than 1,000 ppm. In their guidelines, DCHD recommends that produce not be grown or eaten if the lead concentrations in the garden soil are greater than 1,000 ppm.

Considered and Eliminated Exposure Pathways

Drinking Water

Drinking water within a 4-mile radius of the site is provided by public water suppliers [1, 2]. The Metropolitan Utilities District, a local drinking water supplier, operates 52 groundwater wells and one surface water intake. Metropolitan Utilities District supplies drinking water to 600,000 customers in Omaha and Papillon, Nebraska and Carter Lake, Iowa. The Council Bluffs Waterworks provides the drinking water supply for the approximately 57,000 customers in Council Bluff, Crescent, and Underwood, Iowa. Most of the water supplied by Council Bluffs Waterworks comes from surface water intakes. It is unknown whether any private wells exist within the downtown Omaha area.

The Metropolitan Utilities District routinely tests water as it leaves the treatment plant and at the tap to ensure contaminants, including lead, are below health-based levels established under the Safe Drinking Water Act [47]. Under certain conditions, the piping in older homes can contain lead solder that can introduce lead into the home's water supply. Because of the dissolved mineral content and alkaline pH of the water in Omaha, leaching of lead solder from pipes in this area is not expected. Therefore, exposure to harmful concentrations of lead in drinking water is not expected.

Information regarding the presence or potential uses of private wells within the Omaha Lead site is unavailable [2]. As indicated in a recent EPA document, high lead concentrations are present in the top few inches of surface soil [3]. Because lead particles typically adhere to the surface soil and are not readily transported to subsurface soil, it is unlikely that lead has polluted groundwater in the Omaha area. Therefore, it is unlikely for any private wells that may exist in the area to be contaminated with lead from the Omaha Lead site.

Surface Water

In general, surface water runoff enters the Missouri River, which is east of Omaha [2]. The Missouri River supports recreational fishing and boating and serves as a drinking water source. Surface water intakes are located upstream and downstream of the Omaha Lead Site. Surface water samples collected in 1996 and 1999 did not indicate significant indicate lead contamination. In addition, the high volume of water in the Missouri River reduces the potential exposure to affected surface water. The limited duration and frequency of recreational activities that might involve contact with surface water further reduces potential exposure.

Fish Ingestion

Soil runoff is not expected to have much affect on surface water, so fish are unlikely to contain significant quantities of lead [2]. Although specific data are unavailable, eating fish from the Missouri River is not expected to result in hazardous exposure to lead.

Evaluation

Distribution of Elevated Soil and Blood Lead Levels in the Omaha Lead Site Area

ATSDR did spatial analysis of the soil and blood lead data provided by EPA and DCHD to identify those soil and blood samples obtained from the initial site investigation area. ATSDR then calculated the mean of all the soil samples at a location (drip line, yard, garden, and play area) so we could identify the risk of exposure to lead from all sources. For the blood lead data, we identified the number and percent of children in the initial site investigation area with levels of 10 µg/dL or greater. We also identified the demographic information for the initial site investigation area found on Table 1 using spatial analysis techniques.

In developing this PHA, ATSDR considered conducting statistical spatial analyses of the soil and blood lead data including matching individual blood lead results to residential soil lead locations then evaluating the relationship between the two. ATSDR decided not to do these analyses because:

- The blood lead data were collected through voluntary participation compared to the systematic way that the soil lead were obtained, which could introduce uncertainity into any analysis. Children whose parents chose to have them tested may have a significantly different chance of living at a location with elevated soil lead levels than children whose parents chose not have them tested. Therefore, any analysis might not reflect the actual relationship between blood and soil lead levels.
- The relationship between blood and soil lead levels is more complex than what can be demonstrated through a simple comparison of blood and soil lead levels at the same location. As indicated on page 262 of ATSDR Toxicological Profile for Lead [24], *"The relationship depends on depth of the soil sampled, sampling method, cleanliness of the home, age of the children, and mouthing activities, among other factors."* In addition, the amount of soil contact that a child may have is likely to vary depending on season of the year. A reasonable way to address these problems is to collect data on lead levels in soil, blood, house dust, water, and other media at the same time, then analyze. Such an investigation is beyond the scope and purpose of a PHA.
- The results of such analyses would not change or help refine the recommendations and public health action plans proposed in this PHA.

Figures 2 and 3 display the distribution of elevated soil lead and blood lead levels in and around the Omaha Lead site. The soil lead map (Figure 2) display the ***maximum*** lead level for each location sampled by EPA through 2003. Table 2 shows the ***mean*** (or average) soil lead levels at each location sampled through 2003. ATSDR calculated the mean of all the samples at a location (drip line, yard, garden, and play area) so we could identify the risk of exposure to lead from all sources. The mean soil lead levels are the highest in that portion of the Omaha Lead site north of Dodge Street (U.S. Highway 6).

The blood lead levels for the Omaha Lead site area from July 2000 through 2003 are displayed on Figure 3. Table 2 shows the percent with levels of 10 μg/dL or greater in the Omaha area for children 6 years and younger. As with the soil lead results, the highest concentrations are in that portion of the Omaha Lead initial site investigation area north of Dodge Street (U.S. Highway 6). From July 2000 through August 2002, there were 289 children 6 years old and younger living in the Omaha Lead initial site investigation area who had blood lead concentrations of 10 μg/dL or greater. During 2003, there were 195 children in the site area with 10 μg/dL or greater. Thus, 484 children were identified with levels of 10 μg/dL or greater (also referred to as EBLLs). However, given that about 30% of the 6 years and younger children in the area were tested, the number of EBLL children may have been 1,600 or greater for July 2000 through 2003.

As indicated on Table 2, 9.7% of the children tested in the Omaha Lead initial site investigation area for 2000 to 2002 had blood lead levels of 10 μg/dL or greater compared to 5.5% of Douglas County children. In 2001, 2.0% of Nebraska children and 3.1% in the United States had elevated blood levels [37]. In 2003, 6.2% of the children in the Omaha Lead initial site investigation area had EBLL.

Table 2 – Soil and Blood Lead for the Omaha Area*

	Number of Locations Sampled	Mean Soil Lead Level in Parts per Million (ppm)	Number of Blood Samples – 2000–02	Percent of Children With EBLL$^{\alpha}$ in 2000–02	Number of Blood Samples – 2003	Percent of Children With EBLL$^{\alpha}$ in 2003
Douglas County	15,191	251	12,754	5.5	9,600	3.5
Site Investigation Area	10,170	332	2,970	9.7	3,122	6.2
Site Area North of Dodge Street	4,231	362	1,228	10.8	1,088	6.9
Site Area South of Dodge Street	5,939	308	1,742	8.8	2,034	5.9

*The soil lead sampling results are from electronic files provided to ATSDR by EPA in 2002 and 2004. They are the mean of the samples taken at each location tested. Douglas County Department of Health (DCHD) provided the blood lead sampling data to ATSDR in electronic files in 2002 and 2004.
α = EBLL is elevated blood lead level which is 10 μg/dL or greater.

Possible Health Consequences From Elevated Soil and Blood Lead Levels

Of the 484 EBLL children in the Omaha Lead initial site investigation area, 320 were identified from July 2000 through 2003 with blood lead levels of 10–14 µg/dL. Another 159 of the 484 children had blood lead levels of 15–44 µg/dL. Four children had levels between 45 µg/dL and 69 µg/dL and one child had a level greater than 69 µg/dL. Those children with blood lead levels of 10–20 µg/dL are at risk of having decreases in IQ of up to 11 points, and slightly impaired hearing and growth [28]. Those children with levels from 20 µg/dL to 40 µg/dL could experience problems in metabolizing vitamin D, which is important in bone development. Children with levels greater than 40 µg/dL could experience anemia and other blood-related problems. Colic, kidney disease, and diseases of the brain have been observed in children with blood lead levels greater than 60 µg/dL.

Sources of Lead Exposure for Children with Blood Lead Levels above 10 µg/dL

Our review of the available data indicates that there are two major sources of lead for children living in the Omaha Lead site area—past emissions from the ASARCO refinery and lead-based paint. Our evaluation indicates that most of the children with EBLLs live in areas where the mean soil lead concentration exceeds 400 ppm. ATSDR review of EPA's soil sampling data indicates that 42% (4,322/10,170) of the properties sampled in the Omaha Lead initial site investigation area through 2003 had at least one location where the lead level exceeded 400 ppm. Therefore, lead in soil is likely a significant source of exposure to lead.

DCHD's recent review of the blood lead data from 1996 through 2001 indicates that 96% of the children with blood lead levels of 15 µg/dL or greater lived in homes built before 1950 [23]. Nearly all pre-1950 homes were painted both inside and out with paint that could contain up to 50% lead [23, 37]. Thus, children 6 years and younger living in pre-1950 homes likely are exposed to lead from paint if the lead-based paint has not been sealed or removed.

Eliminating or Reducing the Lead Exposure of Children

Eliminating or reducing the blood lead levels of children in or near the Omaha Lead site involves identifying specific locations where exposure to lead-contaminated soil and lead-based paint is occurring. This is being done through:

1. Primary prevention activities that evaluate, identify, and promote control of residential lead hazards through ongoing temporary mitigation (i.e., sealing or repainting) or permanent elimination (i.e., complete removal).
2. Effective intervention for children with known lead exposure to prevent or reduce further exposure to mitigate adverse health effects.

As part of this effort, DCHD has developed the following case management plan for every child reported to have a blood lead level of 10 µg/dL or greater [22]:

1. Provide general patient/family education.
2. Coordinate care and follow-up testing following CDC guidelines between patient, physician or other primary medical provider, and DCHD.

3. Provide family education, including a home visit with assessment of possible exposure sources and exposure history for confirmed blood lead levels 15 µg/dL and above. Refer individuals and families as needed for follow-up care or intervention.
4. Conduct environmental assessment for lead-based paint with lead hazard reduction follow-up and enforcement (confirmed blood lead levels of 15 µg/dL and above).
5. Coordinate free venous or capillary retesting.
6. Refer their address to EPA for soil testing and possible remediation if the child's residence is in the seven ZIP Codes east of 45th Street that encompass the Omaha Lead site focus area [13].

Steps 4 and 6 of this plan provide a mechanism to address lead-based paint and lead-contaminated soil as exposure sources for the children identified as having EBLLs by DCHD's program. ATSDR data review indicated that about 30% of the total number of eligible children—those 6 years and younger, in or near the Omaha Lead site—were tested. DCHD identified a similar percentage for testing in the site area for 2002 [48].

Public health actions to deal with the lead exposure of children in the Omaha site area should focus on increasing the percentage of children 6 years and younger that are tested. This would help locate and then mitigate exposures due to lead-contaminated soil or lead-based paint. The various agencies involved with this site should develop and initiate a detailed plan to do that.

ATSDR Children's Health Concerns

ATSDR has established an ongoing initiative to protect children from exposure to hazardous substances. ATSDR recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of their water, soil, air, or food. Because of their immature and developing organs, infants and children are usually more susceptible to toxic substances than are adults. Children are smaller, which results in higher doses when compared with adults. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care. ATSDR's evaluation contained within this document considered children as a susceptible subpopulation.

As indicated earlier, the occurrence of EBLLs in children 6 years and younger is concentrated in or near the Omaha Lead site. These children are at risk of a variety of lead-related effects, including slight decreases in intelligence, impaired hearing and growth, behavioral changes, and other effects. The main sources of exposure to lead in or near the Omaha Lead site appear to be soil contaminated with lead emitted from the ASARCO refinery and lead-based paint. The ongoing efforts to reduce exposure to both these sources need to continue and, if possible, be enhanced.

Health Outcome Data Evaluation

A health outcome data evaluation or health statistics review is the analysis of existing health information (i.e., from death certificates, birth defects registries, cancer registries, blood lead screening data bases, etc.) to determine if there is excess disease in a specific population, geographic area, or time period. Health outcome data may help determine whether the occurrence of certain adverse health effects are higher than expected in the area potentially affected by site contaminants. The evaluation of health outcome data may also give a general picture of the health of a community. However, elevated rates of a particular disease may not necessarily be caused by hazardous substances in the environment. Other factors, such as personal habits, socioeconomic status, and occupation, also may influence the development of disease. In contrast, even if elevated rates of disease are not found, a contaminant may still have caused illness or disease.

The Superfund law requires that evaluation of health outcome (for example, mortality and morbidity) data be considered in a PHA [49]. Steps to achieve that are discussed in the *ATSDR Public Health Assessment Guidance Manual* and other guidance [44, 50, 51]. ATSDR guidance recommends that an evaluation of health outcome data be done only if all the criteria listed below are met [51]. Here are the criteria and the determination of whether they are met at this site:

1. *Presence of a completed human exposure pathway*
    - There are three completed current or past exposure pathways at Omaha Lead (residential soil, lead-based paint, and ASARCO air emissions).
2. *Great enough contaminant levels to result in measurable health effects*
    - As discussed on page 25, blood and soil lead levels are great enough to either result in measurable health effects or increase a child's risk of having a blood lead level above CDC's health concern level of 10 µg/dL. Ingestion is the principle route of exposure in the residential and lead-based paint exposure pathways.
    - Exposure to lead in the ASARCO air emissions pathway among residents of eastern Omaha occurred from 1871 through 1997. The ASARCO air emissions pathway is the most likely one where carcinogenic effects might occur as most human studies identify inhalation as the route of exposure [34, 36].
3. *Sufficient persons in the completed pathway for health effects to be measured*
    - ATSDR estimates that 9,700 or more children 6 years and younger are at risk of exposure to lead in the residential soil and lead-based paint exposure pathways in the Omaha Lead site area.
    - We estimate that more than 100,000 individuals were being exposed to lead emissions from the ASARCO Refinery when that facility closed in 1997. ATSDR identified seven ZIP codes in the Omaha Lead site area that best approximates the area where this past exposure occurred.
4. *A health outcome database exists from which disease rates for population of concern can be identified*
    - DCHD has maintained a blood lead screening database since 1994.
    - Data on cancer rates in the seven ZIP codes identified by ATSDR are available from the Nebraska Cancer Registry (NCR).

ATSDR concludes that the Omaha Lead site meets the criteria for conducting an evaluation of health outcome data. DCHD provided ATSDR with blood lead screening data from the database that it has maintained since 1994. The evaluation of these data is an integral part of this PHA. NCR provided ATSDR with cancer data for the seven ZIP codes that best approximate the area where exposure was likely to have occurred. ATSDR will release its review of these cancer data as a separate report.

Community Health Concerns

ATSDR is conducting a number of activities to communicate to the community about ATSDR activities related to the Omaha Lead site and to solicit health concerns. These include:

1. participating in EPA public availability sessions, meetings of the Citizens Advisory Group (CAG) for the Omaha Lead site (monthly), health-based clinics, neighborhood groups, churches, and other community groups to provide technical assistance and health education;
2. conducting ATSDR public availability sessions to identify and discuss the concerns of the community about the health-related aspects of the Omaha Lead site remediation and removal, and ATSDR documents and activities;
3. meeting with community leaders and elected officials, physicians and other health professionals, health clinic directors, and neighborhood groups to brief them on ATSDR's health education activities, identify their health-related concerns and questions, and to determine the best ways to deliver health education to meet the unique needs of this culturally diverse community; and
4. coordinating the development of the ATSDR health education plan with ATSDR's Division of Health Education and Promotion, community representatives, DCHD, EPA, NHHSS, NDEQ, and the University of Nebraska Cooperative Extension Service.

Public Comments

The Omaha Lead site PHA was available for public review and comment from June 7 through September 6, 2004, at three library locations in Omaha: W. Dale Clark, South Omaha Branch, and Washington Branch. The document was also available for viewing or downloading from the ATSDR Web site: http://www.atsdr.cdc.gov/HAC/PHA/omahalead/pdfnote.html. ATSDR extended the end of the public comment period from August 6 to September 6 at the request of Gould Battery.

Announcements on the availability of the Omaha Lead site PHA were in local newspapers. The PHA was sent to members of the Omaha Lead CAG; members of Congress and the Nebraska Legislature from the Omaha area; the Mayor of Omaha; members of the Omaha City Council; and staff in DCHD, NDEQ, NHHSS, and EPA. These organizations and individuals also received written notice that the comment period had been extended. The PHA was also distributed to residents at neighborhood association and other community meetings.

The Omaha Lead CAG, the Nebraska Health and Human Services System (NHHSS), Union Pacific, and Gould Battery provided comments. The comments received are in Appendix D, beginning on page 44, along with ATSDR's responses to them.

Conclusions

ATSDR concludes that:

1. The ongoing exposure to lead of children 6 years old and younger living in or near the Omaha Lead site is a serious public health problem. Our review of the data for the period July 2000 through 2003 indicate that 484 children in or near the site had blood lead levels of 10 µg/dL or greater. Given that about 30% of the children 6 years and younger in the area were tested, the number of EBLL children may have been 1,600 or greater for July 2000 through 2003.

2. The main sources for the lead are soil contaminated with lead emitted from the operation of the ASARCO refinery and lead-based paint. Public health actions should focus on these two sources.

3. Public health actions to deal with the lead exposure of children in and around the Omaha Lead initial site investigation area should focus on increasing the percentage of children 6 years and younger that are tested. This would help locate and then clean up lead-contaminated soil or mitigate exposures due to lead-based paint at residences where children with EBLLs live. There should also continue to be a strong focus on primary prevention. This is making homes lead-safe through remediating lead-contaminated soil and/or mitigation of lead-based paint prior to exposure occuring.

   DCHD, ATSDR, NCEH, NHHSS, and EPA should work together to develop a plan to do this and to identify the additional resources necessary to implement it. This plan should focus on increasing public knowledge regarding lead hazards, promoting primary prevention activities, and encouraging and facilitating yearly blood lead testing for all children 6 years and under. Aggressive blood lead testing of young children would increase the likelihood of identifying children currently exposed. This will allow timely interventions such as clean up of contaminated soil or mitigation of lead-based paint.

The Public Health Hazard Category for current conditions at the Omaha Lead site is *public health hazard*. ATSDR bases this conclusion on the ongoing exposures to lead at levels that are known to cause adverse health effects. Appendix B presents a description of each of the Public Health Hazard Categories considered during the classification process.

Recommendations

ATSDR recommends that EPA continue to investigate and remove lead-contaminated soil from properties, particularly homes with children 6 years of age and under, homes with children with EBLLs, schools and daycare facilities.

ATSDR recommends that DCHD, in cooperation with NCEH, NHHS, EPA, and ATSDR, develop and implement a plan to increase the percentage of children 6 years of age and younger in and near the Omaha Lead initial site investigation area that participate in the childhood lead blood screening program. These agencies should also identify the resources needed to implement the plan. ATSDR recommends that this plan focus on educating residents living in high risk areas (which include both soil contamination and old housing) how to reduce their risk in the long term by implementing primary prevention strategies as well as learning short term interim strategies. The plan should also encourage residents of the affected area to have children 6 years of age and younger tested on a yearly basis to detect exposure above the level of concern.

Public Health Actions

The public health action plan describes the actions designed to mitigate or prevent adverse human health effects that might result from exposure to hazardous substances associated with site contamination. ATSDR commits to this public health action at the Omaha Lead site.

- ATSDR is working with DCHD, NCEH, EPA, and NHHSS to initiate a plan to increase the percentage of children 6 years of age and younger in and near the Omaha Lead site focus area who participate in the childhood blood lead screening program. ATSDR will work to identify and request or obtain the resources to implement those efforts. ATSDR will work to ensure that this plan focuses on educating residents living in high-risk areas (areas with soil contamination and old housing) about how to reduce their long-term risk by implementing primary prevention strategies. It will also provide short-term, interim strategies for reducing risk. The plan should also encourage residents of the affected area to have children 6 years of age and younger tested on a yearly basis to detect exposure above the level of concern.

ATSDR will update this public health action plan for the Omaha Lead site as additional data or conditions warrant.

Site Team

Authors
John Crellin, Ph.D.
Senior Environmental Epidemiologist
Division of Health Assessment and Consultation

Annmarie DePasquale, MPH
Environmental Health Scientist
Division of Health Assessment and Consultation

ATSDR Members
Youlanda Outin
Health Communication Specialist
Division of Health Assessment and Consultation

Paula Peters
Health Education Specialist
Division of Health Education and Promotion

Theresa NeSmith
Health Education Specialist
Division of Health Education and Promotion

Kris Bisgard, D.V.M., M.P.H.
Epidemiologist
Division of Health Studies

Rachel Powell
Communication Specialist
Office of Communications

Sue Casteel
ATSDR Region 7
Regional Representative
Division of Regional Operations

National Center for Environmental Health
Paula Staley
Project Officer
Lead Poisoning Prevention Branch
Division of Emergency and Environmental Health Services

References

1. US Environmental Protection Agency. Hazard ranking score documentation record, Omaha Lead site, Douglas County, Nebraska. Kansas City, Kansas: US Environmental Protection Agency, Region 7. 2002 Jan 16.

2. Black and Veatch Special Projects Corporation. Final preliminary assessment/site investigation report, Omaha Lead, Omaha, Douglas County, Nebraska; prepared for the US Environmental Protection Agency. Kansas City, Missouri. August 2001.

3. Black & Veatch Special Projects Corp. Remedial investigation—residential yard soil, Omaha Lead site. Kansas City, Kansas: Black & Veatch Special Projects Corp. Prepared for the US Environmental Protection Agency, Region 7. June 2004. Available at URL: http://www.epa.gov/Region7/cleanup/superfund/sites/omaha_ne_lead_RI.pdf

4. Hydrometrics, Inc. Phase I detailed site assessment for groundwater at the ASARCO Omaha plant, Omaha, Nebraska, for ASARCO, Inc. Helena, Montana. March 1995.

5. Parametrix, Inc. Ecological risks associated with releases of ASARCO Omaha refinery groundwater into the Missouri River, Omaha, Nebraska; prepared for ASARCO, Inc. Sumner, Washington. November 1995.

6. Hydrometrics, Inc. Soil and groundwater characterization for the ASARCO Omaha plant, Omaha, Nebraska; prepared for ASARCO, Inc. Helena, Montana. November 1995.

7. The Case of ASARCO, Incorporated, Consent Order of Stay, before the Nebraska Department of Environmental Quality. Lincoln, Nebraska. January 13, 1997.

8. Tsuji J. Kleinfelder, Inc., director of risk assessment and toxicology services, letter with attachment to Dennis Heitman, Nebraska Department of Environmental Quality, subject: risk evaluation report for the ASARCO Omaha Site. February 13, 1997.

9. Vines C. Dynamac Corporation, letter with attachments to Maureen Hunt, US EPA, subject: Omaha Lead site—summary of company articles from library archives. Ada, Oklahoma. September 1, 1999.

10. Bahnke D. Letter with attachment from Environmental Protection Agency, Region 7, to Robert Little, manager, environmental services, ASARCO, Inc, for written consent for entry and access. April 5, 2000.

11. Jacobs Engineering Group, Inc. Background summary report, Omaha lead refining site, Omaha, Douglas County, Nebraska. Pasedena, California: Jacobs Engineering Group, Inc. January 27, 2000.

12. Brown K. Letter with attachment from EPA technical support center director to Don Bahnke, remedial project manager, US Environmental Protection Agency Region 7, regarding contour plots, ASARCO Superfund site. December 28, 1998.

13. Bahnke D. Letter with attachment from remedial project manager, US Environmental Protection Agency Region 7, to Michael J Sanderson, Superfund division director, concerning request for Removal Action, 12-month exemption, and $2 million exemption at the Omaha Lead site. August 2, 1999.

14. US Environmental Protection Agency. Proposed plan—residential yard soils, Omaha Lead site. Kansas City, Kansas: US Environmental Protection Agency Region 7. July 16, 2004.

15. Nebraska Health and Human Services Risk Assessment Program (NHHSRAP) and US Environmental Protection Agency (EPA). Interim baseline human health risk assessment, Omaha Lead Superfund Site. Lincoln, Nebraska: Nebraska Health and Human Services Risk Assessment Program. Kansas City, Kansas: US Environmental Protection Agency. June 2004.

16. Centers for Disease Control and Prevention. Screening young children for lead poisoning: guidance for state and local public health officials. Atlanta: US Department of Health and Human Services; 1997.

17. Douglas County Health Department. Douglas County blood lead screening results exceed national average. Omaha: Douglas County Health Department; 1998 Nov 18.

18. Douglas County Health Department. Blood lead levels in Douglas County by ZIP codes. Informational transmission from Douglas County Health Department lead program coordinator to Don Banhke, US Environmental Protection Agency, February 2, 2001.

19. US Environmental Protection Agency. Superfund lead-contaminated residential sites handbook. Washington, DC: US Environmental Protection Agency. 2003 Aug. EPA 9285.7-50. Available at: http://www.epa.gov/superfund/programs/lead/products/handbook.pdf

20. US Environmental Protection Agency. SW-846 on-line—test methods for evaluating solid waste, physical/chemical methods, methods 3010A and 6010B. Washington, DC: US Environmental Protection Agency. Available at: http://www.epa.gov/epaoswer/hazwaste/test/main.htm.

21. US Environmental Protection Agency. Risk assessment guidance for Superfund. volume 1, part A. Washington, DC: U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. 1989 December. EPA/540/1-89/002. Available at URL: http://www.epa.gov/oswer/riskassessment/ragsa/index.htm.

22. Douglas County Health Department. Fact sheet on childhood lead poisoning prevention program. Omaha: Douglas County Health Department; 2002 Sep.

23. Leinenkugel K. Kids, houses and dirt: finding out what we know about lead exposures in Douglas County, Nebraska [master of public administration project]. Omaha: University of Nebraska-Omaha. 2002 May. Available at URL: http://www.unomaha.edu/~wwwpa/project/leinenkugel.html.

24. Agency for Toxic Substances and Disease Registry. Toxicological profile for lead. Atlanta: US Department of Health and Human Services. 2001 Jul.

25. Agency for Toxic Substances and Disease Registry. Impact of lead-contaminated soil on public health. Atlanta: US Department of Health and Human Services. 1992 May.

26. Agency for Toxic Substances and Disease Registry. The nature and extent of lead poisoning in children in the United States: a report to Congress. Atlanta: US Department of Health and Human Services. 1988 Jul.

27. Sedman RM. 1989. The development of applied action levels for soil contact: A scenario for the exposure of humans to soil in a residential setting. Environ Health Perspect 1989;79:291–313.

28. Centers for Disease Control and Prevention. Preventing lead poisoning in young children. Atlanta: US Department of Health and Human Services. 1991 Oct.

29. Agency for Toxic Substances and Disease Registry. Multi-site lead and cadmium exposure study with biological markers incorporated. Atlanta: US Department of Health and Human Services. 1995.

30. US Environmental Protection Agency. Air quality criteria for lead. Research Triangle Park, North Carolina: US Environmental Protection Agency. 1986. EPA 600/8-83-028F.

31. Bellinger D, Rappaport L. Developmental assessment and interventions. In: Harvey B, editor. Managing EBLLs in young children: recommendations from the Advisory Committee on Childhood Lead Poisoning Prevention. Atlanta: US Department of Health and Human Services. 2002.

32. Needleman HL, Schell A, Bellinger D, Leviton A, Allred EN. The long-term effects of exposure to low doses of lead in childhood: An 11-year follow-up report. N Engl J Med 1990;322(2):83–8.

33. Integrated Risk Information System. Lead. Accessed on-line at http://www.epa.gov/iris. December 2, 2004.

34. International Agency for Research on Cancer. Inorganic and organic lead compounds. IARC Monographs on the carcinogenic risks to humans, vol. 87, 10–17 (in preparation). Lyon, France: International Agency for Research on Cancer (IARC). February 2004.

35. National Toxicology Program. Call for public comments on seven nominations proposed for listing in the report on carcinogens, 11th edition. Federal Register 2002 Nov 6;68:62825–7. Available at URL: http://ntp.niehs.nih.gov/ntp/NewHomeRoC/RoC11RfCmtsFR.pdf.

36. National Institute of Environmental Health Sciences. Lead and lead compounds. Review summary of the National Institute of Environmental Health Sciences (NIEHS/NTP) RoC Review Committee (RG1). Research Triangle Park, North Carolina: US Department of Health and Human Services. January 2005. Available at URL: http://ntp.niehs.nih.gov/ntpweb/index.cfm?objectid=035E5806-F735-FE81-FF769DFE5509AF0A.

37. Meyer PA, Pivetz T, Dignam TA, Homa TM, Schoonover J, Brody D. Surveillance for elevated blood lead levels among children—United States, 1997–2001. MMWR 2003;52(SS-10): 1–22.

38. Madhaven S, Rosenmann K, Shehata T. Lead in soil: recommended maximum permissible levels. Environ Res 1989;49:136–42.

39. Schilling R, Bain RP. Prediction of children's blood lead levels on the basis of household-specific soil lead levels. Am J Epidemiol 1989:128(1):197–205.

40. US Environmental Protection Agency. Overview for the IEUBK model for lead in children. Washington, DC: US Environmental Protection Agency. 2002 Aug. OSWER #9285.7-31. Available at URL: http://www.epa.gov/superfund/programs/lead/products/factsht5.pdf

41. US Environmental Protection Agency. Clarification to the 1994 revised interim soil lead (Pb) guidance for CERCLA sites and RCRA corrective action facilities. Washington, DC: US Environmental Protection Agency. OSWER directive #9200.4-27P. Available at URL: http://www.epa.gov/superfund/programs/lead/products/oswer98.pdf

42. Lead-based paint hazard elimination. Federal Register 1988 53:20790–806.

43. Lead; identification of dangerous levels of lead; final rule. 40 CFR Part 745. 2001 Jan 5. Available at URL: http://www.epa.gov/lead/403_final.pdf.

44. Agency for Toxic Substances and Disease Registry. Public health assessment guidance manual. Atlanta: US Department of Health and Human Services; January 2005. Available at URL: http://atsdr1.atsdr.cdc.gov:8080/HAC/HAGM/

45. Baker EL Jr, Hayes CG, Landrigan PJ, Handke JL, Leger RT, Houswortb WJ, et al. 1977. A nationwide survey of heavy metal absorption in children living near primary copper, lead, and zinc smelters. Am J Epidemiol 106(4):261–73.

46. Hough RL, Breward N, Young SD, Crout NMJ, Tye AM, Moir AM, et al. Assessing potential risk of heavy metal exposure from consumption of home produced vegetables by urban populations. Environ Health Perspect 2004;112(2):215–21 (online 2003 Oct 31). Available at URL: http://ehp.niehs.nih.gov/members/2003/5589/5589.html.

47. US Environmental Protection Agency. Understanding the Safe Drinking Water Act. Washington, DC: US Environmental Protection Agency. 1999 Dec. EPA 810-F-99-008. Available at URL: http://www.epa.gov/safewater/sdwa/understand.pdf.

48. Douglas County Health Department. 2002 Blood lead level screening results. Omaha: Douglas County Health Department. 2003.

49. Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Pub. L. No. 95-510 (Dec 11, 1980) as amended by the Superfund Amendments and Reauthorization Act of 1986, Pub. L. No. 99-499 (Oct 17, 1986), codified together at 42 U.S.C. 103. Subchapter I—Hazardous Substances Releases, Liability, Compensation, 9604(i)(6)(F).

50. Agency for Toxic Substances and Disease Registry. Memorandum from Robert C Williams, director, to Division of Health Assessment and Consultation staff on interim guidance for use of health outcome data in public health assessments. June 17, 1996.

51. Descriptive Epidemiology Workgroup. Health outcome data in the public health assessment process. Atlanta: US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. 2002.

Appendix A - Exposure Pathways for the Omaha Lead Site

Appendix A - Exposure Pathways for Omaha Lead

Pathway Name	Environmental Media and Transport Mechanisms	Point of Exposure	Route of Exposure	Exposure Population	Time	Notes	Complete Exposure Pathway?
Soil	Lead present in soil and house dust as a result of operations at the site	Surface soil in Omaha and house dust with soil in it	Incidental ingestion, inhalation	Residents (particularly children 6 years and younger)	Past, Present, Future	Available data indicates elevated soil lead and blood lead levels among children in the Omaha area	YES
Lead-based paint ***(Not a site-related exposure pathway)***	Lead present in house dust, soil, and paint chips due to the use of lead-based paint	House dust, soil, and paint chips in homes with deteriorating lead-based paint	Incidental ingestion	Residents (particularly children 6 years and younger)	Past, Present, Future	Available data indicates that 96% of children with blood lead levels above 10 μg/dL live in homes built before 1950	YES
ASARCO Refinery Emissions	Airborne lead emissions from ASARCO Refinery	Likely the same area as where soil lead levels are elevated	Inhalation	Residents	Past	This exposure likely occurred from the opening of the refinery in 1871 until closure in 1997	YES
Ingestion of Homegrown Produce	Uptake of lead from soil by fruits and vegetables grown in residential and community gardens	Produce consumption	Ingestion	Residents	Past, Present, Future	Because of the climate and small garden size, only small quantities of fruits and vegetables are expected to be grown in residential gardens.	YES
Drinking Water	Movement of lead from soil to groundwater	Municipal drinking water	Ingestion, inhalation , direct contact	City water supply users	Past, Present, Future	Continued monitoring of municipal water supply	NO
Surface Water	Movement of lead from soil and groundwater to surface water	Missouri River and streams that drain into it from Nebraska	Direct contact	Residents	Past, Present, Future	No contaminants have been detected in surface water samples collected in 1996 and 1999	NO
Fish Uptake	Movement of lead from soil and groundwater to surface water	Fish consumption	Ingestion	Residents	Past, Present, Future	It is unlikely for fish to contain significant quantities of lead due to limited runoff	NO

Appendix B - Levels Of Public Health Hazard

Appendix B

Levels of Public Health Hazard

ATSDR classifies exposure pathways at hazardous waste sites according to their level of public health hazard. The following classifications indicate whether people could be harmed by exposure pathways and site conditions:

Urgent Public Health Hazard:	This category applies to exposure pathways and sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.
Public Health Hazard:	The category applies to exposure pathways and sites that have certain physical features or evidence of chronic (long-term), site-related chemical exposure that could result in adverse health effects.
Indeterminate Public Health Hazard:	The category applies to exposure pathways and sites where important information is lacking about chemical exposures, and a health determination cannot be made.
No Apparent Public Health Hazard:	The category applies to pathways and sites where exposure to site-related chemicals may have occurred in the past or is still occurring, however, the exposure is not at levels expected to cause adverse health effects.
No Public Health Hazard:	The category applies to pathways and sites where there is evidence of an absence of exposure to site-related chemicals.

Appendix C – Gardening Guidelines

Gardening Guidelines [22]

Soil Lead Levels < 400 ppm

- Discard old and outer leaves of vegetables. Peel root crops before eating. Do NOT compost these materials. Wash all vegetables with a 1% vinegar in water solution (1–2 oz. of vinegar in 1 gallon of water) or soapy water (taking care to rinse the soap off prior to consumption). There is more concern about lead contamination from the dirt on the exterior surfaces of unwashed produce than from the amount of lead absorbed by the plant itself.
- Locate gardens away from roads, driveways, old painted structures, potential lead sources, and old garbage dump sites. Lay out gardens to keep leafy greens and other hard-to-wash vegetables far from potential lead sources.
- Give planting preference to fruiting crops (tomatoes, peppers, squash, cucumbers, peas, beans, corn, etc.) rather than leafy vegetables such as lettuce and spinach or root crops such as carrots and radishes.
- Add organic matter to your soil, such as peat moss, compost, and manure. Organic compounds bind lead and make it less available to the plants. Suggested amounts: add three to four 4 cubic feet bales of peat moss to a 100 sq. foot garden plot.
- Maintain the soil pH above 6.5. It is hard for plants to uptake lead when the soil pH is above this level. Lead is also less available to plants when soil phosphorus levels are high.

Soil Lead Levels 400–1,000 ppm - Follow the above practices and also:

- Avoid growing leafy vegetables and root crops in this soil. Grow these crops in raised beds or containers with lead free soil.
- Topsoil of this kind can be purchased from nurseries and garden stores.

Soil Lead Levels > 1,000 ppm

- Do NOT garden in this soil.
- Install raised beds or try container gardening.

What about soil that has not been tested for lead?

- Assume the soil may have some lead contamination if it is in an area by housing built before 1978 or near past or present industrial sites. Use the above suggestions as a guide to reducing lead exposure.
- Consider having the soil tested for lead, especially if the buildings on the property were built before 1978. Also, consider testing if children younger than 7 years of age play in bare soil on the property or you grow vegetables in potentially contaminated soil.

These guidelines were developed by Douglas County Health Department [22].

Appendix D – Responses to Public Comments

Responses to Public Comments

The Omaha Lead site PHA was available for public review and comment from June 7 through September 6, 2004, at three library locations in Omaha: W. Dale Clark, South Omaha Branch, and Washington Branch. The document was also available for viewing or downloading from the ATSDR Web site at URL: http://www.atsdr.cdc.gov/HAC/PHA/omahalead/pdfnote.html. ATSDR extended the public comment period from August 6 to September 6 at the request of Gould Battery.

Announcements on the availability of the Omaha Lead PHA were published in local newspapers. The PHA was sent to members of the Omaha Lead CAG; members of Congress and Nebraska legislators from the Omaha area; the Mayor of Omaha; members of the Omaha City Council; and staff in DCHD, NDEQ, NHHSS, and EPA. These organizations and individuals also received written notice that the comment period had been extended.

The Omaha Lead CAG, NHHSS, Union Pacific, and Gould Battery provided comments. Those comments are listed below along with ATSDR's responses.

Comments From the Omaha Lead Citizen's Advisory Group

1. The CAG suggests removing the cancer discussion from the PHA. It is unclear why ATSDR believes a cancer evaluation is necessary for the area simply because lead is classified as a probable human carcinogen. The Omaha Lead site CAG understands that for carcinogens, ATSDR can and does request cancer evaluations, but the CAG is not aware of this being done at other sites. The CAG also believes that it is unlikely that an increased cancer incidence would be seen that could definitively be linked to the site.

   Response

   ATSDR will release the evaluation of cancer rates in the Omaha Site as a health consultation and will not include it in the PHA. This is being done so that the Omaha CAG, ATSDR, EPA, NCEH, NHHSS, NDEQ, and DCHD can continue to emphasize the ongoing exposure of Omaha children to lead as the major public health problem related to the Omaha Lead site.

The Superfund law requires that evaluation of health outcome (for example, mortality and morbidity) data be considered in a PHA [49]. Steps to achieve that are discussed in the *ATSDR Public Health Assessment Guidance Manual* and 1996 and 2002 revisions to that guidance [44, 50, 51]. ATSDR guidance recommends that an evaluation of health outcome data be done only if all the criteria listed below are met [51]. Here are these criteria and whether they are met at this site:

- presence of a completed human exposure pathway,
  - There are three completed current or past exposure pathways at Omaha Lead

(residential soil, lead-based paint, and ASARCO air emissions).

- great enough contaminant levels to result in measurable health effects,
  - As discussed on page 25, blood and soil lead levels are great enough to either result in measurable health effects or increase a child's risk of having a blood lead level above CDC's health concern level of 10 μg/dL. Ingestion is the principle route of exposure in the residential and lead-based paint exposure pathways.
  - Exposure to lead in the ASARCO air emissions pathway among residents of eastern Omaha occurred from 1871 through 1997. The ASARCO air emissions pathway is the most likely one where carcinogenic effects might occur as most human studies identify inhalation as the route of exposure [34,36].
- sufficient persons in the completed pathway for health effects to be measured, and
  - ATSDR estimates that 9,700 or more children six years and younger are at risk of exposure to lead in the residential soil and lead-based paint exposure pathways in the Omaha Lead site area.
  - We estimate that over 100,000 individuals were being exposed to lead emissions from the ASARCO Refinery when that facility closed in 1997. ATSDR identified seven zip codes in the Omaha Lead site area that best approximates the area where this past exposure occurred.
- a health outcome database in which disease rates for population of concern can be identified.
  - DCHD has maintained a blood lead screening database since 1994.
  - Data on cancer rates in the seven zip codes identified by ATSDR are available from the Nebraska Cancer Registry (NCR).

DCHD provided ATSDR with blood lead screening data from the database that it has maintained since 1994. The evaluation of these data is an integral part of this PHA. The NCR provided ATSDR with cancer data for the seven ZIP codes that best approximate the area where exposure was likely to have occurred. ATSDR will release its review of these cancer data as a separate report.

While the cancer evaluation is not being included in this PHA, there has been an expansion of the cancer discussion. There is increasing evidence of an association to cancer according to several recent studies on the relationship of human exposure to lead.

ATSDR does cancer evaluations as part of the PHA process when the criteria in its guidance are met. Cancer evaluations are often not included in PHAs at lead sites largely because the exposed populations are too small for a meaningful evaluation.

2. The CAG suggests that the PHA should more fully emphasize the presence and potential impact that lead-based paint may have on community health. The PHA contains a good general discussion about lead-based paint being a potential source, but none of the action items recommend aggressively addressing this important source of lead exposure.

Response

ATSDR believes that current language in the PHA strikes the proper balance between lead from refinery emissions and lead-based paint as important sources of exposure of children to lead. Staff from DCHD's Childhood Lead Poisoning Prevention Program suggested much of the language on this issue used in the conclusions and recommendations section. In addition, CDC's Lead Poisoning Prevention Branch reviewed the PHA and made several suggestions that strengthened what was written on this issue.

3. Other than presenting more current blood lead data, the PHA provides no additional data or information that was not available with the earlier Health Consultations. As such, the CAG finds the PHA to be unbeneficial to the community.

Response

ATSDR's PHAs are reviews of available environmental and biological data to determine whether public health is affected and what should be done about it, if it is. The Omaha Lead site PHA does that. We are not sure what earlier health consultations are being referenced. ATSDR issued health consultations related to Omaha in 2000 and 2004. Both were in response to requests from EPA for ATSDR's evaluation of two technical issues and did not include any significant reviews of data.

4. The CAG suggests placing greater emphasis on the potential risks to fetuses as well, given that the fetus is highly sensitive to the toxic effects of lead.

Response

The potential health risk from exposure fetuses to lead is accounted for in the PHA as the conclusions in the document are based on CDC's 10 μg/dL concern level for blood lead levels in children and EPA's soil screening level of 400 ppm. The potential for health effects in fetuses is a component in the derivation of these levels.

5. Given the diverse cultural make-up of the community, the CAG suggests including an evaluation of cultural issues related to the Omaha Lead Site.

Response

ATSDR typically includes an evaluation of cultural issues in its PHA. ATSDR will cooperate with, interact, and be closely involved with the various cultural groups in the site area during all of the health education activities it is involved related to the Omaha Lead site.

Comments from the Nebraska Health and Human Services System

6. Page 5, Summary, second paragraph. The population of concern at this site is children under the age of seven, not "6 and younger." To be consistent with other information and assessments provided to the community, the population assessed in this report should include those between 72–84 months of age as well.

   Response

   > *The term "children under the age of seven" is the equivalent of "6 and younger," now further modified as "6 years and younger." Both refer to children less than 84 months old.*

7. Page 5, Summary, third paragraph. ASARCO, lead-based paint, and leaded gasoline are listed as sources of the lead contamination at the site. Other business, such as Gould, should also be mentioned here, similar to the language at the top of page 9.

   Response

   > *This is a summary and as such not everything can be mentioned. The focus of the summary is on that information relevant to the conclusions and recommendations. Specific mention of Gould Battery in the summary is not relevant to this focus.*

8. Page 9, Site History. Please include information here that states what initiated the investigation of the site (i.e., City Council request).

   Response

   > *PHAs focus on that information and data relevant and supportive of the conclusions and recommendations in the document. This historical information was not included because it did not meet this criterion and because this information is in EPA's documents.*

9. Page 11, third paragraph. Please include Don Bahnke's title and agency.

   Response

   This information regarding Don Bahnke has been removed from the document.

10. Page 11, Concerns about Blood Lead Levels in Children, last sentence. Please provide a table or figure to support this statement.

    Response

    > *Support for this statement comes from the two references cited and has also been discussed at recent meetings of the Omaha Lead CAG. Inclusion of a table or figure illustrating this point would not add to the overall purpose and message of the document.*

11. Page 12, Demographics. Please include information as to why these statistics (race, ethnicity, etc.) are included and how they are used in the assessment. Please also include information on the percentage of pre-1978 housing if available.

Response

This information is a standard component of PHAs. A sentence has been added to this section to indicate the significance of these data. ATSDR chose to include data on pre-1950 housing rather than pre-1978 housing because CDC and others generally conclude that the presence of pre-1950 housing is a better measure of potential exposure to lead. This is because lead-based paint was more frequently used inside homes before 1950 and because lead-based paint had a significantly higher lead content before 1950 than from 1950 to 1978.

12. Page 12, Land Use and Natural Resource. The significance of this information is therefore, what? Please provide a conclusion or discussion as to how this information is utilized in the assessment.

Response

This section is typically found in PHAs. However, your comment led us to reconsider whether the section added to the overall purpose and message of the document. We concluded that it did since the data do lend support to the discussion of eliminated pathways.

13. Page 13, Data Used, third paragraph. Please include language explaining why "non-drip line" samples are used.

Response

We made revisions to address this suggestion.

14. Page 13, Data Used, forth paragraph. Please include information on why metals other than lead were tested.

Response

We have added this information to the PHA.

15. Page 14, Contaminant of Concern. Please identify the criteria for selecting contaminants of concern.

Response

We have added information on selecting contaminants of concern.

16. Page 14, Contaminant of Concern, second paragraph, last sentence. Please edit this sentence to state that lead is *not likely to* dissipate, biodegrade, etc.

Response

While organic lead compounds and some inorganic lead compounds do biodegrade to a limited degree, the lead in soil does not so this sentence is correct as written.

17. Page 14, Contaminant of Concern, last paragraph, first sentence. This sentence should be edited to emphasize that only a fraction of the lead that an individual takes in is absorbed. It should also discuss the storage of lead in the body.

Response

We have made this revision.

18. Page 14, Contaminant of Concern, last paragraph, last sentence. Not true. If exposure has ended but past exposure had occurred, blood lead levels may reflect the release of lead stores from bone. Therefore, measuring past rather than just "recent or ongoing exposure."

Response

This sentence is correct as written. X-ray fluorescence of bones is the method by which the amount of stored lead can be measured. While some of the lead in blood may have come from lead stores in bone, there is no method to identify what that stored percentage might be or to then measure the amount of lead being stored.

19. Page 16, first paragraph. Because this is a public document, language discussing the "dose-response" needs to be expanded and simplified so that it can be easily understood.

Response

There is sufficient information on this topic in the preceding paragraph.

20. Page 16, second paragraph, second sentence. The word "subjects" should be replaced with the word, *animals* so that it is clear that the studies were performed on animals, not humans.

Response

We have revised this sentence to incorporate this suggestion and to update the discussion of the carcinogenity of lead.

21. Page 16, third paragraph. Please include information on effects of lead between 10–20 μg/dL.

Response

We have done this.

22. Page 17, top of the page. This sentence should read "was linked *to* a change of..."

Response

We have made this revision.

23. Page 17, forth bullet. Please simplify this discussion so that it would be easier to understand by a member of the general public.

Response

As suggested, we have revised this discussion to make it easier to understand.

24. Page 17, paragraph following bullets, third sentence. Please edit this sentence to read "... mean observed *(measured)* and predicted *(modeled)* blood lead concentrations..."

Response

We have made this suggested change.

25. Page 18, Current Standards, Regulations, and Recommendations for Lead. Please include the date for the "Lead-Based Paint Poisoning Prevention Act."

Response

We have added this date to the document.

26. Page 19, Completed Exposure Pathways, second paragraph. Please include information on pre- 1978 housing if available.

Response

As indicated in our response to comment 11, the presence of pre-1950 housing is a better measure of potential exposure to lead, so we chose to focus on that. We did review the data on housing age for the site investigation area and the rest of Douglas County. For the site area, 33% of the housing units were built from 1950 through 1978. Therefore, about 94% of the housing in the Omaha site area was built before the use of lead-based paint was banned in 1978. However, this figure is misleading because lead-based paint was used only on the outside from 1950 through 1978.

27. Figure 3. There is no reference in the text prior to this figure.

Response

The reference to Figure 3 in the first sentence on the page that follows the figure.

28. Page 21, Soil, first sentence. "Soil" is not a complete exposure pathway but the exposure medium. Incidental ingestion of soil should be listed as the exposure pathway.

Response

We chose "Soil" as the name of this pathway because it is a convenient "nickname" for "Soil contaminated mostly from lead emissions by the ASARCO refinery." ATSDR defines exposure pathways as having five elements, which are: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and a receptor population. Contaminated soil is both the source and the exposure medium. "Incidental ingestion of soil" is the route of exposure.

29. Page 21, Soil, second sentence. This sentence should be removed. No one on the site has been exposed for this length of time and ASARCO is not the only source for the lead in site soil. Perhaps this sentence could read "lead contamination of site soil has likely occurred since the late 1800's from industrial smelting operations in the area."

Response

This sentence will remain as it is accurate as written. Exposure to lead from the ASARCO facility has occurred since 1870.

30. Page 21, Soil, first paragraph. Please spell out the acronym, "RPM" since this is the first time it appears in the document.

Response

The statement containing "RPM" has been removed from the document.

31. Page 21, Soil, second paragraph. Please change the word "swallow" to the word *ingest.*

Response

We believe that swallow is a more universally understood and user friendly term than ingest so it will remain.

32. Page 21, ASARCO Refinery Emissions. Inhalation of airborne emissions from site smelting operations should not be listed as a complete exposure pathway. This exposure is no longer occurring. The second sentence in this paragraph should read *metal levels,* rather than "metals levels." The last sentence of this paragraph should be removed.

Response

ATSDR defines completed exposure pathways as those for which the five elements are present and exposure to a contaminant has occurred in the ***past****, is currently occurring, or will occur in the future. This pathway is clearly a past completed exposure pathway. Therefore we conclude that the last sentence in this paragraph is correct as written and will remain.*

33. Page 22, Drinking Water, third paragraph. In this paragraph it states that "As previously discussed, high lead concentrations are present in the top few inches of surface soil." At no point in the document is the depth of the contamination discussed. This sentence should be removed or soil data with depths presented to support this statement.

Response

We have revised the PHA to reference the recently released EPA Remedial Investigation on Residential Yard Soil.

34. Page 28. Information on page 27 does not continue over onto this page.

Response

We were unable to find this problem in the document released to the public so are unable to respond to this comment.

35. Page 29, Conclusions, first paragraph, last sentence. This conclusion cannot be drawn from the information provided in the document. This statement could be changed to say that

ATSDR believes that the primary sources for the lead are lead-based paint and soil contaminated with lead emitted from historic smelting operations on the site.

Response

ATSDR has revised this sentence to, "The main sources for the lead are soil contaminated with lead emitted from the operation of the ASARCO refinery and lead-based paint. Public health actions should focus on these two sources." *The information in this PHA provides ample support for this conclusion.*

36. Page 30, first paragraph. What is "health outcome data"? Please elaborate. In addition, please refer to comment #24.

Response

We described health outcome data in the Health Outcome Data Evaluation section beginning on page 26 and defined it in the glossary. We have moved the glossary definition into this section to further clarify what health outcome data are.

37. Page 30, Recommendations, third paragraph. The NHHSS Risk Assessment Program would not recommend this evaluation for several reasons: (I) To draw conclusions between cancer rates for individuals on the site and exposure to environmental lead would be a speculative at best. (2) Lead is relatively ubiquitous in the environment, and for adults, occupational exposure, smoking, and other issues would further complicate any attempt to link cancer rates to site smelter emissions. (3) To do a thorough study would be very time consuming, costly, and distract from the primary issue at this site, reducing blood lead levels in children. (4) Any conclusion drawn without a thorough site assessment would do nothing more than further alarm and confuse the public.

Response

Please see ATSDR's response to comment one for a detailed response to this issue.

38. Page 31, #2. This statement should read that NHHSS has prepared cancer statistics for the site. No evaluation is currently being prepared or planned by our agency. ATSDR is the agency requesting the data for the site evaluation. Please remove last sentence since requested information has already been provided.

Response

We have deleted this conclusion and its companion from the PHA because we are releasing the review of cancer data as a separate document. In addition, we have revised the Health Outcome Data Evaluation section to indicate that NHHSS provided the cancer data and that ATSDR is doing the evaluation.

39. References. Please list the agency and title for all individuals sited in the reference section.

Response

All ATSDR documents must adhere to the ATSDR Style Manual. *The manual does not permit listing agency and title in the references.*

40. Appendix A—Exposure Pathways for Omaha Lead. Route of Exposure, Soil—Inhalation (should be inhalation of particulates) is listed as an exposure route but it is not discussed in the document.

Response

We did not discuss inhalation as a route of exposure in the body of the document as it did not add to the justification for our conclusions. However, we did discuss the Refinery Emissions pathway, which was an important way that exposure occurred in the past.

41. Appendix A—Exposure Pathways for Omaha Lead. Route of Exposure, Drinking Water—Inhalation of lead during showering and direct contact with lead in water while showering would not be considered routes of potential exposure.

Response

We have deleted showering from the route of exposure cell in drinking water row.

42. Appendix A—Exposure Pathways for Omaha Lead. Notes, Ingestion of Homegrown Produce—Community Gardens (City Sprouts) are present on the site in addition to residential gardens.

Response

We have added community gardens to the notes cell of the homegrown produce row and to the description of this pathway earlier in the document.

43. Appendix A—Exposure Pathways for Omaha Lead. Complete Exposure Pathway, Refinery Emissions—Only current and future exposure pathways should be considered as complete. Refinery Emissions should not be considered a complete pathway.

Response

One of the differences between EPA and other environmental agencies and ATSDR is that we do consider and evaluate past exposures. We are instructed in our guidance for PHAs to identify past exposure pathways as completed if all five elements for a pathway are present.

44. Appendix D, Glossary. Please limit the glossary to terms used in this report.

Response

ATSDR has a policy that the most recent agency-generated glossary be included in every PHA.

Comments from Union Pacific

Union Pacific Railroad (UPRR) is submitting the following comments on the Agency for Toxic Substances and Disease Registry's (ATSDR)'s Public Health Assessment (PHA) for the Omaha Lead Site ("Omaha Lead Site" or "Site") in Omaha, Nebraska. UPRR places a high value on the health of children in Omaha; therefore, a key objective of preparing these comments is to ensure that any remedies or actions taken at the Omaha Lead Site will have tangible, positive impacts on the health of the children.

In keeping with this key UPRR objective, UPRR concurs with ATSDR's recognition "that the unique vulnerabilities of infants and children demand special emphasis in communities with contamination of their water, soil, air, or food." [PHA at 27]. UPRR also applauds ATSDR's recommendation for a plan to: "[1] increase the percentage of children ...that participate in the childhood lead blood screening program; [2] focus on educating residents; 3] implement. ..primary prevention strategies as well as learning short term interim strategies [and] [4] encourage residents of the effected area to have children under 7 years of age tested on a yearly basis." [PHA at 30.] UPRR has long supported a comprehensive solution to address the exposure that Omaha's children have to lead, recognizing that exposure may come from many sources.

Regrettably, however, ATSDR's analysis in the PHA is critically flawed and should be substantially re-written. First, ATSDR has simply accepted the erroneous paradigm expressed by the United States Environmental Protection Agency (EPA) regarding the primary Site source(s) and Site exposure pathways. Second, though the PHA acknowledges that lead-based paint is a lead source and presents a completed exposure pathway, stating for example that "available data indicates that 96% of children with blood lead levels above 10 µg/dL live in homes built prior to 1950" (PHA, Appendix A—Exposure Pathways for Omaha Lead), inexplicably, ATSDR comments that lead-based paint is "not a site-related exposure pathway" [id.] and downplays the significance of lead-based paint throughout the initial sections of the PHA. Third, ATSDR did not consider available data concerning, *inter alia,* the multiple sources of lead in Omaha, lead in indoor dust from lead-based paint, lead from water pipes, and the contribution from renovation of older homes. Each of these issues is addressed in the General Comments that follow.

45. *Comment:* EPA has repeatedly suggested that the American Smelting and Refining Company (ASARCO) lead refinery that operated from the early 1870's until 1997 on the eastern boundary of Omaha is the primary source for the soil contamination at the Omaha Lead Site. That "primary source" theory is applied by ATSDR from the outset of the PHA *[see,* e.g., Summary if the smelter is the primary source of lead, why is it that lead-paint is always listed first and then the data is made to fit that conclusion. It is an erroneous theory; one that is not borne out by the facts or environmental data.

    EPA contracted with Dynamac Corporation (Dynamac) to identify companies that potentially manufactured, used, or sold lead products, or generated lead wastes. Dynamac identified 53 such companies in Omaha and 78 in Council Bluffs. The Omaha list includes companies like Carter White Lead Company, Continental Can Company, Baton Metal Products Works, Gould National Batteries, Inc., Grant Battery Storage, Great Western Type Foundry, Lawrence Shot and Lead Company, and Omaha Shot and Lead Works. The Dynamac research is enclosed under "Copies of Selected References." Further research was done by MFG, Inc. and those industrial sources for which addresses could be confirmed are shown on the enclosed map. The existence of additional lead sources has also been well documented in reports by Dynamac (1999), Leinenkugel (2002), and others.

ATSDR discusses the ASARCO refinery, but ignores numerous other and potentially more significant sources of lead. ATSDR needs to consider alternate sources and provide discussion regarding potential impacts to the study area and elevated blood-lead levels in children at the Site.

ATSDR states that the prevailing wind directions in Omaha are northerly or southerly. [PHA at 9]. Applying this information, the soil concentrations shown in Figures 2, 3 and 4 of the PHA do not correlate well with northerly and southerly wind blown emissions primarily from a single source. The blood lead levels shown in Figure 5 do not correlate with that paradigm, either, as the three highest blood lead levels are dispersed across the Site and relatively removed from the prior ASARCO location. Rather, the elevated blood leads are clustered, appearing to correlate better to exposure from multiple Site sources, dispersed as shown on the enclosed MFG map (see particularly sources numbered as 84 and 85 on the map).

Recommendation: For the PHA to have validity, ATSDR must consider all lead sources that may have potential impacts to the study area and elevated blood-lead levels in children at the Site.

Response

ATSDR's PHAs are reviews of available environmental and biological data to determine whether public health is impacted and what should be done about it if it is. The Omaha Lead site PHA does that. The evidence in EPA's remedial investigation clearly indicates that emissions from the refinery are the primary source of lead in yard soil in the Omaha Lead site area [3]. The data from the census on age of housing reviewed in this PHA and the evaluation done by DCHD clearly indicate that lead-based paint is an extremely important source of lead [23]. ATSDR, therefore, concluded that soil lead and lead-based paint were the primary sources of the lead detected in the blood of Omaha children and supports actions to reduce blood lead levels by addressing those sources through childhood lead poisoning prevention and soil remediation.

46. *Comment:* ATSDR correctly concludes that a primary source of child lead exposure within the Site is lead-based paint. However, by not including and evaluating all of the relevant information regarding the prevalence of lead-based paint at the Site, the PHA minimizes the importance of this pathway and potentially misleads the public.

In contrast to ATSDR's Conclusion, early sections of the PHA imply that there is uncertainty regarding the presence and significance of lead-based paint at the Site and give the impression that it is of secondary importance. To provide the public with a balanced view of all potential lead health concerns, additional, readily available information regarding lead-based paint must be included in the PHA.

ATSDR seems to have arbitrarily limited its health assessment to pathways and lead presence that EPA can remediate under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). ATSDR's health assessment responsibility is not limited to just those remediation issues that EPA can address under CERCLA. ATSDR's authority for conducting public health assessments is derived, in part from Section 104(i) of CERCLA [42 U.S.C. §

9604(i», which includes authorization to provide consultation related to exposure to hazardous or toxic substances [CERCLA Section 104(i)(4)]. ATSDR's regulations pertaining to requests for health assessments state that one of the criteria to evaluate is whether individuals have been exposed to a hazardous substance. In a public health assessment, ATSDR has the obligation and authority to review all exposure pathways that may present a public health hazard.

Furthermore, the Public Health Assessment Guidance Manual [ATSDR, 2001 (Table 8.1)] identifies 13 follow-up health actions that can be taken by ATSDR, none of which include soil removal or remediation. The 13 follow-up health actions are:

1. Community health education
2. Community health investigation
3. Health professional education
4. Voluntary residents tracking system
5. Biological indicators of exposure study
6. Biomedical testing
7. Case study
8. Disease and symptom prevalence study
9. Registries
10. Site-specific surveillance
11. Substance-specific applied research
12. Cluster investigation
13. Health statistics review.

It has been documented that the presence of lead-based paint can contribute significantly to elevated blood lead levels. Additionally, it is generally known that the older the house, the more likely it is that the house will have lead-based paint, thereby increasing the potential for children residing at that house to have elevated blood lead levels. [In] fact, the PHA states that 96% of the children with blood lead levels greater than or equal to 10 ~g/dL live in residences with lead-based paint. Based on that information alone, it seems that activities focused on reducing exposure to lead-based paint would be important to public health.

ATSDR has the authority to identify the full scope of hazardous exposures and completed pathways present at an NPL site. To do otherwise presents an inaccurate and incomplete picture, is misleading to the public and may miss the key health risk factors at a given site. Consequently, ATSDR's statement that "lead-based paint in homes is not related to the Omaha Lead NPL site..." [PHA at 19; *see also,* PHA Appendix A] is without merit, misleading to the public, and seriously undermines the value and credibility of the PHA.

Recommendation: The PHA must be amended to give appropriate analysis and weight to the exposures presented by lead-based paint. The PHA should emphasize the prevalence of lead-based paint in Omaha area housing, the impact lead-based paint can have on residential blood lead levels, and the importance of instituting a program focused on reducing exposure to lead-based paint. Specifically, at a minimum the report should include:

Graphical representation of EPA sampling results for drip zone areas versus average yard soil concentrations absent drip zone samples; Summary findings from the Leinenkugel report; Expanded discussions of the Douglas County annual paired data investigations that provide further site-specific insight as to the prevalence and relative importance of lead-based paint in child elevated blood-lead levels (EBLs); Correlation analyses of EBLs and housing age; and discussion of the potential for renovation activities in older homes to exacerbate EBLs.

Inclusion of this information throughout the PHA, along with the information currently provided on lead in soil, will assist the community in understanding why ATSDR concludes lead-based paint is an important exposure factor at the Site and thereby improve the lead health education component of the PHA.

Response

ATSDR believes that current language in the PHA strikes the proper balance between lead from refinery emissions and lead-based paint as important sources of exposure of children to lead. Staff from DCHD's Childhood Lead Poisoning Prevention Program suggested much of the language on this issue used in the conclusions and recommendations section. In addition, CDC's Lead Poisoning Prevention Branch reviewed the public health assessment and they made several suggestions that strengthened what was written on this issue.

Please note that the following statement is made on Table 8.1 in the ATSDR Public Health Assessment Guidance Manual just above the list of 13 actions cited by the commenter.

> *"ATSDR will make recommendations in the health assessment to mitigate the health risks posed by the site. The recommendations issued in the health assessment should be consistent with the degree of hazard and temporal concerns posed by exposures to hazardous substances at the site."*

47. *Comment:* The PHA identifies but does not address serious data gaps and makes assumptions without including any supporting data. Contrary to Section 3.0 of the Public Health Assessment Guidance Manual (ATSDR, 2001) which encourages gathering as much site-specific information as possible in order to increase the accuracy of health assessment conclusions, the PHA contains numerous areas where data were either not gathered or existing national and site-specific data were not identified or incorporated in the PHA. The referenced information should be available to ATSDR from EPA or within ATSDR's own inventory maintained per the ATSDR's mandate under CERCLA to "establish and maintain [an] inventory of literature, research, and studies on the health effects of toxic substances..." [CERCLA Section 104(i)(1)(B)]. Where data gaps are identified, ATSDR's regulations authorize ATSDR to arrange for sampling or additional data gathering. [42 C.F.R. § 90.8.] Data gaps were identified in the PHA, but ATSDR took no action to obtain additional data. More egregiously, ATSDR did not include readily available data from EPA, and relevant lead exposure studies, including Leinenkugel (2002), the draft Baseline Risk Assessment for the OLS, and the Urban Soil Lead Abatement Demonstration Project by EPA (EPA, 1993b).

Recommendation: ATSDR should identify and address the following data gaps in the PHA.

- Representative paired data (including blood lead, soil, dust, paint, demographics, etc.) has not been collected by EPA. Paired data would improve the evaluation of potential sources contributing to elevated blood lead levels in children. Knowledge of potential sources would provide information needed to guide health advisories, inform the public of preventive measures, and guide future blood lead monitoring. Paired data is an important component for ensuring that remedial actions will have tangible, positive impacts on the health of children in the Omaha community. Limited paired indoor dust and soil data were collected by the EPA and should be referenced in the PHA. UPRR collected additional paint and water data and provided that information to EPA for consideration and incorporation into the administrative record for the Site. ATSDR should consider that data, as well.

- Spatial evaluation of data has not been conducted and is needed for valid source/receptor/exposure pathway analysis. ATSDR relies heavily on the soil sampling results provided by EPA. However, neither EPA nor ATSDR seem to have conducted any statistically valid spatial evaluation of the data. Spatial evaluation would provide a basis for determining which areas may have been affected by the ASARCO facility (as opposed to other sources of lead). EPA's Superfund Lead-Contaminated Residential Sites Handbook [EPA, 2003] describes the need to develop contours. Yet, contouring of the lead results is not shown. This is a data gap and should be identified as such by ATSDR.
- Comparison of blood lead data to other risk factors (age, condition of housing, smoking, occupational exposures, etc.).
- ATSDR should also meaningfully incorporate the information that is readily available from regional and national studies concerning lead exposure in urban settings to provide a more balanced assessment of the exposures, health risks, and appropriate responses at the Site, such as Leinenkugel (2002) and the Urban Soil Lead Abatement Demonstration Project (EPA 1993b).

Response

Union Pacific should direct most of the suggestions made above to EPA, as they relate to the legal and regulatory issues pertaining to the remediation of this site. Their suggestions do little to address the lead poisoning of children now occurring in Omaha.

In developing PHAs, ATSDR considers all available environmental and health data in evaluating potential health effects and identifying possible health actions. However, we include in the PHA only those data that directly relate to potential health effects and our recommended public health actions. This approach enhances the readability and clarity of the document. We do include discussions of data conflicts and uncertainties when relevant.

Specifically, for the Omaha Lead site PHA, ATSDR did not receive the paired dust-soil data developed by EPA until after the PHA was released. The other "paired" data identified by Union Pacific were either not provided to ATSDR or would require a special investigation to collect. Typically, such investigations are not conducted as part of PHAs.

ATSDR did do a spatial evaluation of the soil and blood lead data and presented some of the results of that evaluation in Figures 2 through 5. We considered performing statistical spatial analysis of the soil and blood lead data sets, but concluded that the available data were unsuitable for such an analysis.

48. *Comment:* ATSDR's references to the closure of the ASARCO facility are misleading. The PHA briefly mentions the closure of the ASARCO facility in 1997. However, much of the blood lead evaluation presented in the report includes data from both before and after operation. Grouping of pre- and post-ASARCO facility closure blood lead data in statistical

analyses is misleading and does not provide insight as to the potential role of air emissions on EBLs. Additionally, ATSDR suggests that children within the OLS continue to be exposed to airborne lead emissions. Since ASARCO was closed in 1997, NO child within the target age range of up to 6 years of age has ever been exposed to airborne lead emissions from ASARCO's operation. These comments are therefore, untrue, misleading, and tend to improperly exaggerate the contribution from the ASARCO facility.

Recommendation: ATSDR should include a temporal trend analysis for blood leads at the site by neighborhood. To the extent possible, the trend analysis should look at annual changes as well as pre- and post-ASARCO facility conditions. Any identified trends should be evaluated relative to the ongoing potential for soil and paint to be significant sources. ATSDR must also remove all references and implications to current exposures from airborne lead emissions from the ASARCO facility.

Response

ATSDR focused its evaluation on the ongoing exposure of children to lead and made no reference to current exposure to ASARCO emissions. The temporal analysis suggested by Union Pacific goes well beyond the scope of a public health assessment. Additionally, such an analysis would provide little or no information that would be relevant to the current situation.

49. *Comment:* It is inappropriate for ATSDR to recommend a soil cleanup value (action level) when none has been established for this Site.

Recommendation: UPRR recommends that ATSDR remove all endorsements of a specific action level until the baseline risk assessment is finalized and a Record of Decision is issued.

Response

ATSDR has substituted the term "screening level" for "action level" throughout the body of this document.

50. *Comment:* The PHA is deficient in its failure to include a Quality Assurance/Quality Control (*QA/QC*) analysis of the data relied upon. The quality of data ATSDR uses to prepare a health assessment is critical to increase the level of confidence in any conclusions or recommendations. This issue is recognized throughout ATSDR guidance. For example, Section 5.0 of the Public Health Assessment Guidance Manual [ATSDR, 2001] states: "sampling data and techniques should be evaluated for validity and representativeness." Typically, a *QA/QC* summary is used to verify the acceptability of the data. According to Appendix C of the Public Health Assessment Guidance Manual (ATSDR, 2001), to determine if data is valid, the following should be evaluated: health assessment data requirements, field data quality, laboratory data quality, and specific media considerations.

Health assessment data requirements include supplied data quality objectives (DQOs) and the satisfaction of *QA/QC* criteria. The Public Health Assessment Guidance Manual [ATSDR, 2001 (Appendix C.1.2)] states: "data evaluated and used to make health assessment determinations for hazardous waste sites must meet *QA/QC* criteria." To determine if *QA/QC* criteria have been met, a case narrative and data review summary should be included in the PHA. The Public Health Assessment Guidance Manual (ATSDR, 2001 [Appendix C.1.2]) clearly states: "when those documents are not available [the case narrative and data review summary], the investigator should assume the data may not meet *QA/QC* criteria."

When a health assessment is based on data that does not satisfy *QA/QC* criteria, the Public Health Assessment Guidance Manual (ATSDR, 2001 [Appendix C.l.2]) states that the health assessment should acknowledge "the possibility of reaching inaccurate conclusions in the health assessment." The PHA makes no reference to data quality, contrary to all of the above requirements.

Recommendation: UPRR recommends ATSDR include a *QA/QC* summary in the PHA, which addresses the issues discussed above. If the data cannot be demonstrated to satisfy *QA/QC* criteria, ATSDR must include a qualifying discussion in the PHA.

Response

ATSDR no longer requires that a QA/QC summary be included in PHAs. Health assessors do carefully evaluate the quality of data reviewed in the development of a public health assessment and mention any relevant qualifications or limitations in the document. We did alert the reader to the limitations of the blood lead data. In addition, we described in some detail how EPA obtained and analyzed the soil lead samples.

51. *Comment:* ATSDR's public input has been limited and insufficient to enable ATSDR to identify or address community health concerns. ATSDR has improperly relied primarily on "public input" from EPA and EPA Public Availability Sessions that are generally poorly attended and are focused on EPA's agenda rather than the community health concerns that ATSDR must consider. Conversely, ATSDR has failed to consider current community health studies such as Leinenkugel (2002). Section 2.1 of the Public Health Assessment Guidance Manual (ATSDR, 2001) lists "community health concerns" as one of three key data components to a health assessment (the other two being "environmental characterization data" and "health outcome data"). Section 3.2 of the Public Health Assessment Guidance Manual (ATSDR, 2001) indicates that specific "community health concerns" should be identified via community meetings, environmental and health complaints, and community health studies. Section 4.0 of the Public Health Assessment Guidance Manual (ATSDR, 2001), titled, *Responding to Community Health Concerns,* discusses the methods that should be used to gather community concerns and how to respond to them during the health assessment process.

Recommendation: UPRR recommends that ATSDR gather the information proposed by its own guidance, applying methods recommended in that guidance and include community health concerns and responses to those concerns in the PHA in accordance with Section 4.0 of ATSDR's guidance manual.

Response

ATSDR typically includes an evaluation of community health concerns in its PHAs. ATSDR is conducting its health education activities in cooperation and interaction with the various community groups in the site area. ATSDR believes that this should allow the community to have significant input in the public health actions at this site. Incidentally, we cited the study by Leinenkugel in the public health assessment. ATSDR considers its results important evidence for the conclusions of the document.

52. *Comment:* The PHA states that soil and lead-based paint are sources of lead exposure but does not identify sources of lead to soil.

Recommendation: UPRR suggests listing known potential sources of lead to soil, such as deteriorating lead-based paint, leaded gasoline, wheel weights, brake pads, industrial emissions, etc. Along with recognizing these other potential sources of lead, UPRR also recommends including an analysis of additional pathways.

Response

ATSDR did identify the main sources, which are soil lead and lead-based paint, due largely to emission from the ASARCO Refinery. We also identified and discussed all the potential site-related exposure pathways. Though not site-related, we also described the lead-based paint because of it importance as a source for lead in children. ATSDR does not consider the additional sources of lead identified by Union Pacific as relevant to the ongoing public health problem.

53. *Comment:* ATSDR has no basis to for its discussion and recommendations concerning the cancer risk presented by lead at the Site. That discussion is likely to be unnecessarily alarming to the public and the proposed evaluation will not provide any meaningful information. The proposed comparison between cancer data for the Site and other cancer data within the state has no scientific merit or value. The large number of uncontrolled variables (e.g., use of tobacco products) and the difference in data set development render such evaluations meaningless. Furthermore, the need for the proposed evaluation is not supported by the PHA.

Recommendation: Arbitrary collection and presentation of geographically contrasted cancer data is not scientifically warranted or advisable and should be discontinued. All references to that exercise should be omitted from the final PHA.

Response

See ATSDR's response to comment one.

SPECIFIC COMMENTS

54. *Comment:* The title of this document is inconsistent with other references to the Site as the "Omaha Lead Site," versus the "Omaha Lead Refinery Site."

Recommendation: UPRR recommends referring to the site as the "Omaha Lead Site."

Response

ATSDR has made this change.

55. *Comment: On page 5,* ATSDR indicates ASARCO as the primary source of lead contamination in soil at the Site. This statement is based on speculation rather than sampling data and in-depth analysis. Other sources of lead at the Site need to be listed and discusses in detail. These sources include: Home sources, such as lead-based paint, dust, toys, and vinyl shades/blinds; Hobby sources, such as stained glass, paints, homemade pottery, and lead sinkers; Other industrial sources, such as solid waste, coal combustion, steel production, and

foundries (Angle, 1975 and Dynamac Corp., 1999, and MFG, inc. 2004 b); Vehicular sources, such as leaded gasoline, waste oil, wheel weights, brake pads, and batteries; Dietary sources, such as drinking water , chocolate, insecticides, pesticides, and folk remedies; Occupational sources, such as welding, remodeling, torch cutting, demolition, and plumbing; and Other sources, such as fertilizers, pesticides, second-hand smoke, hair dyes, and children's jewelry.

Recommendation: UPRR recommends identifying and characterizing all potential sources of lead. The PHA analysis should be revised to address theses sources and exposure pathways.

Response

ATSDR concludes that this document identifies and evaluates those sources of lead that are relevant to the ongoing public health problem in Omaha. We believe that including the information suggested by Union Pacific would distract from the main messages of the Omaha Lead site PHA.

56. *Comment: Page 5, Paragraph 5,* the EPA "Action Level" is referred to in this paragraph as 400 parts of lead per million parts of soil (ppm). An action level for lead does not exist; instead, EPA has used 400 ppm as a screening tool for the purposes of initial site investigation before any risk-based evaluations can be conducted.

Recommendation: UPRR recommends revising the text to clarify and explain that EPA uses 400 ppm as a screening tool and that it is not an action level. All references in the PHA to 400 ppm as an "action level" should be deleted.

Response

ATSDR has substituted the term "screening level" for "action level" throughout the body of this document.

57. *Comment: On pages 5, 11, 12, 26, and 27,* ATSDR discusses the Douglas County Health Department's (DCHD) blood lead surveillance data and compares percent exceeding 10 µg/dL in various geographic areas. Parts of this discussion hinge on zip codes, but none of the maps provide zip code boundaries, so the reader cannot interpret the relationship between these three zip codes versus the seven zip codes discussed elsewhere, the zip codes and the overall Site boundaries, or the zip codes and the north-of-Dodge/south-of-Dodge division discussed elsewhere in the report.

Recommendation: UPRR recommends adding a figure showing zip code boundaries in the various geographic areas discussed in the PHA. Also, demographic data needs to be presented by zip code to allow for comparison with blood lead data.

Response

The site-specific data presented by ATSDR is the most relevant for the Omaha Lead site and therefore we will continue to use it in this PHA. ATSDR used spatial evaluation techniques to identify the locations where soil samples were obtained and where *children who had their blood sampled, lived. In addition, EPA provided us the boundaries of the initial site investigation area. Using this information, we were able to identify the mean soil leads, percent of children with elevated blood lead levels, and demographic characteristics specifically for the initial site investigation area. We believed that a site-specific evaluation would be more useful than repeating information provided earlier by EPA and DCHD. Incidentally, all of the blood lead data cited by ATSDR on the pages identified above were for Douglas County or Nebraska, not for ZIP code areas so the commenter's points about three or seven ZIP codes are not relevant.*

58. *Comment: On Page 5*, it would be informative and relevant to mention that for homes with lead-based paint, in the absence of lead paint abatement, soil removals may not be effective because: (1) soil may be re-contaminated in future (post-cleanup) by deteriorating paint, and (2) lead- based paint is the most likely cause of blood lead levels greater than or equal to 10 ~g/dL.

    Recommendation: UPRR recommends adding text to the PHA explaining that for homes with lead-based paint, soil removal would most likely be only a temporary solution to high lead content within soils and would still leave a primary interior exposure point intact. Consequently, this would not result in blood lead levels being reduced significantly within the Omaha Lead Site.

    Response

    ATSDR discusses the issue of interior lead-based paint in this PHA both as an exposure pathway and in the public health action plan.

59. *Comment: On page 6,* the PHA states that ATSDR has evaluated the effects of EPA's current cleanup and removal actions and concludes that the EPA clean-up criterion is protective of public health as a result of the removal of lead contaminated soil. EPA's Urban Soil Lead Abatement Demonstration Project, authorized in 1986, does not support this conclusion (EPA, 1993b). The EPA Urban Soil Lead study shows that soil remediation alone does not eliminate children's continued exposure to lead and, at locations with exterior lead-based paint soil recontamination is likely. UPRR is not aware of any data or evaluations from the Omaha Lead that support the statement.

    Recommendation: UPRR recommends that additional text and supporting data be added to the PHA explaining how this conclusion was reached. If it is not supported by Site-specific data or data evaluation, the statement should be deleted.

    Response

    The statement has been deleted from the document.

60. *Comment: On pages 6, 9, and 21,* the report refers to an action level of 400 ppm. Without having a completed risk assessment, recommendation of an action level of 400 ppm is inappropriate. The action level (cleanup level) will be identified in the Record of Decision (ROD). Including a cleanup number in the PHA when the required processes to select a cleanup level have not been completed is inaccurate and misleading.

Recommendation: UPRR recommends that ATSDR remove all references to a specific action level until the baseline risk assessment is finalized, a risk-based action level has been established, and the Record of Decision has selected the remedy and associated cleanup level.

Response

ATSDR has substituted the term "screening level" for "action level" throughout the body of this document.

61. *Comment: On pages 7, 9, and 12*, the PHA contains inconsistent references to the property included in the NPL listing for the Site. The Site only includes residential properties, child care facilities, schools, and other residential-type properties. It does not include any commercial or industrial property. [*See, e.g.,* EPA Site listing documents and Fact Sheet, Omaha Lead Site, June 2002.] Neither the ASARCO site nor the former Gould Battery site are included in the Site.

    Recommendation: UPRR recommends that ATSDR correct all Site property descriptions in the PHA to include only residential-type properties, child-care facilities, and schools.

    Response

    We deleted the reference to other properties on page 7. ATSDR did not identify a need to make changes on page 9, as we wrote that the location of the former ASARCO facility was not part of the site and did not identify Gould Battery as part of the site.

62. *Comment: On Figures 1 through 5*, it is misleading to identify only one industrial source for lead contamination at the Site. This is especially true considering there is significant doubt as to the contribution of activities at that industrial location to impacts within the Site boundaries.

    Recommendation: UPRR recommends that ATSDR identify all industrial lead sources on these figures rather than just the ASARCO site. A more complete listing of all industrial lead sources for contamination at this Site is found in the attached Dynamac Corporation report (Dynamac, 1999). The locations of these sources are shown on the attached map titled "Potential Sources" (MFG, Inc., 2004).

    In addition to identifying all industrial lead sources, UPRR recommends overlaying an indication of the age of housing within the site to clarify the location of potential sources of lead-based paint.

    Response

    A major goal of the Omaha Lead site PHA is to focus attention on the ongoing exposure of Omaha children to lead. As indicated in the PHA and earlier responses to comments, ATSDR has concluded that lead in soil from refinery emissions and lead-based paint are main sources of lead. Therefore, we developed our figures to reflect this conclusion. We do indicate in the document that there are additional sources.

63. *Comment: On page 9,* ATSDR indicates lead refining operations at ASARCO are the primary source of lead contamination in soil at the Site. This contention has not been proven and is based on speculation rather than sampling data and in-depth analysis. Other sources of lead contamination at the site need to be listed and discussed in detail.

Recommendation: UPRR recommends that ATSDR remove text indicating lead refining operations at ASARCO as the primary source of lead contamination in the soil at the Site. Instead, UPRR recommends that ATSDR identify all sources of lead contamination at the Site, which are discussed in detail in the attached Dynamac Corporation report (Dynamac, 1999) and shown on the attached map titled "Potential Sources" (MFG, Inc., 2004).

Response

We will make no change regarding the source of lead in soil as ATSDR concurs with the evidence in EPA's remedial investigation that clearly indicates that emissions from the refinery are primary source of lead in yard soil in the Omaha Lead site area [3]. The number and importance of the various sources of lead in the Omaha area is a legal issue between EPA and UPRR. It is not relevant to resolving the ongoing childhood lead poisoning problem in Omaha.

64. *Comment: On page 9,* ATSDR has indicated that the original site boundaries were based on air dispersion modeling conducted by EPA. The results of the air dispersion modeling should be discussed in detail. Concentration isopleths should be included in this report to present the relationships between soil data and the air dispersion modeling to demonstrate whether there is any correlation. This information would be especially helpful since the document refers to an investigation area with a 4 to 5 mile radius. It would also be useful to know how the investigation area was determined.

Recommendation: UPRR recommends including a discussion of the air modeling evaluation in the PHA.

Response

ATSDR does not believe that a discussion of the air modeling is relevant to the purpose of the PHA and therefore will not include one. We state on page 9 of the PHA "EPA started an evaluation of the extent of the soil contamination by modeling the atmospheric deposition patterns around the ASARCO facility [9]." ATSDR did not indicate the air modeling was the basis for the original site boundaries.

65. *Comment:* On page 11, ATSDR's analysis of data severely undermines the credibility of the PHA. As noted at the outset of these comments, ATSDR has simply relied on EPA's theory that ASARCO is the primary lead source and then reviewed and discussed only the data that fits EPA's theory. For example, ATSDR does not include any analysis with the statement "[i]n general, the available data indicates a decreasing trend in the number of children with elevated blood lead levels with increasing distance from downtown Omaha." ATSDR improperly reaches the conclusion that the trend supports its pre-determined conclusion that ASARCO is the primary lead source. While the observed decreasing trend could be attributed to distance from downtown industrial source locations, it is likely that the trend of house age and distance from downtown

Omaha is correlated better with blood lead levels. There is likely also a correlation in blood lead levels and proximity to major freeway systems that ATSDR ignores.

Recommendation: UPRR recommends ATSDR evaluate the impact of other lead sources at the Site, add a discussion regarding the trend of house age and distance from downtown Omaha and the impacts of proximity to the freeway system.

Response

ATSDR's response to this comment is the same as our response to comment 63. In addition, the discussion of the Nebraska surveillance data has been removed from the text of the document.

66. *Comment: On page 13*, UPRR has significant concerns about the data quality and absence of detail concerning the data that ATSDR has relied on in the PHA. ATSDR's failure to independently review either of these issues is contrary to its own guidance, as noted in the General Comments. ATSDR relies solely on EPA soil samples collected from each property Indeed, EPA's residential property soil data is a critical underpinning of the PHA. In the discussion about this data on Page 13 of the PHA, ATSDR describes it as non-drip line data, purportedly from lead sources other than paint. ATSDR's analysis is problematic for two reasons. First, ATSDR does not provide sufficient information (including *QAlQC)* about the sample collection to allow the reader to determine whether the data is only from non-paint sources. Second, ATSDR ignores what it acknowledges to be a significant source of lead exposure, lead-based paint. Specifically, it is unclear if the five samples collected at each property location were composited or if the samples were analyzed separately. If the samples were analyzed separately, ATSDR fails to identify any difference between yard samples and drip line samples. Moreover, drip line soils (and soil affected by lead paint) also contribute to children's blood lead levels, and should also be evaluated if the objective of the document is to assess potential public health impacts. Additionally, evaluation of the correlation between drip line soil and other yard soil could yield important insights. The PHA states that the drip line samples were collected to determine whether there is lead in soil from peeling lead-based paint on the house. To understand the relative contributions to lead exposure from exterior lead-based paint and other sources and to complete the exposure analysis that ATSDR undertook in the PHA, ATSDR should also determine whether there is any correlation between the DCHD blood lead data with the drip line soil data.

Recommendation: UPRR recommends that ATSDR: 1) evaluate the data quality and residential property soil data to determine whether it meets quality criteria; 2) discuss in greater detail whether the non-paint impacted soil was segregated from the drip-line soil; 3) and the relative correlation between blood lead levels and each type of soil (if it was segregated). The PHA should then be revised to include the above data analysis to inform the public of the lead source and its impact.

Response

Regarding recommendation one, ATSDR responded to the data quality issue in its response to comment 50 on page 61. As for number two, the description of the soil sampling is taken from the EPA document cited and it clearly indicates that EPA separated the yard samples from the drip line samples. As indicated on page 23, ATSDR used the mean of all the samples (yard, drip line, garden, and play area) at a location in its evaluation, as we are interested in the overall health risk. However, our description of *this on page 23 was not very detailed, so we revised the description in this document. The third recommendation, to correlate blood lead levels and each type of soil, is not feasible as we have no idea of the source of the lead in a child whether it be soil from a specific location around a dwelling or lead-based paint from inside a house.*

67. *Comment: On page 13*, ATSDR notes that the DCHD data is not complete because reporting blood lead level results below 10 ~g/dL was not required prior to 2000. However, ATSDR fails to discuss the very important implications of that fact. Statistics based on data prior to 2000 may be skewed high. The reported percentage with blood lead levels exceeding 10 ~g/dL could be biased high, because non-reporting may artificially lower the total (which includes those less than 10 µg/dL). Additionally, such non-reporting may be more prevalent in some geographic areas than in others.

    Recommendation: UPRR recommends that ATSDR discuss the fact that statistics based on data prior to 2000 may be skewed high.

    Response

    Inclusion of that sort of discussion would not affect ATSDR conclusions and recommendations for this site, so there is no reason to discuss this issue any more than what is already in the PHA.

68. *Comment: On page 13*, ATSDR also states that most of the DCHD data came from voluntary participation in the testing. Because participants in blood lead survey data were volunteers, self-selection may bias the results. For example, parents who have more reason to suspect lead poisoning in their children might be more likely to volunteer their children for a blood lead survey.

    Recommendation: UPRR recommends that ATSDR clearly state that, because participants in blood lead survey data were volunteers, self-selection might bias the results.

    Response

    Inclusion of that sort of discussion would not affect ATSDR conclusions and recommendations for this site, so there is no reason to discuss this issue any more than what is already in the PHA.

69. *Comment: On page 14,* The Contaminants of Concern section is based on preliminary information. At the time when the PHA was released to the public, the baseline risk assessment was not complete.

    Recommendation: UPRR recommends that a discussion be added to the PHA explaining that the contaminants of concern are preliminary due to the lack of a baseline risk assessment.

    Response

    ATSDR has reviewed the Interim Baseline Human Health Risk Assessment, which was released shortly after the public comment release of the Omaha Lead site PHA. ATSDR found that this document confirmed what was in the PHA, so there will be no change.

70. *Comment: On page 16,* ATSDR has pre-supposed soil to be the source of elevated blood levels in children at the Site Studies have shown household dust contaminated with lead to be a significant contributor to elevated blood levels in children (CDC, 1991 and CDC, 2002).
Recommendation: UPRR recommends that, in order to adequately address human health concerns at the Site, ATSDR identify and evaluate all potential sources of lead and routes of exposure.

Response

ATSDR did not presuppose on page 16 or elsewhere in the PHA that soil was the ***only*** *source of elevated blood lead levels. ATSDR agrees with UPRR that household dust is an important contributor to elevated blood levels in children. However, UPRR apparently is incorrectly identifying household dust as a* ***source of lead*** *while it is actually the* ***exposure medium****. The lead in household dust can come from soil contaminated from ASARCO's emissions, lead-based paint, or a number of other sources. The discussion of lead that starts on the bottom of page 16 is titled "Relationship of Soil Lead Levels to Blood Lead Levels."*

71. *Comment: On page 17,* the IEUBK model was developed as a tool to determine soil cleanup levels at a given site. Inputs to the model can include site-specific data from other possible exposure pathways, but the IEUBK model pre-supposes soil remediation of lead contamination. It is not used to determine that soil remediation is not required. ATSDR also notes that the actual remediation levels should be based on modeling with site-specific data, but does not discuss the implications of EPA's failure to input site-specific data. ATSDR does acknowledge the function of the IEUBK model, but should provide a more detailed explanation consistent with this comment.
Recommendation: ATSDR should include a more complete explanation of the IEUBK model and its limited purpose. ATSDR should also discuss the implications of EPA's failure to input site-specific data in the IEUBK model.

Response

NCEH/ATSDR is concerned about this issue and brought this issue to EPA's attention in comments provided on the Proposed Plan. However, inclusion of that sort of discussion would not affect ATSDR's conclusions and recommendations for this site. We believe the discussion of this issue already provided in the PHA is sufficient.

72. *Comment: On page 18,* the last sentence of this section is contrary to adopted standards at a number of CERCLA sites and is presented without explanation or basis.
Recommendation: UPRR recommends that the last sentence of this section be deleted.

Response

This statement comes from the rule, so it will remain in the PHA.

73. *Comment: On page 19, a* public health assessment at the Site cannot be considered complete without analysis of the exposures from lead-based paint. The fact that at least 63% of housing in the Omaha Lead Site was built prior to 1950 and that any housing built prior to

1978 may contain lead-based paint is very important. Yet, ATSDR does not present the figures for the percentage of housing within the Site that was built before 1978. The 2002 study reported by Kathy Leinenkugel concerning lead exposures at the Site is one good source of housing condition information that was ignored by ATSDR.

Recommendation: UPRR recommends that ATSDR include a comprehensive analysis of the exposures present at the Site from lead-based paint in older housing within the Site. The analysis should: (I) be put in the context of very high percentage of housing in Omaha and in Nebraska that could have lead-based paint; (2) be repeated in other sections of the PHA where it is relevant, such as during the discussion of relative percents of blood lead levels exceeding 10 μg/dL; and (3) include a discussion about the high potential for recontamination of both soil and non-soil sources (e.g., house dust) of lead to children from lead-based paint, unless the paint source is removed.

Response

ATSDR does cite Ms. Leinenkugel's evaluation on page 26. Its results are a key piece of evidence in ATSDR's justification for identifying lead-based paint as one of the two primary sources of lead. This is sufficient for the purpose of the PHA.

74. *Comment:* Page 21 contains a number of inaccurate and/or unsupported statements. Editorial comments, such as that attributed to the EPA RPM, Don Bahnke in paragraph 1, have no probative value and are generally not presented in public health assessments. ATSDR once again erroneously references an EPA "action level." No action level for lead has been selected for the Site. EPA has used 400 ppm as a screening tool for the purposes of initial site investigation before any risk-based evaluations can be conducted. ATSDR states that Figures 2 and 3 "likely" represent where exposure to airborne emissions from ASARCO occurred. Yet, ATSDR did not evaluate the air dispersion modeling that would support or refute this contention. The statement is simply made without any supporting data. There is no place for blatant speculation, such as this in a public health assessment. Lastly, Nebraska Health and Human Services evaluated exposure risks from home-grown vegetables at the Site. That information was available, at least in draft form, prior to ATSDR's publication of the PHA, but was ignored. UPRR notes that ATSDR's regulations require that ATSDR consider relevant, available site-specific data in making a public health assessment. [42 C.F.R. Part 90.]

   Recommendation: UPRR recommends that ATSDR remove the comment by Don Bahnke. UPRR recommends revising the text to clarify and explain that EPA uses 400 ppm as a screening level and not an action level. UPRR also recommends that ATSDR either demonstrate the truth of its statement about the extent of airborne emissions from ASARCO or delete all references to same. UPRR recommends that ATSDR consider relevant, site-specific data in its revisions to the PHA.

Response

ATSDR has substituted the term "screening level" for "action level" throughout the body of this document.

Mr. Bahnke's statement has been removed from the document.

Regarding the evaluation of homegrown produce by NHHSS, ATSDR contacted Sue Dempsey of NHHSS who indicated that her agency had not made such an evaluation.

ATSDR did identify homegrown produce as a completed exposure pathway on p. 21, but concluded that children would need to eat about ⅓ pound a day or more before this pathway would be a health concern.

EPA conducts its Omaha Lead-related removal action and proposes to remediate this site following its conclusion that the emissions of the ASARCO Refinery contaminated soil in Omaha with lead. Therefore, UPRR should pursue its concern about the truth of the extent of airborne emissions from ASARCO with EPA.

75. *Comment: On page 22,* the potential impact from lead derived from plumbing cannot be eliminated without investigation. In Omaha, as of January 21, 2003, the Metropolitan Utilities District (MUD) water treatment facility switched from using chlorine to chloramines to reduce disinfection byproducts (MUD, 2002). Chloramines can leach lead from pipes and solder, increasing potential exposure via drinking water. The use of chloramines in water treatment is thought to be responsible for the high lead levels in drinking water in Washington D.C. in 2003 (Renner, 2004).

    Recommendation: UPRR recommends including an assessment of the potential impact from lead derived from plumbing, due to the use of chloramines in water treatment.

    Response

    ATSDR considers such an evaluation as not relevant to the PHA. We suggest that UPRR raise this issue directly with MUD.

76. *Comment:* Table 2 needs to include paint and dust data in order to present an unbiased representation of the blood-lead information.

    Recommendation: UPRR recommends including paint and dust data in this table.

    Response

    ATSDR is not aware of any paint or dust data as specific to this location as the soil and blood lead data that could be included on this table. ATSDR does include information on pre-1950s housing in Table 1.

77. *Comment: On page 26,* the report erroneously refers to an action level of 400 ppm. Without a completed risk assessment, recommendation of an action level of 400 ppm is improper. The action level (cleanup level) will be identified in the Record of Decision (ROD). Including a clean-up number in the PHA before the procedures for remedy selection and cleanup level selection have been completed and state in the ROD is improper and potentially misleading.

    ATSDR again makes reference to the percentage of children living in pre-1950 homes, but fails to acknowledge that children living in pre-1978 homes are also at risk of lead-based paint exposures. ATSDR also ignores the much stronger correlation between lead-based paint and children with elevated blood lead levels (96%) versus the correlation between soil concentrations and children with elevated blood lead levels (42%). ATSDR's incomplete analysis is misleading and significant limits the value of the PHA.

    Recommendation: UPRR recommends that ATSDR remove the endorsement of a specific action level until the baseline risk assessment is finalized and EP A has selected a final cleanup level in the ROD. UPRR also recommends that ATSDR include a complete analysis of the housing stock and the correlation between lead-based paint, housing age, and children with elevated blood lead levels. That data and analysis is readily available in reported literature, as referenced in these comments.

Response

ATSDR has substituted the term "screening level" for "action level" throughout the body of this document.

ATSDR will not include the "complete analysis of the housing stock and the correlation between lead-based paint, housing age, and children with elevated blood lead levels" suggested by UPRR as it is not germane to the purpose of the public health assessment.

78. *Comment:* It appears that there is text missing at the top of the page *28*. Please provide the missing text. Also, the second paragraph does not discuss other lead sources as listed in earlier comments.

    Recommendation: UPRR recommends the missing text be provided and that the second paragraph include all other lead sources, as listed in the attached Dynamac Corporation report (1999) and shown on the attached map titled "Potential Sources" (MFG, Inc., 2004).

    Response

    We were unable to identify any missing text in the document released to the public, so we are unable to respond to this concern about missing text. As indicated in several earlier responses, ATSDR does not consider including a list of all the potential sources as being relevant to addressing the ongoing childhood lead poisoning problem in Omaha. Therefore, we have not put such as list in this document.

79. *Comment: On page 28,* As pointed out in earlier comments, mention of a health outcome study for cancer is irrelevant to the discussion, improper, and likely to unnecessarily alarm the public.

    ATSDR also implies that up to 86,000 individuals continue to be exposed to ASARCO air emissions. The ATSDR comment is inaccurate, misleading and improperly exaggerates ASARCO-related risks at the Site.

    Recommendation: UPRR recommends removing the discussion of a cancer study from the PHA for the reasons discussed earlier in these comments. ATSDR must clearly distinguish between past and present completed exposure pathways. No Omaha children in the highest risk ages of 6 years of age and under have ever been exposed to ASARCO air emissions—ASARCO operations ceased before these children were not born.

    Response

    Please see ATSDR's response to comment one.

80. *Comment: On page 30,* ATSDR seems to specifically recommend a soil cleanup level of 400 ppm. This is inconsistent with the rest of the PHA, which indicates that another level could also be identified as a protective trigger. Specifically recommending the removal of soil with lead concentrations greater than 400 ppm precedes the conclusion of the final baseline risk

assessment, which was not completed at the time the PHA was drafted, and is inconsistent with sound science.

Recommendation: UPRR recommends that ATSDR remove the endorsement of a specific action level until the baseline risk assessment is finalized.

Response

ATSDR has removed this language from the document.

81. *Comment: On page 30, i*t is unprecedented and improper for ATSDR to conduct or recommend a health outcome study for cancer at lead sites. In a typical public health assessment, health implication decisions regarding cancer are based on toxicological evaluations that compare exposure dose (i.e., the amount of a substance individuals in an exposure pathway are exposed to daily) to appropriate health guidelines for carcinogenic effects. Currently, health guidelines and epidemiologic data for lead are inadequate and cannot provide a context from which to evaluate outcome data relating lead exposure and human cancer .EPA has not published a cancer slope factor for lead (EPA, 1993a), ATSDR has not established a cancer risk evaluation guide (CREG) for lead, and an exposure level at which a cancer outcome is associated has not been documented.

    Without appropriate health guidelines to assess the cancer risk of lead, a cancer health outcome study for the Omaha Lead Site will not provide any meaningful information. An attempt to quantify the cancer risk for lead would involve numerous uncertainties, many of which are unique to the potentially exposed individual since age, health, nutritional state, body burden, behavioral factors (such as smoking), and exposure duration all influence the absorption, release, and excretion of lead. If a study of cancer rates is conducted for ATSDR by Nebraska Health and Human Services, it will be impossible to associate the resultant cancer incidence solely with lead exposure. Consequently, such a study would not provide any meaningful information for Site response.

    Recommendation: Because it is currently impossible to quantitatively evaluate the potential of lead to cause cancer in humans, UPRR recommends that ATSDR revise the text of the PHA to eliminate any recommendations that advocate performing a cancer health outcome study.

    Response

    Please see ATSDR's response to comment one.

82. *Comment: On pages 41 and 42 of Appendix C,* the State's flyer about gardening recommendations (included in the PHA as an appendix), clearly lists other sources of lead that are not being addressed by EPA. It also addresses the importance of lead-based paint as a lead source to soil.

    Recommendation. As this information is pertinent elsewhere in the PHA, UPRR recommends ATSDR insert this information in relevant places within the body of the PHA.

    Response

    As indicated in several earlier responses, ATSDR does not consider including a list of all the potential sources as being relevant to addressing the ongoing childhood lead *poisoning problem in Omaha. Therefore, we have not put such as list in this document.*

References Cited in Comments

Angle CR, McIntire MS. 1975. Blood lead of Omaha school children—topographic correlation with industry, traffic and housing. Nebr Med J 60(4):97–102.

(ATSDR 2001) See [46].

(CDC 1991) See [30].
Centers for Disease Control and Prevention. 2002. Managing elevated blood lead levels among young children: recommendations from the Advisory Committee on Childhood Lead Poisoning Prevention. Atlanta: US Department of Health and Human Services.

(Dynamac Corporation 1999) See [9].

US Environmental Protection Agency. 1993a. Lead and compounds. carcinogenicity assessment. IRIS summary. November. CASRN 7439-92-1. Available at URL: http://www.epa.gov/IRIS/subst/0277.htm.

US Environmental Protection Agency (EPA). 1993b. Urban soil lead abatement demonstration project, volume 1: integrated report. Washington, DC: US Environmental Protection Agency. EPA/600/AP-93/001a.

(EPA 2003) See [21].

(Leinenkugel 2002) See [25].

Metropolitan Utilities District (MUD) 2002. Your 2002 water quality report. Omaha, Nebraska. Available at URL: http://www.mudomaha.com/pdfs/2002ccr.pdf.

MFG, Inc. 2004. Potential sources [map of potential lead sources in Omaha, Nebraska]. Omaha: MFG, Inc.

Renner R. 2004. Leading to lead—conflicting rules may put lead in tap water. Sci Am (June 21) 291(1): 22, 24.

Additional Comments

The following comments are submitted as an addendum to Union Pacific Railroad Company's (UPRR) original comment package, dated August 5, 2004, on the Public Health Assessment (PHA) prepared by the Agency for Toxic Substances and Disease Registry (ATSDR) for the Omaha Lead Site ("Omaha Lead Site" or "Site") in Omaha, Nebraska. As stated in UPRR's August 5, 2004 comment package, UPRR places a high value on the health of children in Omaha; therefore, a key objective of preparing comments on the ATSDR PHA is to ensure that any remedies or actions taken at the Omaha Lead Site will have tangible, positive impacts on the health of the children.

Additional Specific Comments

Upon further review of the ATSDR PHA and in consideration of the recent publication of a study completed for the U.S. Department of Housing and Urban Development (HUD), *"Evaluation 01 the HUD Lead-Based Paint Hazard Control Grant Program"* (HUD Grant Program Study) , UPRR submits the following additional comments and recommendations.

83. *Comment: On page 6,* the HUD Grant Program Study documents that lead levels in entry dust were correlated with exterior lead-based paint rather than lead from outside soil. These results raise significant doubt about whether remediating soils will address the source of contamination or have a protective effect on public health. Dust data collected by EPA at the Omaha Lead Site show that entry way dust generally has the highest lead concentrations. However, EPA did not speciate entry dust at any of the Site residences. In light of the HOD Grant Program Study findings, without such specific speciation of the lead source(s), any conclusion as to the predominant source of entry lead is unsupported by any facts and is most likely to be from exterior lead-based paint. Thus, the PHA conclusion that the EPA soil clean-up approach is protective of public health by removing lead contaminated soil has no factual or scientific basis.
    Recommendation. ATSDR must remove its conclusions that soil removal in the OLS is protective of human health until additional, site-specific data supporting that conclusion are obtained. UPRR recommends that ATSDR investigate the relationship between lead in dust and lead in paint and soils at the same residential locations at the Site. The source of the lead in the entry dust must be determined by empirical measurement, rather than assumption and speculation. EPA or ATSDR must document a correlation between high levels of lead in entry dust and high lead levels in outside soils before reaching any conclusion about the protectiveness of EPA's soil removal approach.

    Response

    What UPRR suggests is well beyond the scope of a PHA. In addition, the results would not affect what needs to be done to address the childhood lead poisoning problem in Omaha.

84. *Comment* The last paragraph of the Summary section implies that the elevated blood lead levels discussed were caused by exposure to contaminated soil. As noted in the preceding comment, EP A did not collect any data at the Site, use existing Site data, or report any national data to document or support the existence of a causal connection between elevated lead levels in soils

and elevated blood lead levels. In terms of existing Site data that could qualitatively identify lead sources, the Douglas County Health Department (DCHD) has conducted case management activities for many Omaha children with elevated blood lead levels, including evaluation and findings regarding lead sources in the community that are contributing to elevated blood lead levels. EPA and ATSDR should have used this Site-specific information, at least as a qualitative basis, to determine the lead sources for the observed elevated blood lead levels. Yet, ATSDR did not even mention the DCHD case management findings.
Recommendation. In the absence of resources or time for ATSDR to conduct lead speciation to determine the lead sources for children's exposure, at a minimum, ATSDR should use existing, site-specific, qualitative data from DCHD case management findings regarding sources for elevated blood lead levels including paint, home remedies, and occupational exposures.

Response

DCHD case management results would not affect the conclusions and recommendations made in the PHA. These results are important in addressing specific cases of childhood lead poisoning in Omaha and in designing appropriate public health actions.

85. *Comment* The Site Background section omits a number of key historical facts that are important in understanding the multitude of significant potential sources of lead exposures in the Omaha Lead Site.
    - ATSDR fails to consider or even mention the over 200 historical industrial sources of lead other than the ASARCO Refinery and Gould Smelter. Some of these are detailed in the report by Dynamac (Dynamac, 1999), as noted in General Comment I of UPRR's August 5, 2004 comment package, and shown on the map provided in the Attachments to the comment package.
    - The PHA does not include a discussion of the development of the residential areas included in the investigation. Dates and phases of development are critical to understanding the age of housing throughout the Site, the potential for lead-based paint impact and its potential for recontamination of soils and contribution to elevated blood-lead levels.
    - ATSDR must also consider the emissions and disposal of debris from large-scale demolition of over 600 homes in Omaha containing exterior and interior lead-based paint for the continuation and completion of the North Freeway alone (see articles provided in Attachment A of this addendum). This does not take into account other significant road projects associated with Interstate and expressway road construction in this portion of Omaha.
    - ATSDR failed to take into account the past use of pesticides in the Omaha area, though the presence of lead arsenate attributable to pesticides is noted in yard soils in the Site in EPA's Remedial Investigation, Residential Yard Soil, Omaha Lead Site at pages 4-3 and 4-4. Attachment B of this addendum provides a historical perspective of pesticide use in the community by local health departments.
    - ATSDR ignored the proximity of large portions of the Site to interstate and state highways and large arterial streets resulting in lead contamination from leaded gasoline.
    - ATSDR did not consider historic construction activities in the City of Omaha. Specifically, historical records document (see Attachment C of this addendum) that slag from smelting and refining operations was used as a component in sidewalks in the City of Omaha.

Recommendation: UPRR recommends that ATSDR incorporate these key historical facts into its analysis to accurately and fully define the Site history, background, and sources of current lead exposures.

Response

ATSDR did not include these historical facts in the body of the PHA as they would not change the basic conclusions and recommendation.

Errata

Please make the following corrections to the "Comments Of Union Pacific Railroad Company On ATSDR's June 7, 2004 Public Health Assessment for the Omaha Lead Refinery, Omaha, Douglas County, Nebraska."

General Comment 9: Please delete the word "to" in the first line of this comment. The first sentence should read: "ATSDR has no basis for its discussion and recommendations concerning the cancer risk presented by lead at the Site."

Specific Comment 2, page 5: In the third line, change the word "discusses" to "discussed." That sentence should read: "Other sources of lead at the Site need to be listed and discussed in detail."

Specific Comment 6, page 6: In the second to the last sentence, insert a comma after "paint." In the last sentence insert "Site" after "Omaha Lead." The last two sentences of the comment should read: "The EPA Urban Soil Lead study shows that soil remediation alone does not eliminate children's continued exposure to lead and, at locations with exterior lead-based paint, soil recontamination is likely. UPRR is not aware of any data or evaluations from the Omaha Lead Site that support the statement."

Specific Comment 13, page 13: Insert "and" before the numbered clause "3)", replace the word "and" immediately following the number with the word "valuate." This third numbered clause should read: "and 3) evaluate the relative correlation between blood lead levels and each type of soil (if it was segregated)."
Specific Comment 14, page 13: In the first line, replace "CDHD" with "DCHD" so that the first sentence reads: "ATSDR notes that the DCHD data is not complete because reporting blood lead level results below 10 µg/dL was not required prior to 2000,"

Specific Comment 24, page 26: In the last sentence of the comment, add "ic" to "significant." That sentence should read: "ATSDR's incomplete analysis is misleading and significantly limits the value of the PHA."

Specific Comment 26, page 28: Please delete "not" from the last line of the Recommendation. The last sentence of the Recommendation for this Comment should read: "No Omaha children in the highest risk ages of 6 years of age and under have ever been exposed to ASARCO air emissions—ASARCO operations ceased before these children were born."

Comments from Gould Battery

86. Gould Electronics (Gould) is submitting the following comments on the above referenced Public Health Assessment (PHA) dated June 7, 2004. Gould does not have access to the data that ATSDR used in developing the PHA and consequently, is not in a position to provide independent analysis of the site data. Hence, these comments are focused on analyses that Gould believes should be incorporated into the PHA prior to issuing the final report. Gould does not take issue with ATSDR's conclusion that children's exposure to lead should be reduced. That conclusion is applicable to most, if not all, urban residential settings. However, after reviewing the draft PHA, Gould believes that a more rigorous and in-depth analysis of the public health issues in Omaha as they relate to lead needs to be performed prior to drawing conclusions about what interventions are appropriate.

Response

In developing PHAs, ATSDR considers all available environmental and health data in evaluating the potential health effects and identifying possible health actions. However, we include in the PHA only those data that directly relate to that potential health impact and our recommended public health actions. This approach enhances the readability and clarity of the document. We do include discussions of data conflicts and uncertainties when relevant.

87. ATSDR's analysis of the lead issues within the Omaha Lead Site is overly simplistic and consequently comes to the premature conclusion that EPA's plan to excavate soils with lead concentrations above 400 mg/kg will have beneficial impact on children's blood lead levels. The PHA does not explore the relative importance of the various sources of exposure, including lead-based paint and interior dust, before drawing its conclusion. ATSDR does not take advantage of the unique opportunity that is presented at this site where there has been active case management for children with elevated blood lead in combination with a soil removal program that has been ongoing for several years. Unlike at many sites where the beneficial effect of a proposed remedy is hypothetical, in Omaha, the hypothesis that soil removal alone will reduce children's blood lead levels can be actually tested with data. The results of this data analysis can then be used to optimize the intervention efforts so that the maximum benefit in reducing children's blood lead levels can be achieved.

Response

ATSDR emphasized the need to address soil lead and lead-based paint in any public health action undertaken. The analysis suggested by Gould would provide little information to refine the necessary public health actions. The analysis might provide evidence as to the responsibility that Gould and Union Pacific have in the soil lead contamination in Omaha. This is a legal issue between them and EPA.

88. According to the PHA, since 1999, EPA has conducted soil removal at 403 properties, 224 of which had children with elevated blood lead levels. The report does not state what the

corresponding soil lead levels were at those properties or show a relationship between elevated soil and blood lead at those properties. The Douglas County Health Department has said that it performs follow-up on children with elevated blood lead until the child has two consecutive readings below 10 μg/dl so the necessary data should be readily available to ATSDR. The report should provide information on whether the removal of soil has reduced the blood lead of the children living at those properties (beyond declines in blood lead expected as a result of national declines), and the results of any follow-up blood lead testing. The PHA quotes a study that concluded that an increase of soil lead from 100 to 1000 ppm would result in an increase in blood lead of 5.7 μg/dl. If this study was from another site, it may not be relevant for this site due to differences in lead bioavailability. ATSDR should have access to the data to show whether the soil removal that has taken place over the past several years results in a similar decrease, and if not, to answer the question, why not.

Response

ATSDR's response to this comment is the same as for comments 86 and 87.

89. ATSDR states that 96% of the children with blood lead levels above 15 μg/dl live in homes built before 1950 and makes a general statement that "most" children with elevated blood lead levels live in areas (not properties) where at least one soil lead level exceeded 400 mg/kg. The report should state what percent of children with a blood lead level above 15 μg/dl (or 10 μg/dl) live at a property where the average soil lead concentration for the yard, excluding the drip zone sample, exceeds 400 mg/kg. Clearly, the data were available to ATSDR. The blood lead /soil lead database (1420 data points) analyzed by EPA in the Baseline Risk Assessment includes 139 children with elevated blood lead levels who live in homes where the average soil lead is less than 400 mg/kg, and only 39 children with elevated blood lead levels who live in homes where the average soil lead is greater than 400 mg/kg. This suggests that the most important source of lead, i.e., lead based paint is being overlooked or ignored. This type of analysis along with an analysis of the inter-relationship of the various lead sources (i.e., the contribution of lead based paint to soil concentrations in the drip zone) would allow at least an initial assessment of the relative contribution of lead-based paint and soil lead towards elevated blood lead levels.

Response

ATSDR obtained the baseline risk assessment from NHHSS 2 weeks after ATSDR released the Omaha Lead site PHA, so these data ***were not*** *available to ATSDR as stated by Gould.*

On page 2 of Appendix13 of the risk assessment, NHHSS included a caution about the comparison that Gould is making.

> "Therefore, the results of the empirical comparison for the Omaha Lead Site should be used with great caution and with appropriate consideration of the uncertainties associated with the issues outlined above."

The results identified by Gould indicate that 39 of 139 (28%) children were likely affected, at least in part, by soil lead. ATSDR concludes that this provides further support for its conclusion that soil lead and lead-based paint are important sources of the exposure to lead by Omaha children. ATSDR continues to conclude that both sources should be addressed in any public health action.

90. ATSDR has provided no independent analysis in its report that supports a 400 mg/kg soil lead cleanup level. ATSDR clearly contemplates that a site-specific application of the IEUBK Model will be performed for the Omaha site to develop a site-specific clean-up level:

"EPA directs...that 400 ppm soil lead be used as the screening level for evaluating clean-up of lead-contaminated soil. They further direct that actual remediation levels be based largely on the results of entering site-specific values into the IEUBK Model." (page 17–18), and "...ATSDR considers residential soil contaminated at concentrations that exceed EPA's clean-up level to be a public health risk whether that level is the current 400 ppm or a revised number that also meets the 5% risk criteria..." (page 26)

However, the risk assessment did not develop site-specific values for most of the exposure parameters in the IEUBK Model and the 400 mg/kg cleanup level is nothing more than the default. The ATSDR report appears to present the logic that since elevated blood lead levels in children occur in the same general geographic area as soil lead levels above 400 mg/kg, then the soil lead is the cause of the elevated blood lead without further analysis. If 96% of the children with blood lead levels above 15 µg/dL live in houses built before 1950, and if these houses exhibit peeling paint and/or are in poor condition, there is little doubt that lead-based paint is the *major* contributor to their elevated blood lead levels. Further, EPA's risk assessment shows that 79% of the children with blood lead levels above 10 µg/dL live in residences with soil lead levels below 400 mg/kg. The relationship between children's blood lead levels and *both* lead-based paint and soil lead needs to be further explored and discussed in detail in the PHA.

Response

This analysis might provide evidence as to the responsibility that Gould and Union Pacific have in the soil lead contamination in Omaha. This is a legal issue between them and EPA and not a public health issue.

91. The PHA also does not discuss the dust lead levels in these homes and its relationship to paint lead, soil lead or blood lead. According to EPA's IEUBK model, 55% of a child's daily soil/dust intake comes from the ingestion of dust, yet the PHA does not discuss this important pathway with site data nor does the report present what is known about the presence of lead-based paint in these houses. The presence of lead-based paint in these houses will strongly influence dust lead concentrations, which in turn will have a strong effect on blood lead levels. The PHA should include an analysis of the relationship between interior dust lead and blood lead before concluding that soil removal is an effective intervention at soil lead levels above 400 mg/kg. The PHA should also include an analysis of the relationship between soil

lead and dust lead, to estimate the effects of soil remediation on dust lead and therefore blood lead levels.

Response

ATSDR did not identify any valid data on interior dust lead levels during the development of this PHA. We do not consider the dust data identified in the NHHSS risk assessment to be useable. Even if valid interior dust data were available, it would still not address the issue as to what is the source or sources of the lead in the dust. If an analysis could be done to identify the specific source, the results would only provide evidence as to the responsibility that Gould and Union Pacific have in the soil lead contamination in Omaha. The results would not assist in refining the public actions necessary to address childhood lead poisoning in Omaha.

92. When there are limited financial resources to address environmental concerns, no matter what the funding source, responsible public health agencies like ATSDR need to look closely at whether the expenditure truly addresses the primary cause of the health concern, in this case, childhood lead exposure. The PHA does not support a conclusion that soil removal at properties where lead concentrations are above 400 mg/kg addresses the primary source of childhood lead exposure.

Response

EPA and ATSDR are doing what Congress mandated for them to do regarding Superfund sites.

93. Gould appreciates the opportunity to submit these comments and looks forward to ATSDR performing a more complete analysis prior to issuing its final report.

Response

The evaluation already conducted by ATSDR is more than adequate to identify the primary sources of lead exposure in Omaha and the public health actions that need to be taken.

Appendix E - ATSDR Plain-Language Glossary

Appendix E

ATSDR Glossary of Environmental Health Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR serves the public by using the best science to take responsive public health actions and It provide trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption
For a person or animal, absorption is the process through which a substance enters the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with **chronic**].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with **intermediate duration exposure** and **chronic exposure**].

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses to the individual substances [compare with **antagonistic effect** and **synergistic effect**].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems.

Aerobic
Requiring oxygen [compare with **anaerobic**].

Ambient
Surrounding (for example, *ambient* air).

Anaerobic
Requiring the absence of oxygen [compare with **aerobic**].

Analyte
A substance measured in the laboratory. A chemical a laboratory tests for in a sample (such as water, air, or blood). For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates a proposed association between exposure to hazardous substances and disease.

Antagonistic effect
A biologic response to exposure to multiple substances that is **less** than would be expected if the known effects of the individual substances were added together [compare with **additive effect** and **synergistic effect**].

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study
A study to confirm human exposure to a hazardous substance. It does that through **biomedical testing** or by measuring a substance (an **analyte**), its **metabolite**, or another marker of exposure in human body fluids or tissues [also see **exposure investigation**].

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing people to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP
See **Community Assistance Panel.**

Cancer
Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for developing cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see **Comprehensive Environmental Response, Compensation, and Liability Act of 1980**]

Chronic
Occurring over a long time (more than 1 year) [compare with **acute**].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with **acute exposure** and **intermediate duration exposure**].

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)
A group of people, from a community and from health and environmental agencies, who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see **exposure pathway**].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as **Superfund**, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect
A disease or injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see **route of exposure**].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [**dose**] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, **biota** (plants and animals), or any other parts of the environment that can contain

contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and **biota** (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The **environmental media and transport mechanism** is the second part of an **exposure pathway**.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a **source of contamination** (such as an abandoned business); an **environmental media and transport mechanism** (such as movement through groundwater); a **point of exposure** (such as a private well); a **route of exposure** (eating, drinking, breathing, or touching); and a **receptor population** (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a **completed exposure pathway**.

Exposure registry
A system of ongoing follow-up of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with **surface water**].

Half-life ($t_{1/2}$)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation

A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with **public health assessment**].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to estimate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review or health outcome data evaluation
The analysis of existing health information (i.e., from death certificates, birth defects registries, blood lead surveillance databases, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review/health outcome data evaluation is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with **prevalence**].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see **route of exposure**].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with **acute exposure** and **chronic exposure**].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with **in vivo**].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with **in vitro**].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of **metabolism**.

mg/kg
Milligram per kilogram.

mg/cm^2
Milligram per square centimeter (of a surface).

mg/m^3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs

are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see **reference dose**].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.
Mortality
Death. Usually the cause (a specific disease, condition, or injury) is stated.

Mutagen
A substance that causes **mutations** (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites
(National Priorities List or **NPL)**
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see **National Priorities List for Uncontrolled Hazardous Waste Sites]**

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see **exposure pathway**].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific period [contrast with **incidence**].

Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with **health consultation**].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or **radionuclides** that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are **no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard**, and **urgent public health hazard**.

Public health statement
The first chapter of an ATSDR **toxicological profile**. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA [see **Resource Conservation and Recovery Act (1976, 1984)**]

Receptor population
People who could come into contact with hazardous substances [see **exposure pathway**].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see **exposure registry** and **disease registry**].

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD
See **reference dose**.

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [**inhalation**], eating or drinking [**ingestion**], or contact with the skin [**dermal contact**].

Safety factor [see **uncertainty factor]**

SARA [see **Superfund Amendments and Reauthorization Act]**

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see **population**]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or environment.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an **exposure pathway**.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's **toxicological profiles**. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].

Surveillance [see **epidemiologic surveillance**]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see **prevalence survey**].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see **additive effect** and **antagonistic effect**].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological

profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a **safety factor**].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other Glossaries and Dictionaries
Environmental Protection Agency: http://www.epa.gov/OCEPAterms/
National Center for Environmental Health (CDC):
http://www.cdc.gov/nceh/dls/report/glossary.htm
National Library of Medicine (NIH): http://www.nlm.nih.gov/medlineplus/mplusdictionary.html

Health Consultation

ARSENIC IN SOIL IN EAST OMAHA, NEBRASKA

MARCH 20, 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.

HEALTH CONSULTATION

ARSENIC IN SOIL IN EAST OMAHA, NEBRASKA

Prepared By:

Site and Radiological Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

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.

You May Contact ATSDR TOLL FREE at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

HEALTH CONSULTATION

ARSENIC IN SOIL IN EAST OMAHA, NEBRASKA

Prepared By:

Site and Radiological Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Health Consultation

ARSENIC IN SOIL IN EAST OMAHA, NEBRASKA

MARCH 20, 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.

You May Contact ATSDR TOLL FREE at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

Health Consultation

Arsenic in Soil in East Omaha, Nebraska

Overview of Arsenic in Soil in East Omaha, Nebraska

Introduction

This health consultation describes the public health significance of arsenic in soil in east Omaha, Nebraska. The report is being released by the Agency for Toxic Substances and Disease Registry, a federal health agency.

ATSDR works with the U. S. Environmental Protection Agency (EPA) to investigate hazardous waste sites throughout the United States. While reviewing soil data for the Omaha Lead Site, ATSDR discovered elevated arsenic levels at some properties.

Table of Contents

This health consultation contains the following sections:

Statement of Issues

ATSDR

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal health agency in Atlanta, Georgia, with 10 regional offices. ATSDR's regional office in Kansas City, Kansas, includes Nebraska.

Issues addressed

The purpose of this health consultation is to decide whether arsenic levels in soil in east Omaha are a public health hazard for adults and children.

Background

Overview of Background

Introduction

The Background section of this health consultation provides information about the site, including background arsenic levels in soil and the source of arsenic. The section also provides demographic information about people who live in eastern Omaha.

Contents

The background section contains the following topics:

The Site Investigation Area

Site boundaries

The area investigated includes residences, childcare facilities, schools, and other noncommercial/nonindustrial properties in the eastern portion of the City of Omaha, Douglas County, Nebraska. Some properties in this area were contaminated with lead from multiple sources, including air emissions from a lead refining operation.

The area investigated extends roughly from State Street to the north, Harrison Street to the south, 52nd Street to the west, and the Missouri River to the east. The area does not, however, include the central business district. A few properties outside the area also have been sampled.

This health consultation refers to the area as the State Street, Harrison Street, and 52nd Street Site (SH52 Site). Figure A-1 (Appendix A) identifies the area investigated.

Soil sampling history

In March 1999, the EPA began collecting soil samples from residential properties in Omaha to characterize the extent of contamination and to prioritize clean-up activities for the Omaha Lead Site. Soil sampling before 1999 also was conducted by the Douglas County Health Department, the EPA, and other interested parties.

Initially, the EPA tested soil samples for lead because lead was associated with emissions from ASARCO, a nearby smelter. Lead levels in soil were determined using a portable instrument called an x-ray fluorescence (XRF) detector. Because the XRF instrument also could measure other metals in soil at the same time it measured for lead, the concentration of arsenic and other metals was also determined.

From 1999 to the summer of 2005, the EPA tested about 26,800 properties for lead. Of these, almost 25,900 properties were also tested for arsenic. A review of the validity of the arsenic data is contained in Appendix B.

Continued on next page

The Site Investigation Area, Continued

Clean-up activities at the Omaha Lead Site

As part of EPA's Superfund activities for the Omaha Lead Site, EPA has removed contaminated soil from properties in the area since 1999. The first cleanups were conducted at daycare centers and certain residences meeting these criteria:

1. Daycare centers with lead levels in soil exceeding 400 parts of lead per million parts of soil (or 400 ppm), or
2. Residential properties with average lead levels in soil exceeding 400 ppm, if a child 6 years and younger lives at the residence, and if that child's blood lead levels exceed 15 micrograms lead per deciliter of blood.

EPA continues to remediate soils from residential properties and in 2006 was removing soils where soil lead levels exceeded 800 ppm. EPA will determine a final action level for lead when the agency releases a final Record of Decision for the Omaha Lead Site.

Arsenic Background Levels

Background arsenic levels in soil

EPA determined the background level of arsenic in soil by collecting 27 soil samples from neighborhoods 8 miles north of the ASARCO lead refining facility. Arsenic levels in these samples ranged from 3.1 to 10.8 ppm, and the average arsenic level was 7.2 ppm (EPA 2000).

A statistical analysis of the data shows that:

- 95% of arsenic levels from uncontaminated areas should be less than 11.5 ppm arsenic,
- 99% of arsenic levels from uncontaminated areas should be less than 13.7 ppm.

Stated another way, the average arsenic level in uncontaminated soil is about 7 ppm, with the highest arsenic levels from uncontaminated soil rarely exceeding 11 to 14 ppm.

Arsenic Levels in Soil Measured by XRF

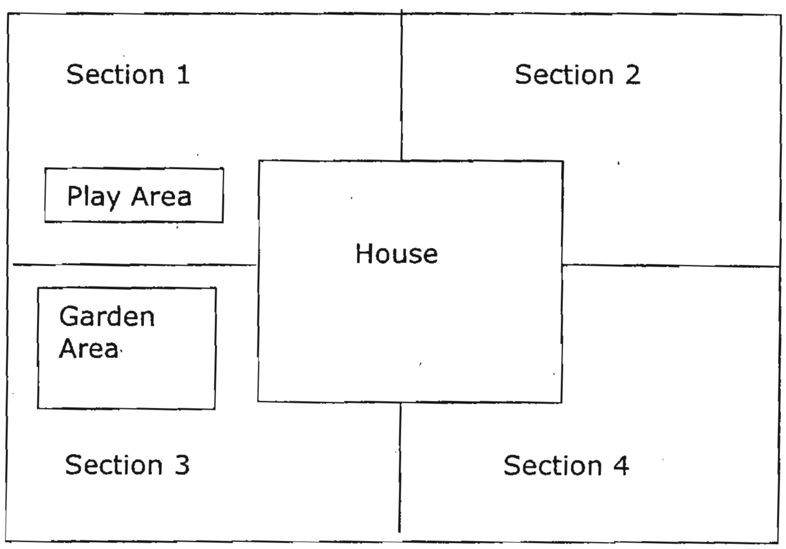
Sample design for individual property testing

In Omaha, EPA tested almost 25,900 properties for arsenic.

From most properties, up to four composite soil samples were collected by dividing the property into four sections or quadrants. The composite soil sample for each section was created by collecting five different soil samples from the section and mixing them together. Therefore, each property could have several composite soil samples, depending upon the number of sections into which the property was divided. Most properties had four composite samples, two from the front yard and two from the back yard. EPA also collected discrete soil samples from gardens, from near the home's drip line, and from play areas.

Diagram 1 shows a typical sample design for a residential property.

Diagram 1



Continued on next page

Arsenic Levels in Soil Measured by XRF, Continued

Number of properties with elevated arsenic

In east Omaha, 777 properties currently have average arsenic levels in soil above 70 ppm. The property with the highest average arsenic level contained 1,184 ppm arsenic. At this property, arsenic levels in various sections were 735 ppm (front yard, section 1), 560 ppm (front yard, section 2), 110 ppm (back yard, section 3), and 3,330 ppm (back yard, section 4).

Table 1 shows the current number of properties for various arsenic levels in soil. For example, 319 properties have yard-wide average arsenic levels in soil between 100 to 199 ppm. In east Omaha, about 3% of the properties (or 3 in every 100 properties) have average arsenic levels above 70 ppm.

Figure A-2 in Appendix A shows the distribution of properties in the study area that have average arsenic levels above 70 ppm. No obvious pattern is present, which indicates that properties with high levels of arsenic in soil are randomly distributed throughout east Omaha neighborhoods.

As part of their clean-up activities for the Omaha Lead Site, the EPA has removed contaminated soil from over 1,355 properties in east Omaha. Of those lead-remediated properties, 39 had average soil arsenic levels above 70 ppm, leaving 777 properties currently with average soil arsenic levels above 70 ppm.

In addition to residential properties, 10 daycare centers currently have average arsenic levels above 70 ppm. The highest average soil arsenic level at a daycare center is 251 ppm.

Maximum Arsenic Levels in Soil

Because EPA collected composite soil samples, the maximum concentration of arsenic in soil is not known with certainty. However, studies at a similar site in Denver, Colorado (i.e., the Vasquez Blvd and I-70 Site), showed that maximum arsenic levels are five to six times greater than average levels (ATSDR 2005a).

This means that for a yard with an average arsenic level of 1,000 ppm arsenic, certain parts of the yard may have as much as 5,000 to 6,000 ppm arsenic in soil. A child with soil pica behavior who eats soil from a highly contaminated part of the yard will have a much higher exposure to arsenic and be at greater risk of harmful effects.

The source of arsenic in highly contaminated yards probably resulted from the application of an arsenic-containing weed killer. The areas of the yard with higher arsenic levels in soil probably resulted higher application of the weed killer in these areas.

Arsenic Levels in Soil Measured by XRF, Continued

Table 1. Number of Current Properties at Different Arsenic Concentrations

Average Arsenic Concentration in ppm	*Number of Properties Currently with Elevated Arsenic in Soil*
greater than 2,000	0
1000 to 1,999	1
900 to 999	1
800 to 899	1
700 to 799	1
600 to 699	1
500 to 599	1
400 to 499	9
300 to 399	22
200 to 299	64
100 to 199	319
70 to 99	357
Total	777

Arsenic Source

EPA's report regarding the arsenic source

In the Remedial Investigation for the Omaha Lead Site (in Appendix D), EPA states the following :

- The source of high arsenic levels in residential yards is not fallout from an industrial source.
- Most soil samples have small amounts of arsenic that resulted from atmospheric fallout, probably from the ASARCO refinery.

Continued on next page

Arsenic Source, Continued

EPA's report regarding the arsenic source (continued)

EPA states that arsenic contamination from the refinery does not raise total arsenic levels above 20 ppm in residential soils (EPA 2004). EPA considers properties with high levels of arsenic in soil to be unrelated to the Omaha Lead Site.

Three soil samples were analyzed by the University of Colorado Laboratory for Environmental and Geological Studies. Their report concludes that arsenic from these three soil samples most likely originated from an arsenic-containing pesticide (EPA 2004). EPA's investigations into the source of arsenic and the type of arsenic present in eastern Omaha can be found at this EPA Web site:
http://www.epa.gov/Region7/cleanup/superfund/sites/omaha_ne_lead_RI.pdf

Demographic Information

East Omaha: demographic information

Eastern Omaha is a racially diverse community made up of whites (62%), African-Americans (25%), Asians (1%), American Indians (1%), and other or multiple races (11%).

In this community, 17% of the residents in the various racial groups identify as Hispanic.[1] Table 2 shows detailed demographic information.

Number of children per household

Demographic information shows that about one of every 4 households in east Omaha includes a preschool child. This information is used to estimate the number of preschool children who eat dirt, which is also known as soil pica behavior. The Discussion section of this health consultation has more information about soil pica behavior.

Continued on next page

Demographic Information, Continued

Table 2. Demographic information for the SH52 Site in Eastern Omaha

Population Parameter	*# People*
Total	158,360
Whites	98,594
African-American	38,819
Asian	2,140
American Indian/Alaskan Native	1,739
Native Hawaiian/Other Pacific Islander	121
Other Races	12,734
Multiple Races	4,213
Children 6 Years and Younger	17,515
Hispanic Origin	22,817
Total Housing Units	66,538

Discussion

Overview of Discussion

Introduction

The Discussion section of the report describes

- How people become exposed to arsenic in soil,
- How to estimate people's exposure, and
- The possible health effects from exposure to arsenic in soil.

Contents

This section contains the following topics:

Exposure to Arsenic in Soil

How exposure occurs to arsenic in soil

Children and adults can be exposed to arsenic in soil by accidentally swallowing small amounts of soil that cling to their hands when they put their hands in their mouths. This exposure is greatest for preschool children because of their frequent hand-to-mouth activity. When arsenic-contaminated soil is tracked indoors, people can also be exposed to arsenic by ingesting arsenic-contaminated dust that clings to their hands.

Preschool children, on average, swallow more soil and dust than people in any other age group. This is because some preschoolers often have close contact with soil and dust when they play, and because they tend to engage frequently in hand-to-mouth activity.

The amount of soil that people ingest daily is somewhere between 30 milligrams to 200 milligrams (ATSDR 2005a; EPA 1997; Calabrese 1997). To put this amount in perspective, it is approximately equal to a pinch (or less than $^{1}/32$ teaspoon) to $^{1}/8$ teaspoon of soil

Exposure to Arsenic in Soil, Continued

An overview of arsenic absorption

As described previously, one way exposure to arsenic in soil occurs is from ingesting contaminated soil that clings to people's hands. Not all the arsenic that is swallowed, however, actually gets into the body—some arsenic will pass through the digestive system without being absorbed. For example, some arsenic is bound so tightly to soil particles it is less likely to be absorbed by the lining of the intestinal tract (the gut) than is arsenic bound loosely to soil particles. This process of how much arsenic actually crosses the gut and gets into the body is known as bioavailability.

For example, if only half of the arsenic in soil is capable of passing from the gut and into someone's body, the soil arsenic is referred to as being 50 percent bioavailable.

The bioavailability of arsenic in soil varies depending upon the source of arsenic (e.g., smelters, mines, pesticide application). Studies have shown soil arsenic bioavailability to range from nonbioavailable to 78% (Roberts 2002; Casteel 1997; Casteel 2001; Freeman 1993; Freeman 1995; Lorenzana 1996).

Several of these studies investigated soil contaminated with an arsenic-based herbicide or pesticide. One group of scientists tested a soil sample from two locations in Florida. Using groups of five monkeys as test subjects to determine arsenic absorption, the arsenic in one soil sample had an average relative bioavailability of 10.7% and a standard deviation of 4.9% while the other soil sample had an average relative bioavailability of 17% and a standard deviation of 10% (Roberts 2002). Because only one soil sample was tested from each location and because the standard deviation is large, some uncertainty exists in the reported relative bioavailability of 10.7% and 17% for these two locations.

EPA studied arsenic bioavailability in residential soil from the Vasquez Boulevard and I-70 (VBI70) Site in Denver, Colorado. Arsenic levels in soil at the VBI70 site are very similar to arsenic levels in soil at the SH52 Site. Properties with high levels of arsenic are randomly distributed in residential neighborhoods, and the predominant form of arsenic is arsenic trioxide, a form typically found in arsenic-based pesticides. Using weanling pigs, EPA tested five composite soil samples from several residential neighborhoods in the VBI70 study area and reported the following relative bioavailability for arsenic: 18%, 18%, 23%, 37%, 37%, and 43%. Using a statistical method, EPA estimated the 95th upper confidence limit of the average relative bioavailability to be 42% (Casteel 2001; EPA 2001). In other words, the average relative bioavailability for soils from the VBI70 site is not likely to

Exposure to Arsenic in Soil, Continued

Uncertainty in arsenic absorption

Some uncertainty exists in estimating relative bioavailability for arsenic from the VBI70 site for several reasons. First, only six soil samples were tested in pigs and second not all of the arsenic that was administered to the pigs was accounted for in their urine and feces.

Arsenic bioavialability in East Omaha

Because the types of arsenic at the VBI70 Site and at the SH52 Site are similar, ATSDR chose a relative bioavailability ranging from 40% to 60% for arsenic in soil.

Other factors affecting arsenic exposure

Other factors are also important in estimating the dose of arsenic, including

- the concentration of arsenic in soil,
- how much soil is ingested,
- how frequently someone ingests soil, and
- a person's weight.

How to estimate arsenic exposure

The following equation estimates the amount of arsenic a person absorbs from ingesting arsenic-contaminated soil

Arsenic Dose =

$$\frac{\text{(arsenic concentration in soil)(milligrams soil ingested)(\% absorption)(0.000001 kg/mg)}}{\text{Body weight in kg}}$$

Variation in arsenic dose

A range of doses is possible because different values can be used for various parameters in the equation. For example, the amount of soil ingested varies from 30 mg for most children, to 200 mg for a small percentage of children, and to 5,000 mg for children with soil pica behavior (ATSDR 2005a; ATSDR 2001; Calabrese 1997). Weight can also vary from 10 kg for a 1-year-old child, to 35 kg for elementary age children, and to 70 kg for an adult. In addition, arsenic bioavailability is probably somewhere between 40% and 60%.

Therefore, because of differences in weight, soil intake, and bioavailability, the estimated dose of arsenic can vary for each age group.

Exposure to Arsenic in Soil, Continued

Comparison of dose to health guidelines

To determine whether harmful effects might be possible from ingesting arsenic-contaminated soil, ATSDR compares the estimated amount of arsenic exposure (or dose) to the Agency's "health guidelines" dose for arsenic.

For arsenic, ATSDR's oral Minimal Risk Levels (MRLs) are available for acute exposures (exposures less than 2 weeks) and for chronic exposures (exposures greater than 1 year).

Health guideline for brief exposures

A Minimal Risk Level is a dose below which noncancerous harmful effects are not expected.[2] In the case of arsenic, ATSDR has developed a provisional acute oral MRL of 0.005 mg/kg/day.[3] The acute dose of 0.005 mg/kg/day means 0.005 milligrams of arsenic per kilogram body weight per day. When someone's estimated dose is below 0.005 mg/kg/day for short periods (e.g., one to two weeks), then non-cancerous harmful effects are unlikely.

The provisional acute oral MRL was derived from a human poisoning episode that showed several transient (i.e., temporary) effects at an estimated dose of 0.05 mg/kg/day. The transient effects observed included nausea, vomiting, abdominal pain, and diarrhea (Mizuta 1956). The acute effect level of 0.05 mg/kg/day identified in the Mizuta investigation is supported by another study (Franzblau 1989).

It is important to note about the acute oral MRL that

- The acute oral MRL is 10 times below the levels thought to cause harmful effects in humans.
- The acute oral MRL is based on people being exposed to arsenic dissolved in water instead of arsenic in soil, a fact that might influence how toxic arsenic in soil is.
- The acute oral MRL applies to exposures less than 2 weeks.

The acute oral MRL applies to non-cancerous effects only; it is not used to determine whether people could develop cancer (ATSDR 2000).

Continued on next page

2 It is important to remember that MRLs cannot be used to determine the risk of cancer.

Exposure to Arsenic in Soil, Continued

Health guideline for long-term exposures

A similar comparison is made to evaluate whether long-term exposure to arsenic might cause non-cancerous harmful effects. In this case, the estimated dose of arsenic over long periods is compared with ATSDR's chronic oral MRL of 0.0003 mg/kg/day.

Estimating Exposure and Determining Possible Health Effects in Children

How soil pica behavior affects arsenic exposure

Children with soil pica behavior have the highest amount of exposure to arsenic in soil because they ingest the largest amounts of soil. Table 3 shows a representative sample of average arsenic levels in residential properties in eastern Omaha along with the estimated absorbed dose of arsenic in children with soil pica behavior.

The estimated absorbed dose of arsenic in children with soil pica behavior can be compared with ATSDR's health guideline for acute (short-term) exposures of 0.005 mg/kg/day. When this guideline is exceeded, a concern might exist for harmful effects and further evaluation is needed.

A representative soil pica example

For example, if preschool children with soil pica behavior live at the property with the highest average arsenic concentration, their estimated absorbed dose of 0.1 mg/kg/day not only exceeds ATSDR's provisional acute oral MRL for arsenic of 0.005 mg/kg/day but also exceeds the estimated level of 0.05 mg/kg/day—a level that causes harmful effects in humans. These children are at risk of harmful effects from arsenic in soil.

Soil arsenic levels and child health concerns

If preschool children with soil-pica behavior live at a property where the average arsenic level is 70 ppm, their estimated dose is 0.005 mg/kg/day if they practice soil-pica behavior three times during the week. Of the properties tested, 777 have average arsenic levels above 70 ppm (see Table 1).

Children with soil pica behavior who live at properties with average arsenic levels greater than 70 ppm are also at risk of harmful effects from arsenic, and this risk increases as the average arsenic level increases. The property with

Estimating Exposure and Determining Possible Health Effects in Children, Continued

Table 3. Estimated Absorbed Doses in Preschool Children with Soil Pica Behavior

Average Arsenic Concentration in Soil in ppm	*Estimated Absorbed Dose in Children with Soil pica Behavior Ingesting 5,000 mg soil Dose in mg/kg/day*	*Provisional Acute Oral MRL in mg/kg/day*	*Exceeds Health Guideline*
1,184	0.1 to 0.14	0.005	yes
1,000	0.08 to 0.12	0.005	yes
900	0.073 to 0.1	0.005	yes
800	0.065 to 0.09	0.005	yes
700	0.057 to 0.08	0.005	yes
600	0.05 to 0.07	0.005	yes
500	0.044 to 0.058	0.005	yes
450	0.036 to 0.047	0.005	yes
350	0.028 to 0.04	0.005	yes
300	0.025 to 0.035	0.005	yes
250	0.02 to 0.029	0.005	yes
200	0.016 to 0.023	0.005	yes
150	0.01 to 0.017	0.005	yes
100	0.008 to 0.01	0.005	yes
70	0.006 to 0.008	0.005	yes
50	0.004 to 0.005	0.005	no

Possible harmful effects for children with soil pica

The most likely health effects that might occur from eating arsenic-contaminated soils include

- nausea
- stomach cramps
- vomiting
- diarrhea
- headaches
- facial swelling, especially around the eyes

The symptoms are temporary and should subside when exposure to arsenic ceases.

Continued on next page

Estimating Exposure and Determining Possible Health Effects in Children, Continued

Assumptions for children with soil pica

The estimated doses in children with soil pica behavior were derived using the following assumptions:

- 5,000 mg of soil ingested (about 1 teaspoon),
- a one-time soil pica event,
- a soil pica frequency of 3 days per week,
- 40 to 60% arsenic bioavailability, and
- an 11-kg (24-pound) child.

Variations in soil pica dose estimations

It is important to remember that the estimated dose in children can vary depending upon how much soil they eat, how much arsenic crosses the gut, how much they weigh, and how frequently they eat dirt.

Uncertainty about health effects from soil pica

Some uncertainty exists in deciding whether adverse health effects might occur in children. This uncertainty exists in two areas: estimating how much arsenic children are exposed to (i.e., the dose) and determining the possible health effects. The uncertainty that exists in estimating the dose for soil-pica children comes from

- estimating the amount of dirt that children with soil pica behavior eat,
- variations in how often children exhibit soil-pica behavior, and
- whether children eat dirt from areas of the yard with low or high levels of arsenic in soil.

Therefore, a child with soil-pica behavior who lives at a property with arsenic-contaminated soil might not get sick if that child eats soil from an area in the yard with low arsenic levels, or if that child eats only a small amount of soil, and the amount of arsenic exposure is below ATSDR's acute oral MRL for arsenic.

Conversely, children with soil-pica behavior might be at greater risk if they eat dirt from a part of the yard that is more heavily contaminated.

Continued on next page

Estimating Exposure and Determining Possible Health Effects in Children, Continued

Clean up of lead-contaminated properties in East Omaha

It should be pointed out that some arsenic-contaminated yards in Omaha also contain unsafe levels of lead, and that these yards were or will be remediated as part of the Omaha Lead Site. About 36 properties cleaned up because of high levels of lead in soil also had average arsenic levels that exceeded 70 ppm.

Nevertheless, some yards contain elevated levels of arsenic but have low levels of lead in soil. These yards will not be cleaned up as part of EPA's activities for the Omaha Lead Site.

Number of children at risk in East Omaha

As stated, using 2000 census data for eastern Omaha, a preschool child lives in 1 out every 4 households.[4] Therefore, of the 777 properties where average arsenic levels in soil are above 70 ppm, about 200 preschool children are present. Because somewhere between 4% and 20% of preschool children will have soil pica behavior during their preschool years, about 10 to 40 preschool children with soil pica behavior live at properties with average arsenic levels exceeding 70 ppm Barltrop 1966, Robischon 1971, Sheelshear 1975, Vermeer and Frate 1979). As mentioned previously, soil pica behavior is most likely to occur in 1- and 2-year-old children and occurs less frequently in older preschool children.

Possible harmful effects in children with typical soil intake

It is also possible to estimate the absorbed dose of arsenic in children with typical soil ingestion (e.g., 30 mg/day to 200 mg/day or a pinch to $^1/_8$ teaspoon) (ATSDR 2005a; EPA 1997; Calabrese 1997). These estimated doses are shown in Table 4.

Children who typically ingest 30 mg of soil daily have estimated absorbed doses below ATSDR's provisional acute oral MRL of 0.005 mg/kg/day. Those children with average soil intake are not at risk of harmful effects from exposure to arsenic in soil, even at the most contaminated properties.

Continued on next page

Estimating Exposure and Determining Possible Health Effects in Children, Continued

Possible harmful effects in children with typical soil intake (continued)

Children who ingest 200 mg soil daily and who live at the most contaminated properties (e.g., the property with average arsenic levels above 800 ppm) have an estimated absorbed dose slightly above ATSDR's provisional acute oral MRL of 0.005 mg/kg/day. These children have a small risk of experiencing nausea, stomach cramps, vomiting, diarrhea, facial swelling, and headaches.

Children with typical soil ingestion who live at properties where average arsenic levels in soil are below 1,000 ppm are not likely to experience harmful effects from arsenic.

Variations in exposure

Like the estimated doses in children with soil pica behavior, the estimated doses in children with typical soil intake will vary depending upon the bioavailability of arsenic in soil, their weight, and how much soil they ingest.

Table 4. Estimated Absorbed Doses in Preschool Children with Typical Soil Ingestion

Average Arsenic Concentration in Soil in ppm	*Estimated Absorbed Dose in Preschool Children Ingesting 30 mg Soil Daily in mg/kg/day*[5]	*Exceeds ATSDR's Provisional Acute Oral MRL of 0.005 mg/kg/day*	*Estimated Absorbed Dose in Preschool Children Ingesting 200 mg Soil Daily in mg/kg/day*[6]	*Exceeds ATSDR's Provisional Acute Oral MRL of 0.005 mg/kg/day*
1,184	0.0009 to 0.0013	no	0.006 to 0.009	yes
900	0.0007 to 0.001	no	0.0046 to 0.0065	yes
800	0.00061 to 0.00087	no	0.0004 to 0.0058	yes
700	0.0005 to 0.0008	no	0.0035 to 0.004	no
70	0.00008 to 0.00012	no	0.0004 to	no

5 To estimate the absorbed dose of arsenic, ATSDR used 30 mg or 200 mg of soil ingested, a daily exposure, a body weight of 16 kg, and either 40 or 60% bioavailability.

Estimating Arsenic Exposure and Determining Possible Health Effects in Adults

Assumptions for estimating absorbed arsenic dose in adults

As previously mentioned, adults also swallow small amounts of soil that cling to their hands while outdoors working, playing, and gardening. To estimate the absorbed arsenic dose in adults, ATSDR assumes that 40 to 60% of ingested arsenic crosses the gut, that adults ingest 50 mg of soil each day, and weigh 70 kg (about 155 pounds).

The estimated absorbed dose of arsenic for adults at various arsenic concentrations in soil is shown in Table 5.

Comparison of absorbed dose to health guidelines

The estimated absorbed dose of arsenic in adults from soil ingestion at all properties in east Omaha is below ATSDR's provisional acute oral MRL of 0.005 mg/kg/day.

The estimated absorbed dose of arsenic in adults also is below ATSDR's chronic oral MRL of 0.0003 mg/kg/day for all properties except for the few properties where the average arsenic level exceeds 800 ppm. At these properties, the estimated absorbed dose of arsenic ranges from 0.00037 mg/kg/day to 0.0005 mg/kg/day, thus slightly exceeding ATSDR's chronic oral MRL of 0.0003 mg/kg/day.

A long-term human study on a large population has shown that a dose of 0.014 mg/kg/day will damage the skin, causing conditions known as hyperkeratosis and hyperpigmentation.[7] The same study showed that a dose of 0.0008 mg/kg/day will not damage the skin (Tseng et al. 1968).

Because the estimated doses for adults who live at the most contaminated properties is significantly below the no-effect level in humans of 0.0008 mg/kg/day, harmful skin effects in adults who live at these properties are not likely.

Continued on next page

7 Arsenic-induced hyperkeratosis is a skin condition found most often on the feet and palms. Many small depressions occur in the skin with small, hard outgrowths of skin in the center of each depression. Hyperkeratosis

Estimating Arsenic Exposure and Determining Possible Health Effects in Adults, Continued

Table 5. Estimated Absorbed Doses in Adults

Average Arsenic Concentration in Soil in ppm	*Estimated Absorbed Dose in Adults in mg/kg/day*[8]	*Chronic Oral MRL in mg/kg/day*	*Exceeds Health Guideline*
1,184	0.0004 to 0.0005	0.0003	yes
900	0.00026 to 0.0004	0.0003	yes
800	0.00023 to 0.00037	0.0003	yes
700	0.0002 to 0.0003	0.0003	no
600	0.00019 to 0.00028	0.0003	no
70	0.00002 to 0.00003	0.0003	no

Background information on arsenic and cancer

According to EPA and the U.S. Department of Health and Human Services, arsenic is known to cause cancer in people. This conclusion is based on convincing evidence from many studies of people who were exposed to either arsenic-contaminated drinking water, to arsenical medications, or to arsenic-contaminated air in the workplace (ATSDR 2000).

Of the different types of cancer from oral exposure, skin cancer—namely, squamous cell carcinoma and basal cell carcinoma—and other types of cancer, including cancer of the lungs, bladder, kidney, and liver, are a concern.

EPA's method for estimating the risk of cancer from arsenic

One way to evaluate the cancer-causing potential from arsenic in soil is to estimate the average amount of arsenic-contaminated soil that people ingest over many years and use mathematical equations to estimate a theoretical increase in cancer risk. EPA typically uses this approach to estimate a potential increased risk of cancer from estimated exposure doses.

Continued on next page

Appendix A

Figures

Figure A-1. Site investigation area

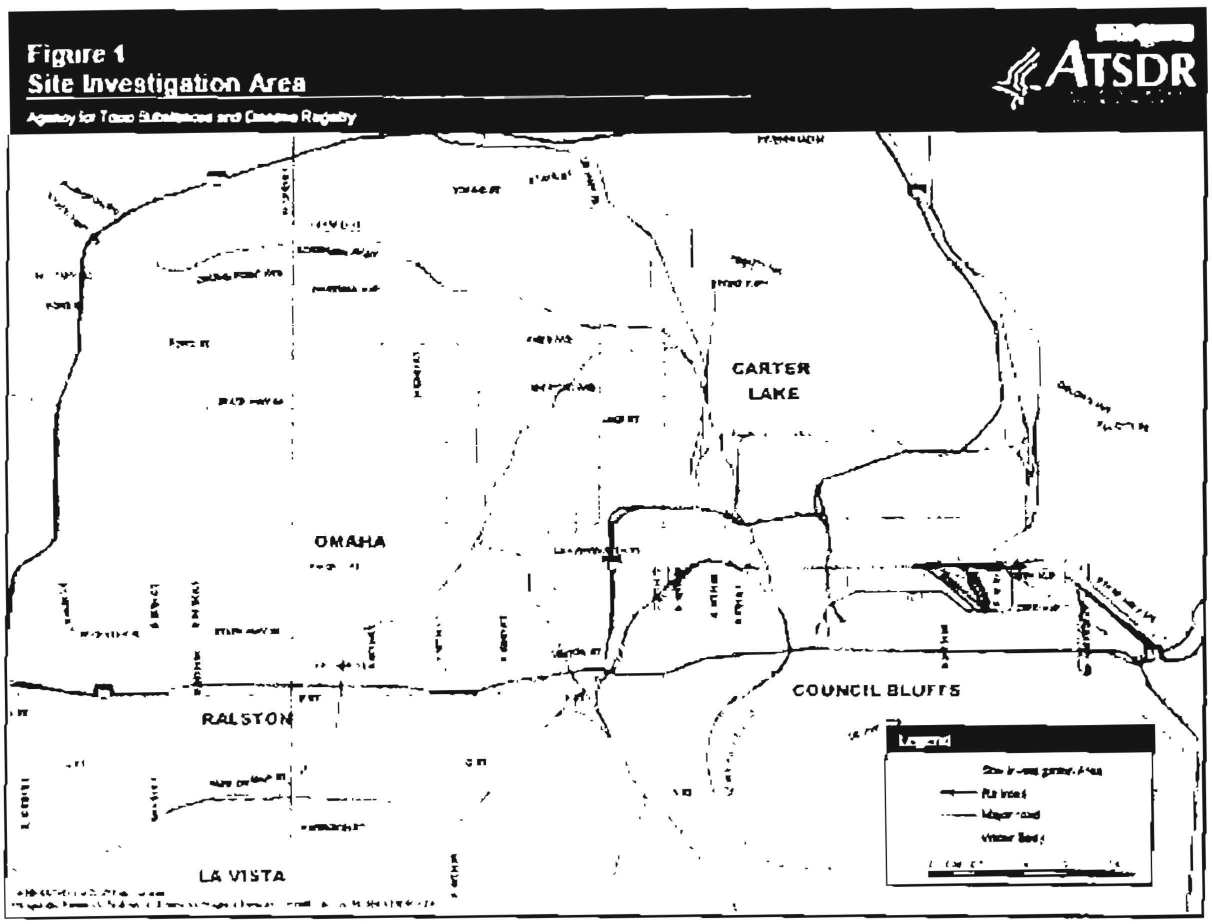
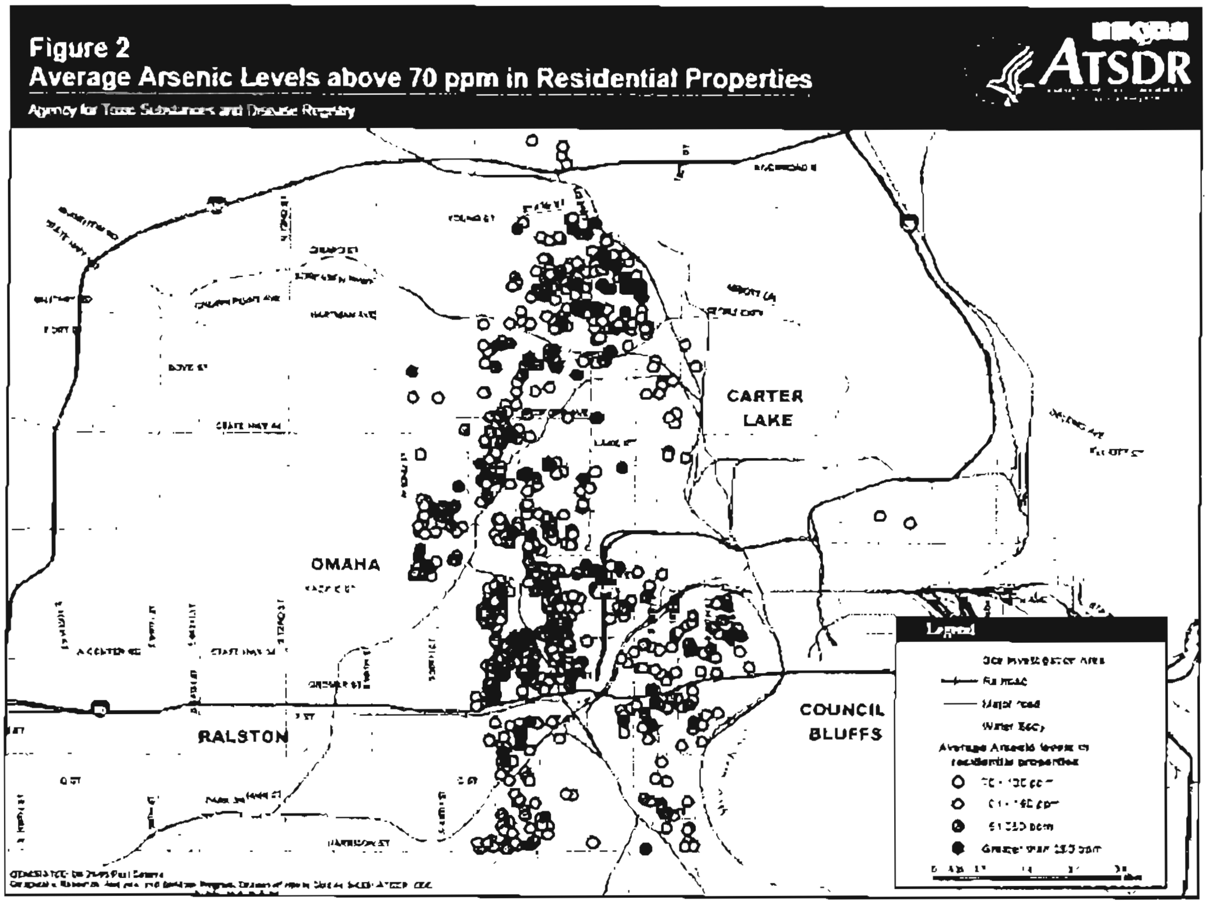


Figure A-2. Properties with average arsenic levels above 70ppm.

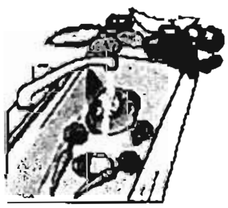


Appendix C

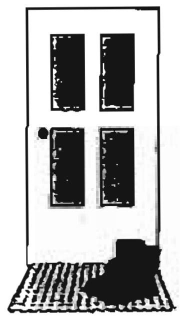
Pictorial: ways to protect your family's health

Ways to protect your health

By keeping dirt from getting into your house and into your body



Wash and peel all fruits, vegetables, and root crops



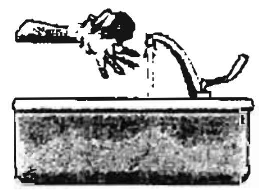
Wipe shoes on doormat or remove shoes

Don't eat food, chew gum, or smoke when working in the yard

Damp mop floors and damp dust counters and furniture regularly

Wash dogs regularly

Wash children's toys regularly



Wash children's hands and feet after they have been playing outside