Health Consultation

Human Health Hazard Posed by Exposure to Lead in Soil and Dust

PANHANDLE SMELTING AND REFINING COMPANY

PONDERAY, BONNER COUNTY, IDAHO

Prepared by the
Idaho Division of Public Health

April 16, 2010

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners 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 or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Foreword

The State of Idaho, Idaho Division of Public Health (IDPH), Bureau of Community and Environmental Health (BCEH) jointly prepared this public health consultation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to environmental contaminants. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The health consultation is an approach used by ATSDR and IDPH to respond to requests from concerned residents for health information on hazardous substances in the environment. The health consultation process evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health.

Summary

Introduction

The top priority of the Bureau of Community and Environmental Health (BCEH) Environmental Health Education and Assessment Program (EHEAP) is to ensure that the individuals using the Panhandle Smelting and Refining Company site have good information to safeguard their health from contamination found at the site. The Idaho Department of Environmental Quality (IDEQ) asked EHEAP to evaluate data documented in this health consultation. The purpose of the consultation is to evaluate the public health risk of lead exposure from soil and outdoor dust during recreational activities at this site located on the banks of Lake Pend Oreille and determine if signs should be posted alerting people to potential lead exposure. The site is scheduled for cleanup and redevelopment which will remove the contamination and reduce people's exposure to lead.

Conclusion

While there is significant uncertainty in the data, EHEAP concludes that breathing and eating lead in soil and outdoor dust at the site for several weeks in the course of a year could harm people's health. This could cause a person to ingest a sufficient amount of lead to potentially cause nervous system damage, especially children, and could possibly affect other organ systems as well. EHEAP is also concerned about arsenic at the site; arsenic has been detected, though data are not yet available to evaluate the public health implications. Any activity other than walking through the area potentially elevates the risk of harming people's health. The potential effects are considered serious health effects. Signage and/or fencing is recommended at the site to educate the public about the health hazards present and to discourage entry into the most highly contaminated areas of the site until remediation has been completed. The landowner may also consider fencing or other deterrence around the most contaminated hot spots.

Basis for Decision

Geometric mean lead levels at the Beach/Rock area and the Woods/Upper Buildings area of the site are high (>4-fold higher than the Environmental Protection Agency (EPA) Preliminary Remediation Goal (PRG)). Using geometric mean soil/dust levels, EPA models predict blood lead levels:

- above the Centers for Disease Control & Prevention (CDC) level of concern of 10 µg /dL for up to 4% of exposed 6-7 year old children at the Beach/Rock and Woods/Upper Buildings areas;
- above 10 µg /dL for up to a third of 12-13 year olds exposed at the Woods/Upper Buildings area; and
- above 10 µg /dL for up to 4% of fetuses carried by adults exposed at the Woods/Upper Buildings area.

Next Steps

EHEAP will continue to work with IDEQ throughout the summer of 2010 to advise users of the smelter site and the surrounding residents of:

- ongoing possible health risks from lead exposure.

- the possibility of parents asking their health care provider about blood lead testing if they are concerned about their children's exposure to lead at the site.

EHEAP will work with IDEQ this summer to:

- post signs that advise the public of the specific health hazards present and divert the public away from the most highly-contaminated areas; and encourage fencing or other measures if welcomed by the landowner.
- develop and distribute a lead fact sheet that is specific to this site.

For More Information

If you have concerns about this site, contact Dr. Kai Elgethun at 208-334-5682. You may also call the Agency for Toxic Substances & Disease Registry (ATSDR) at 1-800-CDC-INFO and ask for information on the Panhandle Smelting and Refining Company site.

Background & Site Description

The Bureau of Community and Environmental Health (BCEH) Environmental Health Education and Assessment Program (EHEAP) was asked to evaluate levels of lead in the soil and outdoor dust at this site. EHEAP first visited the site in 2008, and has been back several times since then to assess current site usage and proposed land development.

Exposure Situation and Nature of Request

The Panhandle Smelting and Refining Company site is on the north shore of Lake Pend Oreille near the towns of Ponderay and Kootenai in Northern Idaho (see Figure 1). The smelter operated for a brief period from 1908-1909 without employing any type of pollution control. The lands near the smelter site were impacted by the deposition of contaminants, including lead, from the facility. Arsenic exposure may also be a hazard, but current arsenic data are insufficient for addressing the health hazard. The site sits between the lake and the Montana Rail Link/Burlington Northern rail line, and is approximately one square kilometer in size. Up to 30 trains per day pass the site at high speeds, and crossing the tracks is considered trespass. The smelter property is the terminus of a proposed multi-use lakefront trail connecting the towns of Sandpoint, Ponderay, and Kootenai. The smelter site is used recreationally by people of all ages, both locals and visitors. Campfires, off-road (BMX) bicycling, picnicking, and sunbathing are popular here based on personal observation by EHEAP at various times of year and based on details provided by IDEQ. A lakeshore path and several paths from public roads across busy freight rail tracks currently provide access. Initial X-Ray Fluorescence (XRF) screening revealed lead levels as high as 51,000 mg/kg. XRF values used for analysis here have been corrected using a calibration curve (see Methods section and Appendix D). EHEAP has some concerns about the accuracy and precision of the data, but feels they are sufficient to make a recommendation about the general health hazards present at this time. The smelter site in its entirety is owned by three different public and private interests. The impacted area in its entirety brings together more than a dozen landowners and thousands of stakeholders, though the high lead areas addressed in this health consultation mostly belong to a single landowner.

Figure 1: Map of Idaho showing location of the Panhandle Smelting and Refining Company, Bonner County.

Detail of the Site

See Figure 2 for a map of the affected area. To better understand risk, the site was divided into three distinct areas that reflect different public use activities observed. Some of the area is heavily vegetated and currently somewhat inaccessible to users. There are several areas where bare soil is exposed. The ground is generally dry during the period of most use, and visible dust is present on vegetation. There is a solid, rock-like slag pile, and a beach consisting of broken slag pieces. There is a wooden dock on site that extends into the lake. Contaminated sediments and slag are visible in the water for the first several meters along the dock. The dock has unrestricted access.

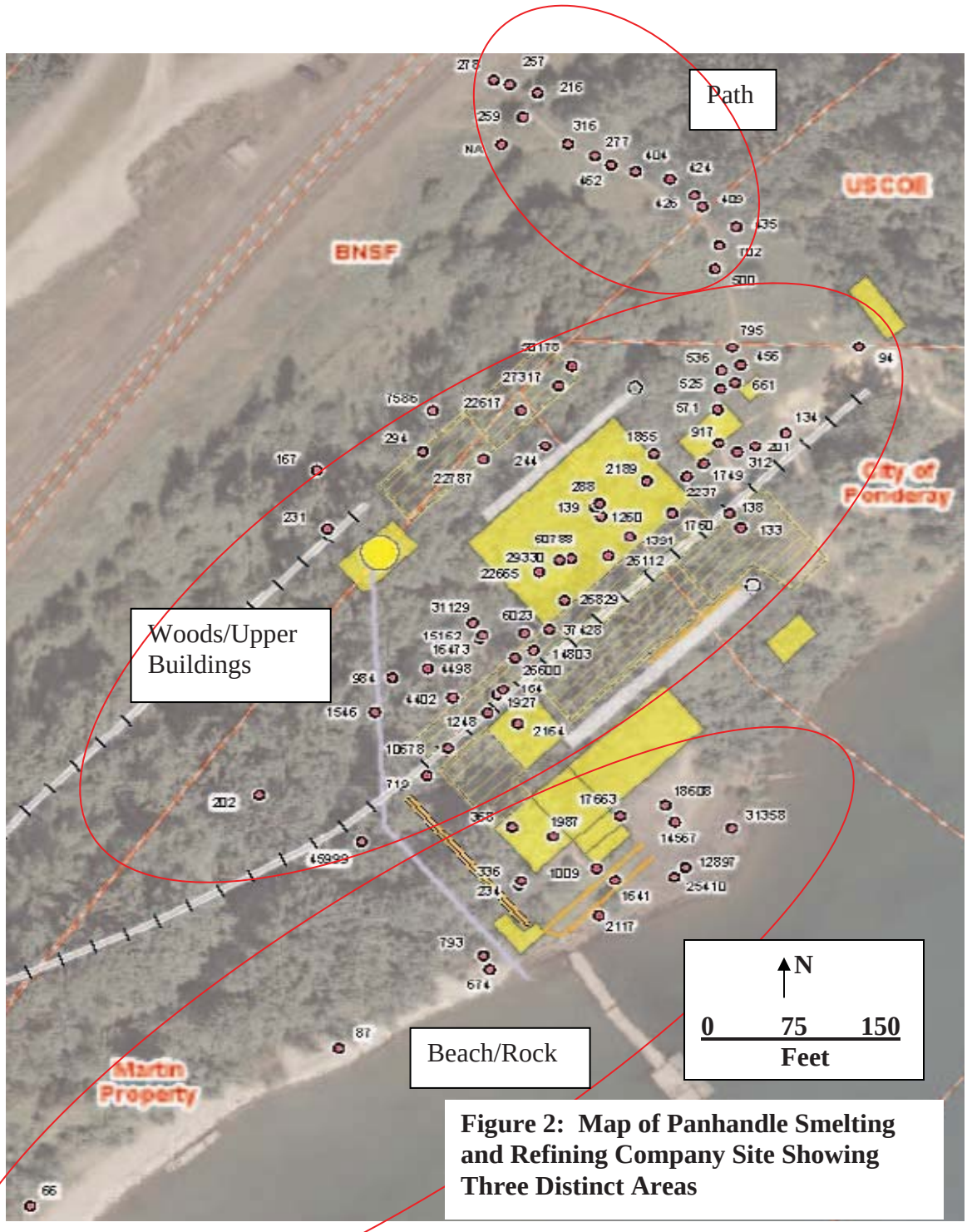

Figure 2: Map of Panhandle Smelting and Refining Company Site Showing Three Distinct Areas

Red dots represent a single calibration-adjusted XRF lead value (in mg/kg).

Lead Toxicity and Comparison Values

Lead can exert negative health effects at any dose; thus, there is no ATSDR Minimal Risk Level (MRL) or EPA Reference Dose (RfD). Health effects associated with exposure to inorganic lead and compounds include, but are not limited to neurotoxicity, developmental delays, hypertension, impaired hearing acuity, impaired hemoglobin synthesis, and male reproductive impairment. Importantly, many of lead's health effects may occur without overt signs of toxicity. Lead has particularly significant neurotoxic effects in children (ATSDR, 2005). Children under 6 years old have a high risk of exposure because of their more frequent hand-to-mouth behavior (CDC, 1991). In adults, 5-15 percent of ingested inorganic lead is absorbed from the gastrointestinal tract; in children, as much as 50 percent is absorbed (ATSDR, 2005). The rest passes through and is excreted. The amount absorbed is often referred to as lead bioavailability. The bioavailability values used in the models and calculations contained herein are detailed in Appendix C.

The EPA residential standard for lead in bare soil is 400 ppm (mg/kg) and for industrial sites is 800 ppm (mg/kg) (Dec 2009 EPA Region 9 PRG). The CDC provides guidance on maximum blood lead levels of 10 µg/dL (a dL is a deciliter or one tenth of a liter), though this level has been scrutinized in the past 20 years. Several researchers have proposed that a level of 2 µg/dL is supported by current research, and some assert that there is no safe level of lead in blood (CDC, 2007).

Methods

Environmental Samples. A field portable X-ray fluorescence (FPXRF) unit was used by IDEQ staff to collect real-time measurements at multiple areas within the site. At every 15^{th} sample site, an outdoor soil/dust sample was taken and sent to an analytical lab for analysis. Analytical results were compared to FPXRF results and a correlation curve was constructed between the values obtained by each method. The curve was then used to correct FPXRF readings if needed. More detail about this method is found in Appendix D. While EHEAP has some concerns about the accuracy and precision of the data, we feel they are sufficient to make a recommendation about the general health hazards present at this time. The sampling took place in the summer of 2007 and the report containing these data was released in May 2009.

Exposure Scenarios by Location. To calculate possible exposure at the site, the site was first divided into three areas. Each area corresponds to distinct recreational activities. These activities were regularly observed at the three areas by EHEAP and IDEQ. The three areas are: 1) the beach and black rock, 2) the woods and upper building, and 3) the path from the railroad tracks. Please refer to Figure 1 and Table 1.

Models. For contaminated lead sites, EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model is commonly used to predict blood lead levels in children up to age 7. The Adult Lead Methodology (ALM) is used to predict adult and older child/adolescent blood lead levels at contaminated sites. EPA recommends that the ALM is used instead of the IEUBK for children older than 7 (EPA, 2003). The ALM can also be used to predict the chances that a pregnant woman's exposure at a lead contaminated site could

elevate the blood lead level of her fetus. See Appendices A, B and C for more detail on the inputs used in the IEUBK model and the ALM.

Exposure Frequency and Duration. The ALM and IEUBK models were used to estimate blood lead levels. Two scenarios were considered: a worst-case frequency (very conservative - most possible days a person might spend at the site) and an estimated median frequency. The estimated median is meant to be realistic and representative of an avid user of the site.

Because the IEUBK model for children is based on a residential exposure scenario and does not specify number of hours of exposure per day, the exposure frequency for children was modified by number of days but not exposure duration per day. Exposure frequency used in the IEUBK calculations is based on expected maximum frequency of that activity that might occur (in days). Exposure duration for older children and adults as defined in the ALM is 8 hrs per day. Exposure frequency thus incorporated estimates of daily exposure duration for the period of days considered. Exposure frequency used in the calculation of the values in Table 3 and 4 is based on expected maximum frequency of that activity that might occur. For the IEUBK model, exposure frequency was used to modify the daily soil/dust ingestion intake rate input parameter for the respective models. The daily soil/dust ingestion intake rate input in the IEUBK model is in units of mass per day over a full year (365 days). For the ALM, there is a field to input the number of 8 hour days of exposure. The ALM assumes 8 hour days over a 219 day work year. See Appendices A and B for more detail on the time-weighting methodology used for frequency/duration of exposure.

Results

The EPA Region 9 PRG for lead is 400 mg/kg for residential soils and 800 mg/kg for industrial soils. These values are set at levels which are considered protective for children. All areas but the path from the railroad tracks have values greater than the PRG for residential and industrial soils (Table 1). Since the site is not residential and somewhat frequent recreational use by locals is known to occur, EHEAP used the IEUBK model to predict lead levels in younger children (6-7 years) and the ALM to predict blood lead levels in older children (12-13 years) and adults (including pregnant women) using the site for recreational purposes. Results using the models to predict blood lead levels are presented in Tables 2, 3 and 4.

Note on Tables 1-7:
GM and GeoMean are short for geometric mean. The geometric mean reduces the effect of very high or very low values that might bias the regular (arithmetic) mean.

Table 1: Mean Lead Concentration in Outdoor Soil/Dust at Three Areas of the Panhandle Smelting and Refining Company Site

Site	GeoMean Soil Lead (mg lead/Kg soil)	95th % Soil Lead (mg lead/Kg soil)	Min Soil Lead (mg lead/Kg soil)	Max Soil Lead (mg lead/Kg soil)
Beach/Rock (n=18)	1545	26302	66	31358
Woods/Upper Buildings (n=55)	2090	39999	94	50788
Path (n=14)	365	571	216	702

Min: Minimum
Max: Maximum
n: number of samples

Table 2: EPA IEUBK Model Output Using *Worst-Case* Frequency of Exposure—Geometric Mean Blood Lead Level and Percent of 6-7 Year Old Children Whose Blood Lead Concentration is Predicted to Exceed 10 µg/dL

Site	Predicted GeoMean Child Blood Lead (µg/dL) using GM Soil/Dust Lead	Predicted GeoMean Child Blood Lead (µg /dL) using 95%tile Soil/Dust Lead	(%) Above 10 µg /dL based on GM Soil/ Dust Lead	(%) Above 10 µg /dL based on 95% Soil/ Dust Lead
Beach/Rock	3.33	25.94	0.96	97.87
Woods/Upper Buildings	4.49	36.19	4.42	99.69
Path	1.61	2.14	0.01	0.05

Only daily lead intake from soil/outdoor dust was considered. No indoor dust, air, or food/water lead exposure was included in these estimates. Exposure frequency for children is modified by number of days but not exposure duration per day. Exposure frequency used in the calculation of the above values is based on expected maximum frequency of that activity and is listed in Appendix A.

Table 3: EPA IEUBK Model Output Using *Median* Frequency of Exposure— Geometric Mean Blood Lead Level and Percent of 6-7 Year Old Children Whose Blood Lead Concentration is Predicted to Exceed 10 µg/dL

Site	Predicted GeoMean Child Blood Lead (µg/dL) using GM Soil/Dust Lead	Predicted GeoMean Child Blood Lead (µg /dL) using 95%tile Soil/Dust Lead	(%) Above 10 µg /dL based on GM Soil/ Dust Lead	(%) Above 10 µg /dL based on 95% Soil/ Dust Lead
Beach/Rock	2.52	20.33	0.17	93.44
Woods/Upper Buildings	3.33	27.81	0.96	98.62
Path	0.96	1.32	0	0

Only daily lead intake from soil/outdoor dust was considered. No indoor dust, air, or food/water lead exposure was included in these estimates. Exposure frequency for children is modified by number of days but not exposure duration per day. Exposure frequency used in the calculation of the above values is based on expected median frequency of that activity and is listed in Appendix A.

Table 4: EPA ALM Model Output Using *Worst Case* Exposure Frequency — Geometric Mean Blood Lead Level and Percent of 12-13 Year Old Children Whose Blood Lead Concentration is Predicted to Exceed 10 µg /dL

Site	Predicted GeoMean Child Blood Lead (µg/dL) using GM Soil/Dust Lead	Predicted GeoMean Child Blood Lead (µg /dL) using 95%tile Soil/Dust Lead	Probability (%) Child Blood Lead Above 10 µg /dL based on GM Soil/ Dust Lead	Probability (%) Child Blood Lead Above 10 µg /dL based on 95% Soil/ Dust Lead
Beach/Rock	2.1	12.1	2.0	59.9
Woods/Upper Buildings	7.2	110.0	33.0	99.9
Path	1.6	1.6	0.7	0.7

Exposure duration for the ALM is 8 hrs per day. Exposure frequency used in the calculation of the above values is based on expected maximum frequency of that activity that might occur and is listed in Appendix B.

Table 5: EPA ALM Model Output Using *Median* Exposure Frequency —Geometric Mean Blood Lead Level and Percent of 12-13 Year Old Children Whose Blood Lead Concentration is Predicted to Exceed 10 µg /dL

Site	Predicted GeoMean Child Blood Lead (µg/dL) using GM Soil/Dust Lead	Predicted GeoMean Child Blood Lead (µg /dL) using 95%tile Soil/Dust Lead	Probability (%) Child Blood Lead Above 10 µg /dL based on GM Soil/ Dust Lead	Probability (%) Child Blood Lead Above 10 µg /dL based on 95% Soil/ Dust Lead
Beach/Rock	1.7	5.0	1.0	18.0
Woods/Upper Buildings	3.4	37.7	7.5	96.2
Path	1.5	1.6	0.6	0.6

Exposure duration for the ALM is 8 hrs per day. Exposure frequency used in the calculation of the above values is based on expected median frequency of that activity that might occur and is listed in Appendix B.

Table 6: EPA ALM Model Output Using *Worst Case* Exposure Frequency— Geometric Mean Blood Lead Level and Probability (%) of Adult and Pregnant Women (fetal exposure) Whose Blood Lead Concentration is Predicted to Exceed 10 µg /dL

Site	Predicted GeoMean Adult Blood Lead (µg/dL) using GM Soil/Dust Lead	Predicted GeoMean Adult Blood Lead (µg /dL) using 95%tile Soil/Dust Lead	Probability (%) Fetal Blood Lead Above 10 µg /dL based on GM Soil/ Dust Lead	Probability (%) Fetal Blood Lead Above 10 µg /dL based on 95% Soil/ Dust Lead
Beach/Rock	1.7	4.3	0.6	10.4
Woods/Upper Buildings	3.0	30.5	4.1	91.2
Path	1.5	1.5	0.4	0.4

Exposure duration for the ALM is 8 hrs per day. Exposure frequency used in the calculation of the above values is based on expected maximum frequency of that activity that might occur and is listed in Appendix B.

Table 7: EPA ALM Model Output Using *Median* Exposure Frequency—Geometric Mean Blood Lead Level and Probability (%) of Adult and Pregnant Women (fetal exposure) Whose Blood Lead Concentration is Predicted to Exceed 10 µg /dL

Site	Predicted GeoMean Adult Blood Lead (µg/dL) using GM Soil/Dust Lead	Predicted GeoMean Adult Blood Lead (µg /dL) using 95%tile Soil/Dust Lead	Probability (%) Fetal Blood Lead Above 10 µg /dL based on GM Soil/ Dust Lead	Probability (%) Fetal Blood Lead Above 10 µg /dL based on 95% Soil/ Dust Lead
Beach/Rock	1.6	2.5	0.5	2.2
Woods/Upper Buildings	2.0	11.2	1.1	50.3
Path	1.5	1.5	0.4	0.4

Exposure duration for the ALM is 8 hrs per day. Exposure frequency used in the calculation of the above values is based on expected median frequency of that activity that might occur and is listed in Appendix B.

Discussion

Exposure Pathways

The soil/outdoor dust in the area was found to have elevated levels of lead. From observation it is known that people, including young children and teenagers, use the area for recreational activities. The age ranges of 6-7 years and 12-13 years were chosen as representative child ages based on the age range of children observed at the site. A completed exposure pathway exists because lead is present in surface soils and dust at the site and ingestion of soil and dust is likely. Ingestion primarily occurs indirectly from hand-to-mouth behavior and contamination of foods. Inhalation of fine dust does occur, but the majority of particles are trapped in the nose and mouth and are swallowed, contributing to the ingestion pathway. Respirable dust (less than 10 micrometers in diameter) can pass into the lungs, but we do not have any data to determine the size distribution of dust particles at the site.

Exposures and Comparison Values

Acute Exposure. EHEAP does not expect acute health effects to occur from potential exposures at the site, even using the most conservative exposure estimates. The primary health hazard of childhood lead exposure is damage to the central nervous system. Lead in soil/dust is usually considered a chronic risk and health-based values have been derived to determine cleanup levels.

Chronic Exposure—Non-Cancer. Public health and environmental agencies, including ATSDR, do not provide comparison values for lead exposure since no amount of lead is without some adverse effect (there is no EPA chronic RfD or ATSDR chronic MRL). The CDC's Childhood Lead program urges monitoring of children for lead and

recommends that blood lead levels be below 10 µg/dL. As mentioned above, this level is under scrutiny and may be lowered substantially in the future. The IEUBK model, modified for a recreational use scenario, shows that the levels of lead in the soil and dust at the Panhandle Smelting and Refining Company site present a danger for children. Using this model to predict the blood lead level of children showed that common recreational activities at the site could increase levels of lead in the children. Also, female adult exposure could increase blood lead to levels considered harmful to fetuses. The inputs to the models were conservative and may overestimate the exposure and subsequent increase in blood lead levels. However, there is growing research that shows that even low levels of lead in blood can be harmful.

Impact on Health

Exposure to both children and adults within the Woods/Upper Building area at the site may be harmful to their health. Exposure to children at the Beach/Rock area may be harmful to their health. Exposure along the Path area does not pose a health hazard.

Uncertainty

EHEAP has some significant concerns about the accuracy and precision of the environmental lead data, though we feel they are sufficient to make a recommendation about the general health hazards present at this time. The biggest concern is that only five samples were sent for lab analysis. Based on these five samples, the XRF both over- and under-estimated soil/dust lead level in comparison to the lab analysis. EHEAP considers the correlation between XRF and lab values to be somewhat weak (see Appendix D).

Geometric mean and 95^{th} percentile lead concentration was used as the model input for the three areas of the site. Spatial distribution of lead concentration was variable and concentration ranges were broad between maximum and minimum values for each area of the site. Because of the broad range of concentrations values, exposures can vary greatly in areas of the site.

Exposure frequency and duration inputs for the models are conservative, and thus may over-estimate blood lead levels.

For seasonal exposures that are restricted to only a fraction of a year (e.g., summer months), some of the lead burden accumulated during the exposure season will be eliminated during the intervening months. However, the IEUBK model and ALM cannot simulate this loss of lead; model predictions correspond to a full year (or working year) of exposure to a contact exposure level regardless of the actual exposure period.

Child Health Considerations

In communities where there are concerns regarding exposures to hazardous chemicals, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous chemicals. A child's lower body weight and higher intake rate results in a greater dose of hazardous chemical per unit of body weight. The levels of lead in soil and outdoor dust

at this site are high enough to potentially elevate the risk of nervous system damage for children (except in the path area).

Conclusion

The top priority of EHEAP is to ensure that the individuals using the Panhandle Smelting and Refining Company site have good information to safeguard their health from contamination at the site. While there is significant uncertainty in the data, EHEAP concludes that breathing and eating lead in soil and outdoor dust at the site for several weeks in the course of a year could harm people's health. This could cause a person to ingest a sufficient amount of lead to potentially cause nervous system damage, especially children, and could possibly affect other organ systems as well. EHEAP is also concerned about arsenic at the site: arsenic has been detected, though data are not yet available to evaluate the public health implications. Any activity other than walking through the area potentially elevates the risk of harming people's health. The potential effects are considered serious health effects. Signage and/or fencing is recommended at the site to educate the public about the health hazards present and to discourage entry into the most highly contaminated areas of the site until remediation has been completed.

Basis for Decision

Geometric mean lead levels at the Beach/Rock area and the Woods/Upper Buildings area of the site are high (>4-fold higher than the Environmental Protection Agency (EPA) Preliminary Remediation Goal (PRG)). Using geometric mean soil/dust levels, EPA models predict blood lead levels:

- above the Centers for Disease Control & Prevention (CDC) level of concern of 10 µg /dL for up to 4% of exposed 6-7 year old children at the Beach/Rock and Woods/Upper Buildings areas;
- above 10 µg /dL for up to a third of 12-13 year olds exposed at the Woods/Upper Buildings area; and
- above 10 µg /dL for up to 4% of fetuses carried by adults exposed at the Woods/Upper Buildings area.

Recommendations

Recommendations are to post the site with signage and/or fence areas as soon as possible to advise the public of the hazards present and prevent further exposure.

Public Health Advice/Public Health Action Plan

EHEAP will continue to work with IDEQ throughout the summer of 2010 to advise users of the smelter site and the surrounding residents of:

- ongoing possible health risks from lead exposure.
- the possibility of parents asking their health care provider about blood lead testing if they are concerned about their children's exposure to lead at the site

EHEAP will work with IDEQ this summer to:

- post signs that advise the public of the specific health hazards present and that divert the public away from the most highly-contaminated areas; and encourage fencing or other measures if welcomed by the landowner.
- develop and distribute a lead fact sheet that is specific to this site.

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Certification

This health consultation, Panhandle Smelting and Refining Company—Human Health Hazard Posed by Exposure to Lead in Soil and Dust, was prepared by the Idaho Division of Public Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodologies and procedures existing at the time the health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.

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Appendix A: Exposure Frequency Estimates for Children

Exposure frequency for the IEUBK model is 365 days per year. Exposure frequency used in the calculation of the values in Tables 2 & 3 is based on expected maximum and median estimated frequency of that activity that might occur as follows:

1. *Beach & Black Rock*

a) Worst Case--Activities: Sunbathing (90 days/year) and Walking (240 days/year). These activity time periods overlap but sunbathing is the far greater exposure. Thus, assume (days): 90 days

b) Median--Activities: Sunbathing (30 days/year) and Walking (80 days/year). These activity time periods overlap but sunbathing is the far greater exposure. Thus, assume (days): 30 days

2. *Woods & Site of Upper Buildings*

a) Worst Case--Activities: Campfire Party (120 days/year), BMX riding (120 days/year) and Walking (240 days/year). These activity time periods overlap but campfire and BXM are the far greater exposures. Thus, assume (days): 120 days

b) Median--Activities: Campfire Party (40 days/year), BMX riding (40 days/year) and Walking (80 days/year). These activity time periods overlap but campfire and BMX are the far greater exposures. Thus, assume (days): 40 days

3. *Path from Train Tracks*

a) Worst Case--Activities: Walking (240 days/year, 10 min per visit). Total (days): 240 days

b) Median--Activities: Walking (80 days/year, 10 min per visit). Total (days): 80 days

Daily soil/dust ingestion rate is assumed to be 0.085 g/day for 365 days, and is modified by exposure frequency. The default IEUBK soil/dust ingestion rate for 6-7 year olds is 0.085 g/day.

Worst Case (g/day):
1. Ingestion Rate =0.02095
2. Ingestion Rate =0.02795
3. Ingestion Rate =0.05589

Median (g/day):
1. Ingestion Rate =0.00698
2. Ingestion Rate =0.00932
3. Ingestion Rate =0.01863

Appendix B: Exposure Frequency Estimates for Adults

Exposure duration for the ALM is 8 hrs per day. Exposure frequency for the ALM is 219 days per year. Exposure frequency used in the calculation of the above values is based on expected maximum frequency of that activity that might occur as follows:

1. *Beach & Black Rock*

a) Worst Case--Activities: Sunbathing (90 days/year, 1 hr per visit) and Walking (240 days/year, 10 min per visit). Total (in 8hr days): 16.25 8hr days

b) Median—Activities: Sunbathing (30 days/year, 1 hr per visit) and Walking (80 days/year, 10 min per visit). Total (in 8hr days): 5.42 8hr days

2. *Woods & Site of Upper Buildings*

a) Worst Case--Activities: Campfire Party (120 days/year, 6 hrs per visit), BMX riding (120 days/year, 1 hr per visit) and Walking (240 days/year, 10 min per visit). Total (in 8 hr days): 110 8hr days

b) Median-- Activities: Campfire Party (40 days/year, 6 hrs per visit), BMX riding (40 days/year, 1 hr per visit) and Walking (80 days/year, 10 min per visit). Total (in 8 hr days): 36.67 8hr days

3. *Path from Train Tracks*

a) Worst Case--Activities: Walking (240 days/year, 10 min per visit). Total (in 8 hr days): 5 8hr days

b) Median-- Activities: Walking (80 days/year, 10 min per visit). Total (in 8 hr days): 1.67 8hr days

For adolescents, an absorption fraction (AF) (bioavailability) of 30% was used to be conservative. 30% is the AF used for children in the IEUBK model. The default AF for adults in the ALM is 12%.

For adolescents, a soil/dust ingestion rate of 0.075 g/day is used. This is lower than any of the IEUBK soil/dust ingestion rates. 0.050 g/day is the default ingestion rate used for adults in the ALM. This rate is then time-weighted by number of 8hr days of potential exposure.

Appendix C: Assumptions for IEUBK Model and ALM

IEUBK

Outdoor Soil Lead Concentration: see Table 1
Soil/Dust Ingestion Weighting Factor (%Soil): 45
Soil/Dust Ingestion Daily (g/day): 0.056 (Worst Case) or 0.01867 (Median)
Soil Bioavailability (%): 30
Dust Bioavailability (%): 30
Indoor Dust Lead Concentration - Constant Value (µg/g): 0
Outdoor Air Lead Concentration - Constant Value (µg/m3): 0
Time Spent Outdoors (hr/day): 4
Dietary Lead Intake (µg/day): 2.22
Lead Concentration in Drinking Water (µg/L): 0

ALM

Parameter	Description	Units	Value
PbS	Soil lead concentration	ug/g or ppm	Conc
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	2.1
PbB_0	Baseline PbB	ug/dL	1.5
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	x
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	y
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	z
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365

Conc.: Soil/Dust Lead Concentration--see Table 1. Model was run with both Geomean and 95%tile lead concentration.
x = 0.05 g/day (Adult); 0.075 g/day (Adolescent)
y = 0.12 (Adult); 0.30 (Adolescent)
z = site specific (see Appendix B)

Appendix D: Field Portable XRF Calibration Curve

5 soil/dust samples were collected and sent to a lab for analysis of metals. These 5 samples were taken alongside corresponding XRF samples and these 5 samples were used to compare results from the two methods and develop a calibration curve (with lab analysis considered the gold standard). Note that this is not a very large sample size from which to derive a calibration curve, and this small sample size may induce error into the results used in the calculations in this health consultation. The XRF both over-estimated and under-estimated lead concentration determined by lab analysis.

Correlation Coefficient
$r = 0.7877$

Strength of Relationship
$r^2 = 0.6205$

Y intercept = -33

Slope = 0.8395

Appendix E: Glossary

Acute Occurring over a short time.

Agency for Toxic Substances and Disease Registry (ATSDR)
The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.

Adult Lead Methodology (ALM)
The EPA method for calculating lead exposure from all environmental sources used to predict the blood lead level in a typical adult female and the corresponding blood lead level in a fetus.

BCEH Bureau of Community & Environmental Health.

Chronic Occurring over a long time (more than 1 year).

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.

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.

Dose 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.

EPA The U.S. Environmental Protection Agency.

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

Geometric mean The nth root of the product of n numbers; in other words, the average of the logarithmic values of a dataset that is then converted back to a base 10 number. This type of mean lessens the effect of outliers on the calculated average value.

Hazardous substance Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.

IDEQ The Idaho Department of Environmental Quality.

IDHW The Idaho Department of Health & Welfare.

Ingestion rate The amount of an environmental medium which could be ingested typically on a daily basis. Units for ingestion rate are usually liter/day for water and mg/day for soil.

Integrate Exposure Uptake Biokinetic Model for Lead in Children (IEUBK)
A model that performs a series of computations that quantify the intake, absorption, distribution, and excretion of the lead over time and predicts the blood lead level in a typical child.

Lowest Observed Adverse Effect Level (LOAEL)
The lowest tested dose of a substance that has been

reported to cause measurable adverse health effects in people or animals.

Media Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.

No Observed Adverse Effect Level (NOAEL) The highest tested dose of a substance that has been reported to have no measurable adverse health effects on people or animals.

Oral Reference Dose (RfD) An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.

Respirable Particle Inhaled fine dust or other fine particle that can get all the way into the lower respiratory tract, ending up in the lungs. Respirable particles are generally less than 10 micrometers in diameter.

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 A number that is used to account for uncertainty in the data and/or severity of the health effect when calculating an oral RfD or other level or dose to which humans can safely be exposed. Safety factors generally range from 1-100.