Health Consultation

LeROI COMPANY SMELTER
NORTHPORT, STEVENS COUNTY WASHINGTON
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Prepared by

The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Washington State Department of Health

Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation 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 hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH 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. The findings in this report are relevant to conditions at the site during the time of this health consultation, and should not necessarily be relied upon if site conditions or land use changes in the future.

For additional information or questions regarding DOH or the contents of this health consultation, please call the health advisor who prepared this document:

Lenford O'Garro
Washington State Department of Health
Office of Environmental Health Assessments
P.O. Box 47846
Olympia, WA 98504-7846
(360) 236-3376
FAX (360) 236-3383
1-877-485-7316
Web site: www.doh.wa.gov/consults

For more information about ATSDR, contact the ATSDR Information Center at 1-888-422-8737 or visit the agency's Web site: www.atsdr.cdc.gov/.

Glossary

Acute	Occurring over a short time [compare with **chronic**].
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.
Aquifer	An underground formation composed of materials such as sand, soil, or gravel that can store and/or supply groundwater to wells and springs.
Cancer Risk Evaluation Guide (CREG)	The concentration of a chemical in air, soil or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a *comparison value* used to select contaminants of potential health concern and is based on the *cancer slope factor* (CSF).
Cancer Slope Factor	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
Carcinogen	Any substance that causes cancer.
Chronic	Occurring over a long time (more than 1 year) [compare with **acute**].
Comparison value	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.
Dermal Contact	Contact with (touching) the skin (see route of exposure).
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.

Environmental Media Evaluation Guide (EMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a *comparison value* used to select contaminants of potential health concern and is based on ATSDR's *minimal risk level* (MRL).
Environmental Protection Agency (EPA)	United States Environmental Protection Agency.
Epidemiology	The study of the occurrence and causes of health effects in human populations. An epidemiological study often compares two groups of people who are alike except for one factor, such as exposure to a chemical or the presence of a health effect. The investigators try to determine if any factor (i.e., age, sex, occupation, economic status) is associated with the health effect.
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**].
Groundwater	Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].
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.
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.
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].
Ingestion rate	The amount of an environmental medium that could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].
Inorganic	Compounds composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc.

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.
Maximum Contaminant Level (MCL)	A drinking water regulation established by the federal Safe Drinking Water Act. It is the maximum permissible concentration of a contaminant in water that is delivered to the free flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
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**].
Model Toxics Control Act (MTCA)	The hazardous waste cleanup law for Washington State.
Monitoring wells	Special wells drilled at locations on or off a hazardous waste site so water can be sampled at selected depths and studied to determine the movement of groundwater and the amount, distribution, and type of contaminant.
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.
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.
Organic	Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.

Parts per billion (ppb)/Parts per million (ppm)	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
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.
Reference Dose Media Evaluation Guide (RMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The RMEG is a *comparison value* used to select contaminants of potential health concern and is based on EPA's oral reference dose (RfD).
Remedial investigation	The CERCLA process of determining the type and extent of hazardous material contamination at a site.
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].
Surface Water	Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].
Volatile organic compound (VOC)	Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Purpose

The Washington State Department of Health (DOH) has prepared this health consultation at the request of the U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology) and Northeast Tri-County Health District (NETCHD). The purpose of the consultation is to review pre-removal soil sampling data and evaluate the potential health hazard posed by contaminants in soil to residents living near former LeRoi Smelter in Stevens County, Northport, Washington. DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background and Statement of Issues

The former LeRoi Smelter site is located northeast of the city center of Northport, Washington. The Northport-Waneta road borders the 32 acre site on the east and south (See Figure 1 and Appendix A). Burlington Northern Santa Fe Railway (formerly the Spokane Falls and Northern Railroad) runs parallel to the Columbia River and is on the northern border of the site [1,2]. Highway 25 makes up the western border of the site. Residential homes are located to the west of the site. A city park is located about 50 feet northwest of the site along the Columbia River.

The former facility smelted lead, copper, gold and silver ores from 1896 to 1921. It was made up of several buildings (the furnace building, the roaster building, and the crusher and ore building), which are no longer standing [1,2]. Currently, the city of Northport operates three drinking water wells located at the site of the brick platform used for initial roasting of the ore.

In September 2003, EPA sent out a fact sheet to residents of the Northport area announcing voluntary free residential soil testing for lead and other heavy metals. The fact sheet encouraged residents at higher risk (pregnant women and children under age seven) to test the soil around their homes.

In October 2003, EPA's Removal Evaluation team collected 210 surface and subsurface soil samples from 118 locations on the former LeRoi Smelter site to be analyzed for lead and arsenic [3]. The site was divided into the smelter complex and the lumberyard area. A 100-foot plot grid was used to collect the samples, 15 locations were not sampled because: 5 lay over concrete; 5 were within 50 feet of the property boundary; 4 were within 75 to 100 feet of city drinking water supply wells; and 1 lay within a building. In addition, 114 samples were taken from 13 residential properties, and 58 composite samples were collected from 18 locations on the Northport School campus [3]. The samples were initially analyzed using X-ray Fluorescence (XRF) screening, (See Appendix B - Table 1). Confirmatory analysis was performed on 20 percent of these samples using Inductively Coupled Plasma Emission Spectrometry (ICP). The results indicated that lead and arsenic contamination is present throughout the smelter complex and areas within the city.

Summary of Sample Results

The concentrations of several elements were measured in 210 samples from the smelter property, 58 samples from the school property, and 114 samples from residential yards. Samples were taken at 0 to 1, 1 to 6, 6 to 12 and 12 to18 inches depths and the intervals were extended to 18 to 24 inches if a garden or play area was present in the residential areas. Lead, arsenic, chromium, copper, nickel, selenium, zinc, and mercury were detected in some samples. Limited analysis for antimony, cadmium, and silver showed the presence of these metals. Beryllium and thallium were not detected at their practical quantitation limits in the residential area.

The XRF results were compared to the laboratory analytical results to determine which samples provided an accurate representation of metals concentrations across the site. For lead below 5000 milligram per kilogram **(**mg/kg), or parts per million (ppm), there was good correlation between both methods [4]. For arsenic the XRF was about ten times higher than the laboratory analytical results [4]. The laboratory analytical results will be used to evaluate the contaminated soils because the XRF results may be less accurate due to interference among the chemicals and because the samples that had high contaminant concentrations according to the XRF, (and were therefore of greatest public health concern) were analyzed by the laboratory.

Contaminants of Concern

Contaminants of concern in soil were determined by employing a screening process. Maximum soil contaminant levels from site locations were screened against comparison values. Several types of health-based screening values are used during this process [see the glossary for descriptions of “comparison value,” “cancer risk evaluation guide (CREG),” “environmental media evaluation guide (EMEG),” and “reference dose media evaluation guide (RMEG).”] Comparison values such as the CREG and EMEG offer a high degree of protection and assurance that people are unlikely to be harmed by contaminants in the environment. For chemicals that cause cancer, the comparison values represent levels that are calculated to increase the risk of cancer by about one in a million. For lead, comparison values are usually based on the goal of keeping blood lead levels in most children below 10 or 15 micrograms per deciliter (μg/dl). With the exception of lead, the comparison values for chemicals that do not cause cancer represent levels that are not expected to cause any health problems. These types of comparison values often form the basis for deciding how clean the final cleanup should be. In general, if a contaminant’s maximum concentration is greater than its comparison value, then the contaminant is evaluated further.

Comparisons may also be made with legal standards such as the cleanup levels specified in the Washington State hazardous waste cleanup law, the Model Toxics Control Act (MTCA). Legal standards may be strictly health-based or they may incorporate non-health considerations such as the cost or the practicality of attainment.

Table.1: Maximum concentrations of contaminants detected in soil and their comparison values at the LeRoi Smelter site and the City of Northport, Northport, Washington.

Contaminant	Maximum Concentration (ppm)			Comparison value (ppm)	Comparison value reference Source	EPA Cancer Group	Contaminant of Concern
	Smelter	Residential	School				
Arsenic	336*	151	22.8	20	EMEG	A	Yes
Antimony	82*	6.1	1.3	20	RMEG	D	Yes
Cadmium	52*	36.1	5.8	2	MTCA (A)	B1	Yes
Lead	17511 *	1880	283	250	MTCA (A)	B2	Yes
Mercury	1.7*	1.8	0.16 U	1	MTCA (A)	D	Yes
Chromium	41	33	32.7	100	MTCA (A)	D	No
Copper	2539*	678	138	2960	MTCA (B)	D	No
Nickel	36	15	13.5	1000	RMEG	-	No
Silver	100	1.0 U	1.0 U	300	RMEG	D	No
Zinc	11700	900	356	20000	EMEG	D	No
Beryllium	0.5 U	0.5 U	0.5 U	50	EMEG	B1	No
Selenium	4.3 U	4.3 U	4.3 U	300	EMEG	D	No
Thallium	7.7	1.0 U	1.0 U	-	-	-	No

EMEG – ATSDR's Environmental Media Evaluation Guide
RMEG – ATSDR's Reference Dose Media Evaluation Guide
MTCA (A) - Model Toxics Control Act Method A - Soil Cleanup Level for Unrestricted Land Use
MTCA (B) - Model Toxics Control Act Method B - Soil Cleanup Level for Unrestricted Land Use
* - 95 UCL instead of max concentration for soil 0 – 6 inches

Lead and arsenic are the main contaminants of concern in Northport soil. This is based on how often, and by how much, soil sample concentrations exceeded both ATSDR comparison values and the MTCA cleanup levels for homes, schools, and parks.

Many soil samples contained concentrations of cadmium and mercury that exceeded ATSDR comparison values and MTCA cleanup levels for homes, schools, and parks. Compared to lead and arsenic, these contaminants present less of a public health hazard because they generally exceeded comparison values by smaller amounts. Furthermore, cleanup actions that address lead and arsenic would also address these contaminants (because these contaminants usually occur together with lead and arsenic).

Discussion

The following discussion addresses both lead and arsenic as the contaminants of concern in soil for this site. In order for exposure to occur, people must come into contact with the contaminated soil. Exposure to these contaminants does not mean that harm will result but since both lead and arsenic exceeded their health comparison values, such exposure needs to be evaluated with respect to site-specific conditions.

Exposure Pathways

For most people, the majority of exposure to soil is expected to occur at home. Exposure can also occur at childcare facilities, schools, parks, the workplace, and elsewhere. Although contact with soil at the smelter site may be infrequent, exposure there is also of concern because of the very high lead levels found there. Exposure to contaminants in soil can occur by swallowing it (ingestion exposure), breathing it (inhalation exposure) or getting it on the skin (dermal exposure). Some people in Northport are likely to be exposed to the contaminants in the soil, increasing their risk of developing health problems. Actions that reduce exposure (such as washing up after playing or working, regular damp mopping, and removing or covering contaminated soil) will reduce the risk of developing health problems.

Ingestion exposure (swallowing)

Ingestion of contaminated soil is expected to account for most of the exposure in Northport. Over time, swallowing even small amounts of soil contaminated with lead or arsenic could lead to a variety of health problems. Most people inadvertently swallow small amounts of soil and dust (and any contaminants they contain). Young children often put hands, toys, pacifiers, and other things in their mouths, and these may have dirt or dust on them that can be swallowed. Soil sticking to homegrown vegetables will be swallowed when the produce is eaten. Adults may ingest soil and dust through activities such as gardening, mowing, construction work, and dusting.

Pica behavior is a persistent eating of non-food substances (such as dirt or paper). In a small percentage of children, pica behavior has been found to result in to the ingestion of relatively large amounts of soil (one or more grams per day). Compared to typical children, those who swallow large amounts of contaminated soil may have added risks from short-term exposure. Some adults may also exhibit pica behavior.

Inhalation exposure (breathing)

Although people can inhale suspended soil or dust, airborne soil usually consists of relatively large particles that get trapped in the nose, mouth, and throat and are then swallowed, rather than breathed into the lungs.

Skin exposure (dermal)

Harmful effects from skin contact with the contaminated soil are unlikely. Based on the measured concentrations of the contaminants, they are not expected to cause skin problems, such as irritation or rashes, from dermal contact. Furthermore, the contaminants (metals) are not absorbed well through the skin, meaning that skin contact is unlikely to lead to health problems in other parts of the body.

Lead – Occurrence, Health Concerns, and Risks

Lead is a naturally occurring chemical element that is normally found in soil. In Washington, normal background concentrations rarely exceed 20 ppm [5]. However, the widespread use of certain products (such as leaded gasoline, lead-containing pesticides, and lead-based paint) and the emissions from certain industrial operations (such as smelters) has resulted in significantly higher levels of lead in many areas the state.

Elimination of lead in gasoline and solder used in food and beverage cans has greatly reduced exposure to lead. Currently, the main pathways of lead exposure in children are ingestion of paint chips, contaminated soil and house dust, and drinking water in homes with old plumbing.

Children less than seven years old are particularly vulnerable to the effects of lead. Compared to older children and adults, they tend to ingest more dust and soil, absorb significantly more of the lead that they swallow, and more of the lead that they absorb can enter their developing brain. Pregnant women and women of childbearing age should also be aware of lead in their environment because lead ingested by a mother can affect the unborn fetus.

Health effects

Exposure to lead can be monitored by measuring the level of lead in the blood. In general, blood lead rises 3-7 μg/dl for every 1,000 ppm increases in soil or dust concentration [6]. For children, the Centers for Disease Control and Prevention (CDC) has defined an elevated blood lead level (BLL) as greater than or equal to 10 micrograms of lead per deciliter of blood (μg/dl) [7]. However, there is growing evidence that damage to the central nervous system resulting in learning problems can occur at blood lead levels less than 10 μg/dl. About 2.2 percent of children in the U.S. have blood lead levels greater than 10 μg/dl.

Lead poisoning can affect almost every system of the body and often occurs with no obvious or distinctive symptoms. Depending on the amount of exposure a child has, lead can cause behavior and learning problems, central nervous system damage, kidney damage, reduced growth, hearing impairment, and anemia [8].

In adults, lead can cause health problems such as high blood pressure, kidney damage, nerve disorders, memory and concentration problems, difficulties during pregnancy, digestive problems, and pain in the muscles and joints [8]. These have usually been associated with blood lead levels greater than 30 μg/dl.

Because of chemical similarities to calcium, lead can be stored in bone for many years. Even after exposure to environmental lead has been reduced, lead stored in bone can be released back into the blood where it can have harmful effects. Normally this release occurs relatively slowly. However, certain conditions, such as pregnancy, lactation, menopause, and hyperthyroidism can cause more rapid release of the lead, which could lead to a significant rise in blood lead level [9].

Health risk evaluation – The IEUBK model

To evaluate the potential for harm, public health agencies often use a computer model that can estimate blood lead levels in children younger than seven years of age who are exposed to lead-contaminated soil. This model (developed by the EPA and called the Integrated Exposure Uptake Biokinetic Model, or IEUBK model) uses the concentration of lead in soil to predict blood lead levels in children [10]. It is intended to help evaluate the risk of lead poisoning for an average group of young children who are exposed to lead in their environment. The IEUBK model can also be used to determine what concentration of lead in soil could cause an unacceptable risk of elevated blood lead levels in an average group of young children. It is often used in this way to set soil cleanup levels for lead. It is important to note that the IEUBK model is not expected to accurately predict the blood lead level of a child (or a small group of children) at a specific point in time. In part, this is because a child (or group of children) may behave differently, and therefore have different amounts of exposure to contaminated soil and dust, than the average group of children used by the model to calculate blood lead levels. For example, the model does not take into account reductions in exposure that could result from community education programs. Despite this limitation, the IEUBK model is a useful tool to help prevent lead poisoning because of the information it can provide about the hazards of environmental lead exposure.

For children who are regularly exposed to lead-contaminated soil, the IEUBK model can estimate the percentage of young children who are likely to have blood lead concentrations that exceed a level that may be associated with health problems (usually 10 µg/dl).

Soil lead concentrations and estimated blood lead levels in Northport

For each type of property listed below, the IEUBK model was used to estimate the percentage of children that could have elevated blood lead levels if they play frequently in areas with lead contamination and exhibit typical behaviors that result in ingestion of soil. These percentages were calculated using the maximum soil lead concentrations measured on each type of property. They are expected to be overestimates because most or all children in the community are likely to have regular exposure only to soil containing less than the maximum amount of lead. Nonetheless, these estimates are useful in determining the potential hazard for those children who may be exposed to the most contaminated areas. Except for the soil lead concentration, model default parameters were used [10].

Residential Properties

The maximum concentration of lead detected in the surface soil (0-1 inch interval) of a residential property was 1,880 parts of lead per million parts of soil (ppm), which is the same as 1,880 milligrams of lead per kilogram of soil (mg/kg) (See Appendix B - Table 4).

For children less than seven years old who have daily exposure to soil containing 1,880 ppm lead, IEUBK model calculations (win Version 1.0 build 255) indicate that about 79% will have blood lead levels greater than 10 µg/dl. The model also predicts that the average blood lead levels of children under seven who play frequently in this area would be 14.6 µg/dl. However, most children in Northport are unlikely to have daily exposure to the soil on this property, and the actual percentage of children with elevated blood lead levels from exposure to soil on residential properties across Northport is expected to be less than 79%.

Northport School Property

The maximum concentration of lead detected at the school was 237 ppm in the surface soil (0-1 inch interval) and 283 ppm in the subsurface soil (6-12 inch interval) (See Appendix B - Table 4). For children less than seven years old who have daily exposure to soil containing 237 ppm lead, model results indicate that about 1.8% will have blood lead levels greater than 10 μg/dl. For exposure to soil containing 283 ppm lead, the model predicts that about 3% of children will have blood lead levels exceeding 10 μg/dl. The model also predicts that the average blood lead levels of children under seven who play frequently in this area would be 3.7 μg/dl and 4.1 ug/dl respectively. The actual percentages are expected to be somewhat less because children are not likely to be at the school and exposed to the maximum lead concentrations every day.

Smelter Complex

The maximum concentration of lead detected in surface soil (0-6 inch interval) was 49,400 ppm. The highest lead concentration at the surface of the tailings pile (0.9-1 inch interval) was 99,700 ppm (See Appendix B - Table 3).

Quantifying the health hazard of the smelter site is difficult because there is no information about how often and where children play on the property. Further, the IEUBK model has not been shown to produce accurate results for soil lead concentrations in the range of those found at the smelter site. Typically, the model predicts that more than 99% of young children with daily exposure to soil lead concentrations greater than 6,000 ppm are likely to have blood lead levels greater than 10 μg/dl, and almost half may have blood lead levels greater than 30 μg/dl. Several sample locations at the smelter complex have soil lead concentrations that exceed 6,000 ppm. Although children are unlikely to be at the smelter complex every day, the lead concentrations are sufficiently high in some areas that even intermittent exposure may present a significant health hazard.

A more realistic exposure scenario of one day a week at the smelter site and the 95 percent upper confidence limit (UCL) was used in calculating the soil lead concentration (0-6 inch interval) at the smelter complex (17,512 mg/kg). DOH assumed that children were exposed for one day a week at the complex and six days a week at home with a maximum level of 1,880 ppm. This exposure scenario yielded an estimated soil lead concentration of 4,113 ppm for use in the model. Based on this scenario, the model predicts an average blood lead level of 24 μg/dl for children under seven years of age. These results indicate that even intermittent exposure at the site may present a significant health hazard.

Evaluation of proposed trigger levels for soil lead cleanup actions in Northport

Final cleanup of contaminated areas can often take years or decades. In some cases, contaminant levels are high enough to warrant faster, interim cleanup actions to ensure that people are not at significant risk before final cleanup can occur. EPA, the Department of Ecology, and DOH agree that the contaminant levels in parts of Northport are high enough to warrant engineering controls such as contaminated soil removal for some properties, and on-site consolidation and covering of contaminated soil (encapsulation). The preferred regulatory solution is usually removal of the contaminated soil. This practice, however, is expensive and can be limited by the availability of clean soil. Encapsulation is an acceptable engineering control method for lead and arsenic contaminated soils. The Northport cleanup proposed by EPA is considered an interim action to quickly address contamination that presents a significant health hazard.

Lead Trigger Levels

EPA asked Ecology to suggest concentrations of lead in soil that would be used to trigger appropriate interim cleanup actions in Northport [11]. Ecology recommended using lead concentrations similar to the interim action trigger levels used for the Tacoma Smelter Plume.

Soil concentrations greater than 250 ppm lead would trigger community education activities promoting self-conducted exposure reduction measures; concentrations greater than 700 ppm would trigger soil removal or containment in areas where children are present; and concentrations greater than 1000 ppm would trigger soil removal or containment in all areas.

The IEUBK model was used to estimate the percentage of children expected to have blood lead levels greater than 10 μg/dl following exposure to these lead levels in soil. The model predicts elevated blood lead levels in about 2% of children with regular exposure to soil containing 250 ppm lead, 26% of children exposed to soil containing 700 ppm lead, and 45% of children exposed to soil containing 1000 ppm lead. The model also predicts that the average blood lead levels of children under seven who play frequently in this area would be 3.8 μg/dl, 7.4 μg/dl and 9.5 μg/dl, respectively. Similarly, the model predicts that the most vulnerable age group (1-2 years old) average blood lead levels would be 4.7 μg/dl, 9.3 μg/dl and 11.8 μg/dl respectively. It is anticipated that these percentages and average blood lead levels will be smaller as a result of implementation of self-conducted exposure reduction measures.

Blood Lead Screening

Previously, two blood lead screening clinics were conducted for children in the Northport area. The first was held in December 1992 and the second was held in September 1993 [12]. The results at the time of sampling indicated that none of the children had blood lead levels above 10 μg/dl (maximum < 7 μg/dl) [12].

Arsenic – Occurrence, Health Concerns and Risks

Arsenic is a naturally occurring chemical element that is normally found in soil. In Washington, normal background concentrations rarely exceed 7 ppm [5]. However, the widespread use of arsenic-containing pesticides, and the emissions from certain smelters has resulted in significantly higher levels of arsenic on many properties in the state.

Arsenic can cause many different health problems in people. Many things influence the types of health problems that may occur:

- The amount and type of arsenic exposure.
- The length of time exposure occurs.

- An individual's sensitivity to the harmful effects of arsenic.

It is difficult to predict how arsenic will affect someone. Different types of arsenic are believed to have different levels of toxicity. Amounts that cause serious health problems for some people may have no effect on others. Also, two people with similar exposures may develop totally different health problems.

Swallowing relatively large amounts of arsenic (even just one time) can cause mild symptoms, serious illness, or death. Milder effects may include skin discoloration, hardening of the skin, nausea, vomiting, stomach pain, or diarrhea [13]. Serious effects may include coma, internal bleeding, or nerve damage causing weakness or loss of sensation in the hands, arms, feet, or legs [13]. Levels of arsenic measured in Northport soils are generally too low to cause health effects from short-term exposure.

Long-term ingestion (greater than 6 months) of smaller amounts of arsenic that have been found in Northport has the potential to cause several different health problems. Illnesses strongly linked to this type of exposure include bladder cancer, lung cancer, non-melanoma skin cancer, liver cancer, prostate cancer, kidney cancer, cardiovascular disease, diabetes mellitus, damage to peripheral nerves, and changes to the pattern of color or thickness of the skin.

Most of these health problems, such as cancer, diabetes, and cardiovascular disease, are common illnesses that affect many people and have several possible causes besides arsenic. Even in arsenic-contaminated areas, we expect that most cases of these health problems will not be the result of arsenic exposure, but due to other factors such as diet, genes, lifestyle, preexisting illness, or exposure to other chemicals. At the same time, exposure to the arsenic-contaminated soils in Northport can increase the risk of developing these illnesses.

Cancer effects

Most cleanups of arsenic contamination are driven by cancer concerns. In the past, numerical estimates of skin cancer risks tended to form the basis for the choice of cleanup levels. More recent information about the ability of arsenic to cause bladder and lung cancer has led to the development of new risk estimates that appear to be more appropriate for use in public health protection. The scientific information on which these new estimates are based is stronger than the data for skin cancer. Also, the types of skin cancers caused by arsenic can usually be treated successfully while bladder and lung cancers are less treatable and have significantly higher fatality rates.

Depending on the type of cancer, a population with no known exposure to environmental contamination could be expected to have a substantial number of cases. About 1/4 to 1/3 of people living in the United States will develop cancer at some point in their lives and its occurrence increases with age [14]. There are many different forms of cancer that result from a variety of causes. Typically, several different factors combine to produce a tumor, and it is usually impossible to identify a single cause for someone's cancer.

Below are estimates of increased risk of bladder and lung cancer for people exposed to Northport soils at the specified locations. Risk estimates would be higher if people were exposed to higher arsenic concentrations and lower if exposed to lower concentrations. The risks are presented as the increased number of cancers if one million people were exposed to the contamination.

It is important to note that these estimates are based on relatively simple calculations and there are several unmeasured factors not considered that could make the true cancer risk somewhat higher or lower. For example, the calculations do not consider the risks of other types of cancer (such as skin cancer, liver cancer, etc.) nor do they consider the possibility that the body may poorly absorb arsenic in Northport soils. Still, the calculations are useful for comparison to public health goals and legal requirements. Exposure assumptions for estimating contaminant doses from soil exposure are found in Table 5.

Residential Properties
The maximum concentration of arsenic measured in the surface soil (0-1 inch interval) of a residential property was 151 ppm. At this level the risk of bladder or lung cancer is about 920 per million people exposed (See Appendix B- Table 6).

Northport School Property
The maximum concentration of arsenic found at the school was 22.8 ppm in a sample collected 6 – 12 inches below the ground surface. Thus the calculated increased risk of bladder or lung cancer is about 137 per million people exposed.

Smelter Complex
The upper confidence limit (95 UCL) of 336 ppm for arsenic in the surface soil (0-6 inch interval) was used to calculate the increased cancer risk for a trespasser exposed for one day a week (52 days/year). The calculated increased risk of bladder or lung cancer is about 320 per million people exposed (See Appendix B - Table 6).

Arsenic Trigger Levels

EPA asked Ecology to suggest concentrations of arsenic in soil that would be used to trigger appropriate interim cleanup actions in Northport. Ecology recommended using lead and arsenic concentrations similar to the interim action trigger levels used for the Tacoma Smelter Plume.

For arsenic, soil concentrations greater than 20 ppm would trigger community education promoting self-conducted exposure reduction measures; concentrations greater than 100 ppm would trigger soil removal or containment in areas where children are present; and concentrations greater than 230 ppm would trigger soil removal or containment in all areas. Increased risks were calculated for bladder and lung cancer from exposure to soil contaminated with those concentrations of arsenic. The estimated increased cancer risk is about 120 per million people exposed to soil containing 20 ppm arsenic, about 600 per million people exposed to soil containing 100 ppm arsenic, and about 1400 per million people exposed to soil containing 230 ppm arsenic (See Appendix B- Table 6).

The typical goal for cleanup of cancer casing contaminants in Washington is one extra cancer per million people exposed. Use of this target caner risk for arsenic, however, would result in a cleanup level well below naturally occurring background levels in Washington soils. The trigger levels evaluated above, therefore, are not based on a target cancer risk of one per million and do consider background and other feasibility considerations.

Non-cancer effects

As noted earlier, most cleanups of arsenic contamination are driven by concerns about cancer. However, exposure to arsenic can lead to several serious health problems besides cancer. These include increased cardiovascular disease, diabetes, and nerve damage. Unfortunately, broadly accepted numerical estimates of these non-cancer hazards have not been established. The only currently available estimates of the non-cancer hazards of arsenic relate to less serious health effects such as changes in skin coloration and thickness from long-term exposure, and to gastrointestinal problems (vomiting, stomach pain, etc.) from short-term exposure.

Below is an evaluation of the likelihood that people could develop non-cancer health problems from exposure to Northport soils. The ultimate goal for cleanup in Washington is that no one would develop non-cancer health problems from arsenic-contaminated soil. Therefore, the evaluation considers people who tend to have greater than average exposure to contaminated soil and not just those with average exposure.

It is important to note that these evaluations are based on relatively simple calculations and there are several unmeasured factors that were not considered that could make the true hazard somewhat higher or lower. For example, the calculations consider only skin changes and gastrointestinal problems, not the myriad of other health problems that arsenic has been shown to cause in people. On the other hand, they do not consider the possibility that the body may poorly absorb arsenic in Northport soils. Still, the evaluations are useful for comparison to public health goals and legal requirements.

The calculations estimate the amount of exposure someone might have to arsenic-contaminated soil at the specified locations. These exposure estimates are compared to the amount of exposure below which non-cancer effects are not expected to occur. Specifically, short-term exposure (less than one week) to less than 0.005 milligrams of arsenic per kilogram of body weight is not expected to cause gastrointestinal problems. Long-term exposure (several years or more) to less than 0.0003 milligrams of arsenic per kilogram of body weight per day is not expected to cause changes in coloration or thickness of the skin. Exposure dose calculations for arsenic comparison values are provided in Appendix B, Table 8.

Residential Properties

The maximum concentration of arsenic measured in the surface soil (0-1 inch interval) of a residential property was 151 milligrams of arsenic per kilogram of soil (See Appendix B - Table 8). Exposure for children is estimated to be about 0.002 milligrams of arsenic per kilogram of body weight per day. This is approximately 10 times the comparison value (0.0003 milligrams of arsenic per kilogram of body weight per day) for evaluating the potential for skin changes.

Exposure for children with pica behavior is estimated to be 0.02 milligrams of arsenic per kilogram of body weight. This is approximately four times the comparison value (0.005 milligrams of arsenic per kilogram of body weight) for evaluating the potential for gastrointestinal problems. Although it is possible that people could develop non-cancer health problems from exposure to soil containing 151 ppm arsenic, it is unlikely.

Northport School Property
The maximum concentration of arsenic found at the school was 22.8 ppm in a sample collected 6 – 12 inches below the ground surface (See Appendix B - Table 8). Exposure for children is estimated to be about 0.0003 milligrams of arsenic per kilogram of body weight per day and is not expected to result in non-cancer health problems. Exposure for children with pica behavior is estimated to be 0.003 milligrams of arsenic per kilogram of body weight and is unlikely to result in gastrointestinal problems.

Smelter Complex
The upper confidence limit (95 UCL) of arsenic 336 ppm in the surface soil (0-6 inch interval) was used to calculated hazard quotient for a trespasser exposed for one day a week (52 days/year). (See Appendix B - Table 8). Using this exposure scenario, the exposure for children is estimated to be about 0.00064 milligrams of arsenic per kilogram of body weight per day. This is approximately 2 times the comparison value (0.0003 milligrams of arsenic per kilogram of body weight per day) for evaluating the potential for skin changes. Exposure for children with pica behavior is estimated to be 0.0064 milligrams of arsenic per kilogram of body weight. This is similar to the comparison value (0.005 milligrams of arsenic per kilogram of body weight) for evaluating the potential for gastrointestinal problems. Although it is possible that people could develop non-cancer health problems from exposure to soil at the smelter complex at the UCL (336 ppm) for arsenic, it is unlikely.

Cadmium

Cadmium is a naturally occurring element in the earth's soil. Background soil cadmium concentration ranges between 0.1 and 5.0 ppm, statewide in Washington State [5].
The EPA classified cadmium as a probable human carcinogen based on animal studies. The main routes of exposure to cadmium are from inhaling contaminated soil or dust particles, and by ingesting contaminated water or food. Cadmium contaminated soil can accidentally be ingested by hand to mouth activity that could increase exposure. Cadmium is stored in the liver and kidneys and slowly leaves the body in the urine and feces [15]. Cadmium absorption through the skin is not normally an important pathway, very little enters through the skin.

Non-cancer effects

In order to evaluate the potential for non-cancer adverse health affects that may result from exposure to contaminated media (i.e., air, water, soil, and sediment), a dose is estimated for each contaminant of concern. These doses are calculated for situations (scenarios) in which nearby residents might come into contact with the contaminated media. The estimated dose for each contaminant under each scenario is then compared to ATSDR’s minimal risk level (MRL) or EPA’s oral reference dose (RfD). MRLs and RfDs are doses below which non-cancer adverse health effects are not expected to occur (so-called “safe” doses). They are derived from toxic effect levels obtained from human population and laboratory animal studies. These toxic effect levels can be either the lowest-observed adverse effect level (LOAEL) or a no-observed adverse effect level (NOAEL). In human or animal studies, the LOAEL is the lowest dose at which an adverse health effect is seen, while the NOAEL is the highest dose that did not result in any adverse health effects.

Because of uncertainty in these data, the toxic effect level is divided by "safety factors" to produce the lower and more protective MRL or RfD. If a dose exceeds the MRL or RfD, this indicates only the potential for adverse health effects. The magnitude of this potential can be inferred from the degree to which this value is exceeded. If the estimated exposure dose is only slightly above the MRL or RfD, then that dose will fall well below the toxic effect level. The higher the estimated dose is above the MRL or RfD, the closer it will be to the actual toxic effect level. This comparison is known as a hazard quotient (HQ) and is given by the equation below:

Equation 1

$$HQ = \frac{\text{Estimated Dose (mg/kg-day)}}{\text{RfD (mg/kg-day)}}$$

The chronic oral MRL for cadmium is 0.0002 mg/kg/day. It is assumed that the body rapidly absorbs about 5 % of the cadmium ingested in water and about 2.5 % of the cadmium ingested in food. The estimated NOAEL for chronic cadmium exposure is 0.005 and 0.01 mg/kg/day from water and food, respectively [16]. Chronic exposure studies in humans indicate that the NOAEL is 0.0021 mg/kg/day and the LOAEL is 0.0078 mg/kg/day [15].

Smelter Complex

The upper confidence limit (95 UCL) of cadmium 52 ppm in the surface soil (0-6 inch interval) was used to calculated hazard quotient for a trespasser exposed for one day a week (52 days/year). The calculated hazard quotient is about 0.1 (See Appendix B - Table 8). Exposure for children is estimated to be about 0.000099 milligrams of arsenic per kilogram of body weight per day and is not expected to result in non-cancer health problems. Exposure for children with pica behavior is estimated to be 0.00099 milligrams of arsenic per kilogram of body weight and is unlikely to result in gastrointestinal problems.

Northport School Property

The maximum concentration of surface cadmium detected in the 0-1 inch interval was 4.75 ppm and subsurface 6-12 inches interval was 5.79 ppm. The maximum concentration of cadmium found in the soil at the campus exceeds the MTCA cleanup level of 2 ppm but did not exceed the ATSDR health comparison values 10 ppm. Cadmium concentrations below ATSDR comparison values are unlikely to pose health threats, and thus not evaluated further in this health consultation.

Residential Properties

The maximum concentration of surface cadmium detected in the 0-1 inch interval was 36.1 ppm. The calculated hazard quotient is about 0.46 (See Appendix B - Table 8). Exposure for children is estimated to be about 0.00046 milligrams of cadmium per kilogram of body weight per day and is not expected to result in non-cancer health problems. Exposure for children with pica behavior is estimated to be 0.0046 milligrams of cadmium per kilogram of body weight. Using EPA's value of 2.5% for gastrointestinal absorption of cadmium, the absorbed dose would be 0.0001 mg/kg/day for a child with pica behavior. This exposure dose is less than the NOAEL (0.0021 mg/kg/day) and the LOAEL (0.0078 mg/kg/day) from chronic exposure studies in humans and is unlikely to result in gastrointestinal problems.

Cancer effects

Some studies have indicated that occupational exposure to cadmium may increase lung cancer risk [15]. The maximum cadmium concentration (36.1 ppm) found at a residential property and the upper confidence limit (95 UCL) of cadmium 52 ppm in the surface soil (0-6 inch interval), (See Appendix B - Table 7), for a trespasser exposed for one day a week (52 days/year) was used to calculate the increase cancer risk. The calculated increase cancer risk for a child from exposure to smelter soils is (3.36×10^{-6}) or (3 in 1,000,000), which is considered to be very low to slight. Similarly, the calculated increase cancer risk for a child from exposure to residential soils is low to very low (1.56×10^{-5}) or about (2 in 100,000). Using EPA's value of 2.5% for gastrointestinal absorption of cadmium, the increase cancer risk to exposure to residential and to smelter soils for cadmium is insignificant, (3.9×10^{-7}) or (4 in 10,000,000) and (8.36×10^{-8}) or about (8 in 100,000,000) respectively.

Mercury

Mercury is a naturally occurring element in the earth's soil. Background soil mercury concentration ranges between 0 and 0.19 ppm, statewide in Washington State [5]. The MTCA cleanup level for mercury is 1 ppm [17]. Mercury exists in the environment in three forms: elemental, inorganic, and organic.

Inorganic mercury contaminated soil can accidentally be ingested by hand-to-mouth activity that could increase exposure. About 10 to 40 percent of the ingested inorganic mercury entering the body can be absorbed through the stomach and intestines, and only a small amount will pass through the skin [18]. Ingested inorganic mercury then enters the bloodstream and moves to different tissues including the kidneys. Inorganic mercury slowly leaves the body in the urine and feces [18].

Non-cancer effects

Smelter Complex

The upper confidence limit (95 UCL) of mercury 1.66 ppm in the surface soil (0-6 inch interval) was used to calculated hazard quotient for a trespasser exposed for one day a week (52 days/year). The calculated hazard quotient is about 0.03 (See Appendix B - Table 8). Exposure for children is estimated to be about 0.000003 milligrams of mercury per kilogram of body weight per day. Similarly, exposure for children with pica behavior is estimated to be 0.00003 milligrams of mercury per kilogram of body weight. These exposure doses are less than the NOAEL (0.23 mg/kg/day) for intermediate exposure and the LOAEL (1.9 mg/kg/day) for chronic exposure to inorganic mercury. Therefore, would not result in any non-carcinogenic adverse health effects.

Northport School Property
Mercury was not detected at the practical quantitation limit (0.160 ppm) at the school campus. Therefore, it is unlikely to pose health threats, and thus not evaluated further in this health consultation on the school campus.

Residential Properties
The maximum concentration of surface mercury detected in the 0-1 inch interval was 1.78 ppm, (See Appendix B - Table 4). The calculated hazard quotient is about 0.23 (See Appendix B - Table 8). Exposure for children is estimated to be about 0.000023 milligrams of mercury per kilogram of body weight per day. Similarly, exposure for children with pica behavior is estimated to be 0.00023 milligrams of mercury per kilogram of body weight. These exposure doses are less than the NOAEL (0.23 mg/kg/day) for intermediate exposure and the LOAEL (1.9 mg/kg/day) for chronic exposure to inorganic mercury. Therefore, would not result in any non-carcinogenic adverse health effects.

Antimony

Antimony is a naturally occurring element in the earth's soil. Background soil antimony concentration ranges between 3.1 and 7.6 ppm, statewide in Washington State [5]. The main routes of exposure to antimony are from inhaling contaminated soil or dust particles, and by ingesting contaminated water or food. Antimony contaminated soil can accidentally be ingested by hand-to-mouth activity that could increase exposure. Antimony entering the body will move to the blood and then most of the antimony goes to the liver, lungs, intestines and spleen, and slowly leaves the body in the urine and feces [19].

Non-cancer effects

Smelter Complex
The upper confidence limit (95 UCL) of antimony 81.88 ppm in the surface soil (0-6 inch interval) was used to calculated hazard quotient for a trespasser exposed for one day a week (52 days/year). The calculated hazard quotient is about 0.4 (See Appendix B - Table 8). Exposure for children is estimated to be about 0.00016 milligrams of antimony per kilogram of body weight per day. Similarly, exposure for children with pica behavior is estimated to be 0.0016 milligrams of antimony per kilogram of body weight. These exposure doses are less than the NOAEL (0.0748 mg/kg/day) for intermediate exposure and the LOAEL (0.262 mg/kg/day) for chronic exposure to antimony. Therefore, would not result in any non-carcinogenic adverse health effects.

Residential Properties
The maximum concentration of surface antimony detected in the 0-1 inch interval was 6.1 ppm, (See Appendix B - Table 4). The calculated hazard quotient is about 0.195 (See Appendix B - Table 3). Exposure for children is estimated to be about 0.000077 milligrams of antimony per kilogram of body weight per day. Similarly, exposure for children with pica behavior is estimated to be 0.00077 milligrams of antimony per kilogram of body weight. These exposure doses are less than the NOAEL (0.0748 mg/kg/day) for intermediate exposure and the LOAEL

(0.262 mg/kg/day) for chronic exposure to antimony. Therefore, would not result in any non-carcinogenic adverse health effects.

Northport School Property

The maximum concentration of antimony found at the school was 1.25 ppm in a sample collected 6 – 12 inches below the ground surface (See Appendix B - Table 4). Since, the maximum antimony at the school campus is less than that at the residential properties. The hazard quotient would be less than the calculated hazard quotient for the residential properties; therefore, would not result in any non-carcinogenic adverse health effects and thus not evaluated further in this health consultation on the school campus.

Drinking Water

Public drinking water wells operated by the city are located at the site of the brick platform used for initial roasting of the ore. These wells are sampled once every three years for lead, arsenic and other metals and have never exceeded state or federal drinking water standards.

Child Health Considerations

ATSDR and DOH recognize infants and children are susceptible to developmental toxicity that can occur at levels much lower than those causing other types of toxicity. Infants and children are also more vulnerable to exposures than adults. The following factors contribute to this vulnerability at this site:

- Children are more likely to play in contaminated outdoor areas.
- Children often bring food into contaminated areas, resulting in hand-to-mouth activities.
- Children are smaller and receive higher doses of metals exposure per body weight.
- Children are shorter than adults, therefore they have a higher possibility to breathe in dust and soil.
- Fetal and child exposure to lead can cause permanent damage during critical growth stages.

These unique vulnerabilities of infants and children demand special attention in communities with contamination of their water, food, soil or air. Children's health was considered in the writing of this health consultation and the exposure scenarios treated kids as the most sensitive population being exposed.

Conclusions

A public health hazard exists for residents exposed to lead and arsenic in soil at the smelter site, lumberyard and some residential properties.

- Young children six years of age and younger are the most susceptible to such exposure.

An indeterminate health hazard exists for nearby residents who might be exposed to lead and arsenic migrating from the site to yard soil and house dust on neighboring properties.

Recommendations

1. Children should not be permitted access to the smelter site and lumberyard until the contaminated areas have been remediated. Signs should be posted to indicate potential health hazards from lead and arsenic in soils.

2. Considering the long time frame until final cleanup is likely to occur, DOH recommends that soil remediation levels for lead and arsenic for this interim action be set at the lowest appropriate level.

3. DOH recommends remediation of the smelter site, lumber yard and residential properties with soil lead and arsenic levels above soil remediation levels to reduce human exposures to lead and other contaminants in community soils and dusts.

4. DOH recommends that efforts be made to educate residents of the hazards posed by exposure to lead and arsenic in the soil and steps they can take to reduce their exposure (such as taking off shoes before entering homes, using gloves while gardening, washing hands after playing outside, eliminating exposed soil in your yard by putting in sod or something, etc.).

5. DOH recommends voluntary blood lead testing for children six years of age and under, older children who play near the site and women of child bearing age to determine if exposure to lead is occurring at levels of public health concern.

6. DOH recommends that EPA's replacement soil meet MTCA cleanup standards for lead and arsenic of 250 and 20 ppm, respectively.

Public Health Action Plan

Action Completed

1. DOH attended a City Council meeting and EPA public meetings in Northport, Washington, and provided educational materials to the community.

2. DOH mailed fact sheets about the LeRoi Smelter and free blood lead screening fliers to residents of Northport area.

3. In August 2004, DOH, Northeast Tri-County Health District and the Northport Community Health Center conducted blood lead testing for children six years of age and under, older children who play near the site and women of child bearing age, to determine if exposure to lead is occurring at levels of public health.

4. Individual blood lead test results were mailed to participants in a letter explaining their health implications.

5. In November 2004, EPA completed soil removal action at the site.

Actions Planned

DOH will coordinate with EPA, Ecology and Northeast Tri-County Health District to develop educational materials for residents regarding the hazards posed by exposure to lead in soil and steps that can be taken to reduce exposure.

Preparer of Report

Lenford O'Garro
Washington State Department of Health
Office of Environmental Health Assessments
Site Assessment Section

Jim W. White
Washington State Department of Health
Office of Environmental Health Assessments
Toxicology Section

Designated Reviewer

Wayne Clifford, Manager
Site Assessment Section
Office of Environmental Health Assessments
Washington State Department of Health

ATSDR Technical Project Officer

Alan Parham
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

References

1. Ecology and Environment, Inc. Preliminary assessments and site inspection report, Upper Columbia River Mines and Mills, Stevens County, Washington TDD:01-02-0028. Prepared for U.S. Environmental Protection Agency, contract no. 68-S0-01-01. Seattle: Ecology and Environment, Inc. October 2002.

2. Ecology and Environment, Inc and Roy F. Weston, Inc. Upper Columbia River expanded site inspection report, Northeast, Washington TDD:01-02-0028. Prepared for U.S. Environmental Protection Agency, contract no. 68-S0-01-01. Seattle: Ecology and Environment, Inc and Roy F. Weston, Inc. March 2003.

3. Herrera Environmental Consultants. LeRoi Smelter Removal Site Evaluation, Draft, Summary of X-ray Fluorescence soil screening results for lead and arsenic. Prepared for Washington State Department of Ecology, Project No. 00-01732-043. Seattle: Herrera Environmental Consultants. November 4, 2003.

4. Herrera Environmental Consultants. LeRoi Smelter Removal Site Evaluation Northport, Washington. Prepared for Washington State Department of Ecology, Project No. 00-01732-043. Seattle: Herrera Environmental Consultants. January 16, 2004.

5. Toxics Cleanup Program, Department of Ecology: Natural background soil metals concentrations in Washington State Publication No. 94-115.Olympia: Washington State Department of Ecology: October 1994.

6. Agency for Toxic Substances and Disease Registry (ATSDR). Analysis Paper: Impact of Lead-Contaminated Soil on Public Health. U.S. Department of Health and Human Services, Public Health Service, Atlanta, Georgia. May 1992.

7. CDC. Preventing lead poisoning in young children: a statement by the Centers for Disease Control, October 1991. Atlanta, Georgia: US Department of Health and Human Services, Public Health Service, CDC. 1991.

8. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry: Toxicological profile for Lead (update) PB/99/166704. Atlanta: US Department of Health and Human Services. July 1999.

9. Agency for Toxic Substances and Disease Registry (ATSDR). Lead Toxicity (Case studies in environmental medicine Course) SS3059. Atlanta: U.S. Department of Health and Human Services, Public Health Service. October 2000.

10. U.S. Environmental Protection Agency. Technical Review Workgroup for Lead. *User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children,* (IEUBK) *Windows version 1.0*, OSWER Directive No.9285.7-42. Document No. EPA 540-K-01-005 Washington, DC: May 2002.

11. Washington State Department of Ecology. Letter to Earl Liverman (EPA) from Guy Gregory concerning cleanup levels and remediation levels, Northport Removal Action. Spokane, Washington. December 15, 2003. 1485-1493, 1998.

12. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry: Petitioned Public Health Assessment Northport Area, Northport, Stevens County, Washington. Atlanta: US Department of Health and Human Services. January 22, 1999.

13. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry: Toxicological profile for Arsenic (update) PB/2000/108021. Atlanta: US Department of Health and Human Services. September 2000.

14. ATSDR Agency for Toxic Substances and Disease Registry. ATSDR Fact Sheet: Cancer. Updated August 30, 2002. Atlanta: US Department of Health and Human Services. Available at internet: http://www.atsdr.cdc.gov/COM/cancer-fs.html.

15. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry: Toxicological profile for Cadmium (update) PB/99/166621. Atlanta: US Department of Health and Human Services. July 1999.

16. U.S. Environmental Protection Agency. Integrated Risk Information System (IRIS) October 2000 update.

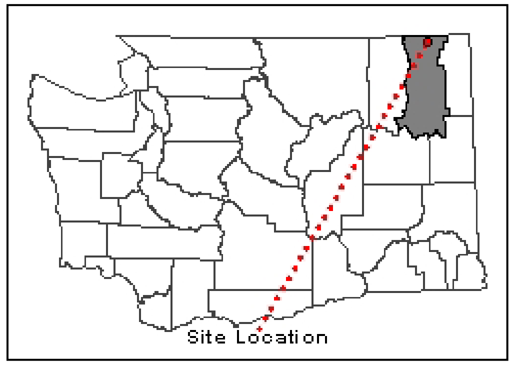
17. Washington State Department of Ecology, Toxics Cleanup Program: Cleanup levels and risk calculations under the Model Toxics Control Act, cleanup regulation, Publication No. 94-145. Olympia: Washington State Department of Ecology: Updated November 2001.

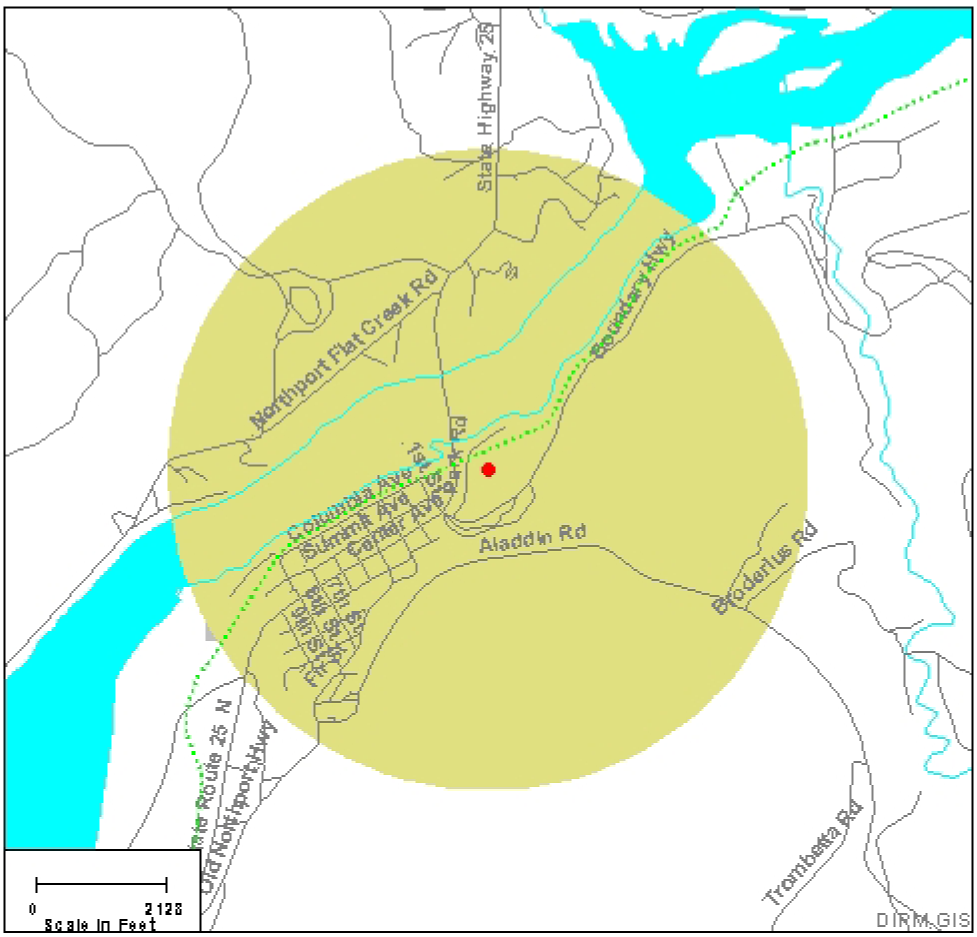
18. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry: Toxicological profile for Mercury (update) PB/99/142416. Atlanta: US Department of Health and Human Services. March 1999.

19. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry: Toxicological profile for Antimony PB/93/110641/AS. Atlanta: US Department of Health and Human Services. December 1992.

Figure 1. Demographic Statistics Within One Mile of the Site* - Northport area, Stevens County

Total Population	**368**
White	**350**
Black	**0**
American Indian, Eskimo, Aleut	**2**
Asian or Pacific Islander	**3**
Other Race	**1**
Hispanic Origin	**18**
Children Aged 6 and Younger	**32**
Adults Aged 65 and Older	**61**
Females Aged 15 – 44	**58**
Total Aged over 18	**276**
Total Aged under 18	**92**
Total Housing Units	**202**





*** Calculated using the area proportion technique. Source: 2000 U.S. CENSUS**

Appendix A: 2004 Photos from the LeRoi Smelter site

Photo 1. City Park entrance with Lumber Yard and LeRoi Smelter in background

Photo 2. On-site showing City well in background

Photo 3. Remaining foundation on-site

Photo 4. Remaining foundation on-site

Photo 5. Remaining equipment on-site

Photo 6. Historical smokestack and city boat ramp

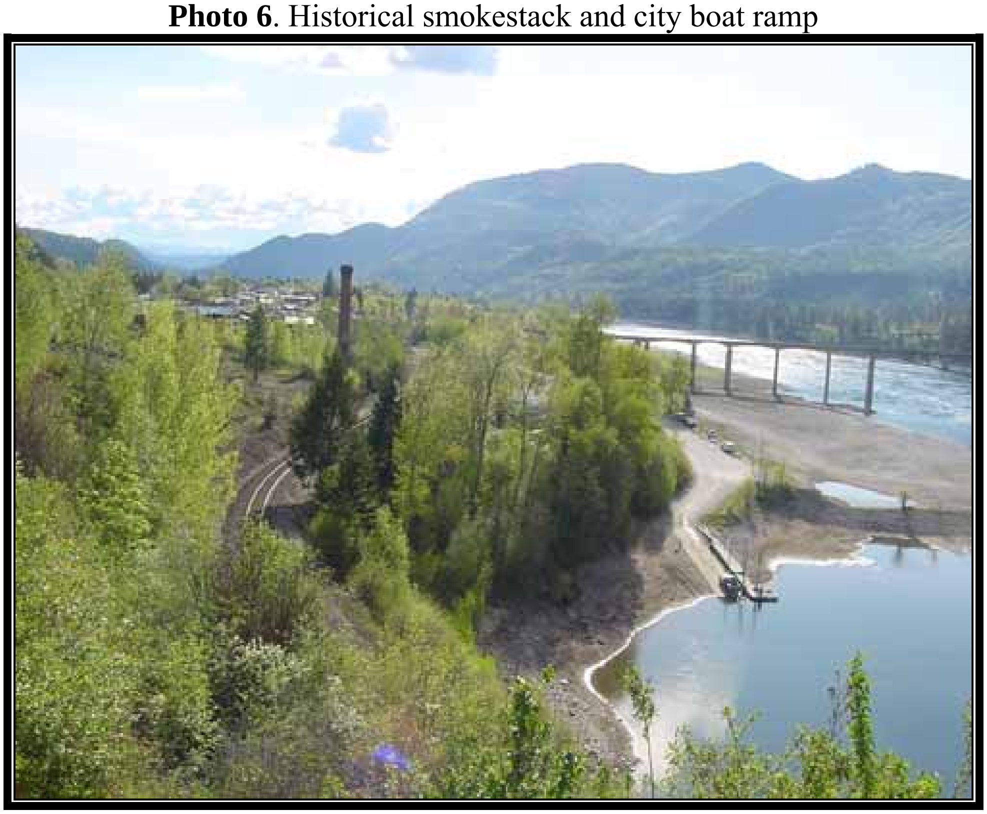
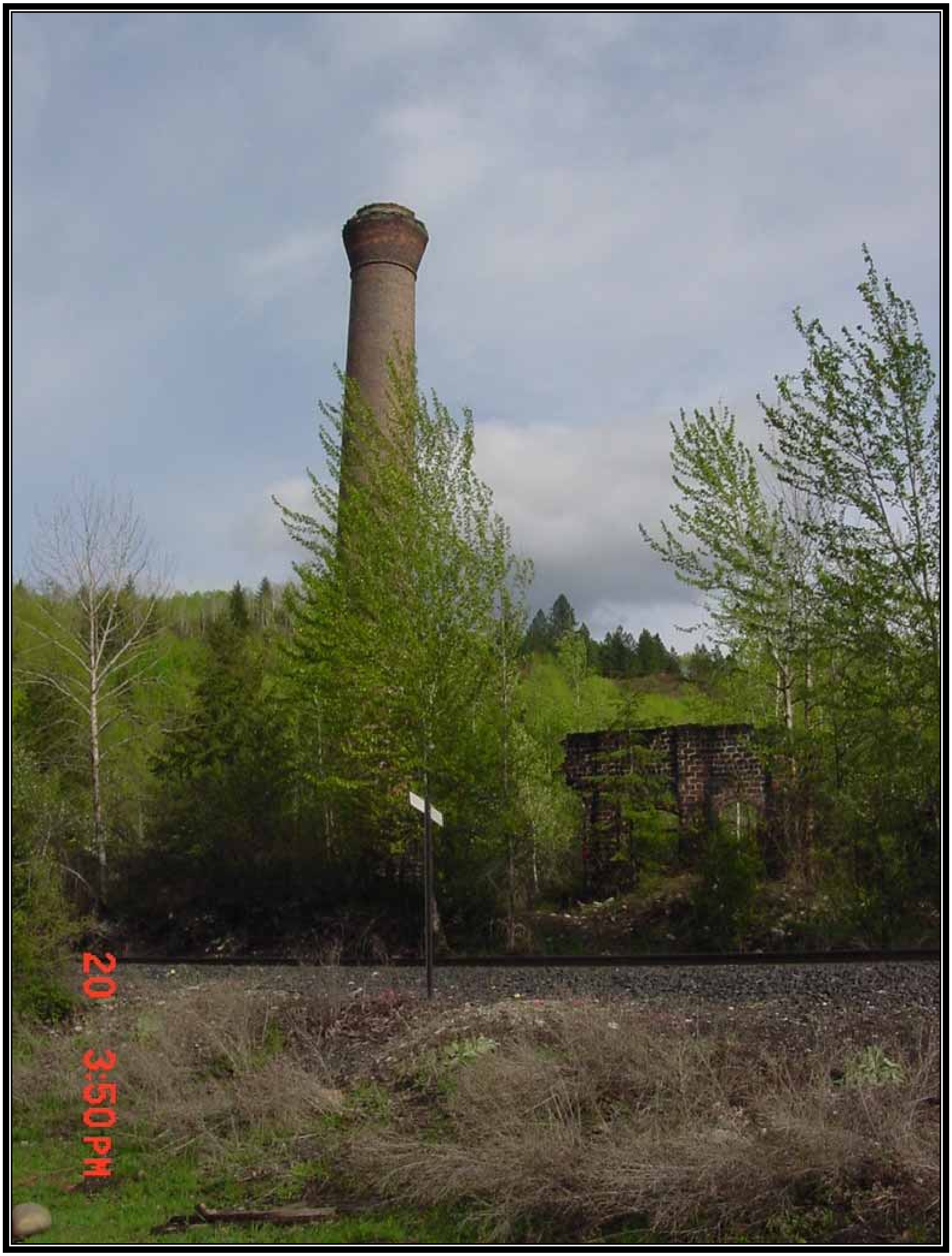


Photo 7. Historical smokestack



Appendix B

Table 1: 2003 Lead and arsenic XRF field screening LeRoi Smelter removal site evaluation, Northport, Washington.

Location	Contaminant	Sample Depth	Maximum Concentration (mg/kg)
Smelter Complex	Lead	Surface Subsurface	47,590 31,898
	Arsenic	Surface Subsurface	3,770 2,029
Lumber Yard Complex	Lead	Surface Subsurface	1,610 2,459
	Arsenic	Surface Subsurface	129 202
Northport School Property	Lead	Surface Subsurface	247 256
	Arsenic	Surface Subsurface	< 44 < 49
Residential Properties	Lead	Surface Subsurface	2,200 2,650
	Arsenic	Surface Subsurface	< 168 154

Table 2: Ecology's recommended remediation levels for interim actions at Northport, Washington.

Chemical/level type	Concentration	Background	Remedial action
Lead	**ppm**		
Cleanup level	250	MTCA Method A	All soil above 15 feet below ground surface must be addressed
Remediation level	250-700	IEUBK model with modified exposure assumptions	Exposure reduction measures
Remediation level	700-1000	IEUBK model modified for school and daycare facility exposure assumptions	Exposure reduction measures; removal or containment for child use areas
Remediation level	>1000	IEUBK model, modified exposure assumptions	Removal or containment
Arsenic	**ppm**		
Cleanup level	20	MTCA Method A	All soil above 15 feet below ground surface must be addressed
Remediation level	20-100	MTCA Method B modified for some child exposure assumptions	Exposure reduction measures
Remediation level	100-230	MTCA Method B modified exposure assumptions	Exposure reduction measures; removal or containment for child use areas
Remediation level	>230		Removal or containment

Table 3. LeRoi Smelter decision area, laboratory analytical results, LeRoi Smelter Removal Site Evaluation.

Sample ID	Units	Analyte Concentration												
		Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Soil														
L0002SS0-6	Mg/kg	1.00 UJ	15.4	0.500 U	2.60	21.8	234	404	0.160 U	15.4	4.30 U	1.00 U	1.00 UJ	182
L0003SS0-6	Mg/kg	19.8	217	0.500 U	20.8	20.2	9,380	10,100	0.400	36.2	4.30 U	16.8	1.00 U	1,290
L0004SS6-12	Mg/kg	7.62	49.6	0.500 U	18.4	19.1	3,030	12,300	0.280	21.2	4.30 U	1.06	1.00 U	807
L0006SS6-12	Mg/kg	19.2	28.7	0.500 U	5.61	14.8	794	14,400	0.160 U	14.5	4.30 U	49.3	1.00 U	557
L0007SS6-12	Mg/kg	7.02	143	0.500 U	7.98	17.6	1,790	1,040	0.160 U	25.2	4.30 U	1.00 U	1.00 U	348
L0010SS0-6	Mg/kg	16.0 J	64.2	0.500 UJ	27.8	14.7	682	4,050	0.220	13.7	4.30 U	1.00 U	1.00 U	549
L0012SS0-6	Mg/kg	3.18	34.5	0.500 U	6.45	20.4	500	397	0.160 U	17.8	4.30 U	1.00 U	1.00 U	155
L0013SS0-6	Mg/kg	14.7	77.4	0.500 U	30.2	17.7	376	3,920	0.580	18.6	4.30 U	1.00 U	1.00 U	681
L0015SS0-6	Mg/kg	2.64	6.74	0.500 U	2.84	23.6	79.9	156	0.160 U	18.0	4.30 U	1.00 U	1.00 U	109
L0030SS6-12	Mg/kg	4.00	86.6	0.500 U	16.5	19.7	1,150	1,290	0.460	15.0	4.30 U	1.00 U	1.00 U	251
L0037SS6-12	Mg/kg	5.83	607	0.500 U	42.5	17.4	14,400	910	0.360	35.9	4.30 U	1.00 U	1.00 U	570
L0040SS0-6	Mg/kg	4.26	98.8	0.500 U	7.02	24.4	1,590	684	0.220	24.8	4.30 U	1.00 U	1.00 U	190
L0041SS6-12	Mg/kg	4.58	28.3	0.500 U	16.3	14.8	1,150	1,640	0.160 U	13.7	4.30 U	1.00 U	1.00 U	217
L0043SS0-6	Mg/kg	89.7	98.7	0.500 U	28.1	16.8	1,110	24,300	0.640	14.8	4.30 U	53.8	1.00 U	991
L0045SS0-6	Mg/kg	29.2	144	0.500 U	32.5	12.3	2,190	11,300	0.600	16.5	4.30 U	16.7	1.00 U	995
L0046SS6-12	Mg/kg	102	224	0.500 U	134	12.5	1,500	34,500	0.580	15.2	4.30 U	40.9	1.00 U	2,540
L0047SS0-6	Mg/kg	112	239	0.500 U	96.1	15.5	4,100	49,400	1.86	20.4	4.30 U	67.7	1.00 U	2,490
L0051SS0-6	Mg/kg	1.00 U	95.8	0.500 U	7.61	40.9	5,450	668	0.320	34.1	4.30 U	1.00 U	1.00 U	133
L0054SS6-12	Mg/kg	3.07	119	0.500 U	12.2	13.4	1,410	895	0.320	14.6	4.30 U	1.00 U	1.00 U	186
L0058SS0-6	Mg/kg	40.8	141	0.500 U	31.3	12.6	4,820	34,300	0.220	35.6	4.30 U	83.3	1.00 U	3,490
L0061SS0-6	Mg/kg	7.89	26.8	0.500 U	8.78	26.5	377	3,000	0.160 U	9.55	4.30 U	3.57	1.00 U	343
L0064SS0-6	Mg/kg	65.6	145	0.500 U	51.3	11.8	2,310	27,100	0.360	18.9	4.30 U	49.3	1.00 U	3,400
L0071SS0-6	Mg/kg	4.02	66.7	0.500 U	19.1	15.8	341	1,370	0.340	13.6	4.30 U	1.00 U	1.00 U	271
L0076SS6-12	Mg/kg	4.91	181	0.500 U	11.7	14.2	2,690	942	0.260	15.3	4.30 U	1.00 U	1.00 U	185
L0077SS0-6	Mg/kg	1.00 U	5.00 U	0.500 U	1.24 U	24.4	38.9	69.1	0.160 U	17.3	4.30 U	1.00 U	1.00 U	99.9
L0080SS0-6	Mg/kg	7.86	99.2	0.500 U	84.0	15.5	479	3,660	0.880	14.0	4.30 U	8.28	1.00 U	522
L0085SS0-6	Mg/kg	2.65	35.6	0.500 U	15.3	19.7	146	821	0.240	14.3	4.30 U	1.00 U	1.00 U	226
L0086SS0-6	Mg/kg	3.60	24.9	0.500 U	11.2	17.4	157	811	0.160 U	12.5	4.30 U	1.00 U	1.00 U	217

L0088SS0-6	Mg/kg	4.57	29.6	0.500 U	36.8	17.6	209	1,820	0.460	15.3	4.30 U	1.00 U	1.00 U	334
L0090SS0-6	Mg/kg	3.17	24.4	0.500 U	9.69	15.9	135	481	0.160 U	12.9	4.30 U	1.00 U	1.00 U	117
L0092SS0-6	Mg/kg	1.81	66.2	0.500 U	9.11	21.4	307	482	0.240	16.1	4.30 U	1.00 U	1.00 U	147
L0095SS6-12	Mg/kg	1.50	40.3	0.500 U	8.54	13.8	193	547	0.200	11.1	4.30 U	1.00 U	1.00 U	144
L0097SS0-6	Mg/kg	1.51	47.5	0.500 U	7.44	14.1	179	372	0.160 U	10.2	4.30 U	1.00 U	1.00 U	105
L0105SS6-12	Mg/kg	4.74	188	0.500 U	10.8	15.4	466	1,660	0.980	13.6	4.30 U	1.00 U	1.00 U	137
L0107SS0-6	Mg/kg	2.43	66.4	0.500 U	13.8	12.9	299	971	0.280	10.8	4.30 U	1.00 U	1.00 U	168
L0111SS0-6	Mg/kg	1.81	78.0	0.500 U	13.5	14.0	326	768	0.280	11.9	4.30 U	1.00 U	1.00 U	156
L0113SS6-12	Mg/kg	3.35	41.2	0.500 U	13.1	23.8	291	1,030	0.440	13.8	4.30 U	1.00 U	1.00 U	211
L0115SS6-12	Mg/kg	2.10	44.8	0.500 U	10.9	30.4	382	1,130	0.880	19.1	4.30 U	1.00 U	1.00 U	234
L0118SS6-12	Mg/kg	7.07	153	0.500 U	29.3	15.1	805	2,360	0.620	13.1	4.30 U	1.00 U	1.00 U	306
L0119SS0-6	Mg/kg	1.00 U	22.6	0.500 U	4.21	32.5	127	259	0.160 U	16.1	4.30 U	1.00 U	1.00 U	113
L0122SS6-12	Mg/kg	1.00 U	7.12	0.500 U	1.77	22.1	51	334	0.160 U	15.1	4.30 U	1.00 U	1.00 U	239
L0127SS6-12	Mg/kg	3.53 J	40.8	0.500 UJ	26.0	18.6	311	1,480	11.1	14.5	4.30 U	1.00 U	1.00 U	300
L0130SS6-12	Mg/kg	2.84	40.4	0.500 U	10.3	16.4	455	1,190	0.240	14.8	4.30 U	1.00 U	1.00 U	353
L0131SS0-6	Mg/kg	2.42	57.4	0.500 U	10.3	17.6	552	933	0.160 U	16.4	4.30 U	1.00 U	1.00 U	268
Sediment														
L0136SD0-1	Mg/kg	10.9 J	104	0.500 UJ	16.1	33.4	4,520	3,690	0.160 U	19.1	4.30 UJ	1.00 U	1.00 UJ	586
Test Pit														
TP0002SS0.9-1	Mg/kg	648	2,610	0.500 U	304	2.04	7,050	99,700	13.3	19.7	4.30 U	99.5	7.66	11,700

Underlined value indicates the sample concentration exceeds the Ecology threshold for recommended exposure reduction measures [250 mg/kg (lead) and 20 mg/kg (arsenic)] or the sample concentration exceeds Ecology MTCA method B cleanup levels for unrestricted land use, direct contact exposure pathway [32 mg/kg (antimony), 160 mg/kg (beryllium), 80 mg/kg (cadmium), 240 mg/kg (chromium), 2,960 mg/kg (copper), 24 mg/kg (mercury), 1,600 mg/kg (nickel), 400 mg/kg (selenium), 400 mg/kg (silver), 5.6 mg/kg (thallium), and 24,000 mg/kg (zinc)].

Highlighted value indicates the sample concentration exceeds the Ecology threshold for recommended soil containment or removal [1,000 mg/kg (lead) and 230 mg/kg (arsenic)].
Values are reported on a dry-weight basis.

Ecology - Washington State Department of Ecology.
EPA - U.S. Environmental Protection Agency.
J - The associated numerical value is an estimated quantity because the reported concentration was less than the required detection limit or quality control criteria were not met.
mg/kg - milligrams per kilogram.
MTCA - Model Toxics Control Act.
PCBs - polychlorinated biphenyls.
U - The material was analyzed for but was not detected. The associated numerical value is the practical quantitation limit.
UJ - The material was analyzed for but was not detected. The reported detection limit was estimated because quality control criteria were not met.

Table 4. Northport Community decision area, laboratory analytical results, LeRoi Smelter Removal Site Evaluation.

Sample ID	Units	Analyte Concentration													
		Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc	PCBs[c]
Soil															
Northport School															
NSD0002SS6-12	mg/kg	1.25	22.8	0.500 U	5.79	31.0	138	283	0.160 U	13.2	4.30 U	1.00 U	1.00 U	212	-
NSD0003SS0-1	mg/kg	1.00 U	9.37	0.500 U	3.19	32.7	60.4	180	0.160 U	12.7	4.30 U	1.00 U	1.00 U	189	-
NSD0014SS0-1	mg/kg	1.15	14.0	0.500 U	4.75	26.4	70.3	237	0.160 U	13.5	4.30 U	1.00 U	1.00 U	356	-
Soil															
Residences															
NP0004SS0-1	mg/kg	3.55	46.9	0.500 U	18.8	25.6	301	944	0.420	13.3	4.30 U	1.00 U	1.00 U	551	-
NP0006SS0-1	mg/kg	1.40	15.3	0.500 U	6.65	26.4	103	343	0.160 U	11.8	4.30 U	1.00 U	1.00 U	301	-
NP0008SS0-1	mg/kg	1.00 U	15.6	0.500 U	5.74	21.3	236	299	0.160 U	14.9	4.30 U	1.00 U	1.00 U	457	-
NP0013SS0-1	mg/kg	6.10	151	0.500 U	36.1	23.6	678	1,880	1.78	13.8	4.30 U	1.00 U	1.00 U	596	-
NP0016SS0-1	mg/kg	3.50	71.5	0.500 U	23.6	30.1	475	1,200	1.48	14.1	4.30 U	1.00 U	1.00 U	557	-
NP0017SS0-1	mg/kg	1.00	25.3	0.500 U	7.98	27.1	148	403	0.160 U	13.7	4.30 U	1.00 U	1.00 U	199	-
NP0020SSPCB[a]	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	0.35 U
NP0022SS0-1	mg/kg	1.65	43.2	0.500 U	15.7	21.9	303	853	0.220	14.1	4.30 U	1.00 U	1.00 U	256	-
NP0027SS0-1	mg/kg	4.10	32.7	0.500 U	18.4	31.6	185	1,020	0.200	11.6	4.30 U	1.00 U	1.00 U	465	-
NP0030SS0-1	mg/kg	3.80	39.5	0.500 U	6.39	28.5	249	466	0.200	13.3	4.30 U	1.00 U	1.00 U	280	-
NP0033SS0-1	mg/kg	1.65	51.9	0.500 U	11.6	18.0	245	695	0.160 U	10.9	4.30 U	1.00 U	1.00 U	324	-
NP0035SS0-1	mg/kg	2.90	39.5	0.500 U	13.6	26.4	246	1,010	1.18	13.6	4.30 U	1.00 U	1.00 U	900	-
NP0037SS0-1	mg/kg	1.00 U	15.8	0.500 U	4.62	16.7	92.0	195	0.160 U	10.3	4.30 U	1.00 U	1.00 U	108	-
NP0039SS0-1	mg/kg	1.40	31.3	0.500 U	5.71	16.7	126	422	0.160 U	12.4	4.30 U	1.00 U	1.00 U	171	

Underlined value indicates the sample result exceeds the Ecology threshold for recommended exposure reduction measures [250 mg/kg (lead) and 20 mg/kg (arsenic)] or Ecology MTCA method B cleanup levels for unrestricted land use, direct contact exposure pathway [32 mg/kg (antimony), 160 mg/kg (beryllium), 80 mg/kg (cadmium), 240 mg/kg (chromium), 2,960 mg/kg (copper), 24 mg/kg (mercury), 1,600 mg/kg (nickel), 400 mg/kg (selenium), 400 mg/kg (silver), 5.6 mg/kg (thallium), and 24,000 mg/kg (zinc)].

Highlighted value indicates the sample result exceeds the Ecology threshold for recommended soil containment or removal [700 mg/kg (lead) and 100 mg/kg (arsenic) in areas where children are present, and 1,000 mg/kg (lead) and 230 mg/kg (arsenic) in areas where children are not present].

Values are reported on a dry-weight basis.

Ecology - Washington State Department of Ecology.

EPA -	U.S. Environmental Protection Agency.
mg/kg -	milligrams per kilogram.
MTCA -	Model Toxics Control Act.
PCBs -	polychlorinated biphenyls.
U -	The material was analyzed for but was not detected. The associated numerical value is the practical quantitation limit.

[a] The MTCA method A cleanup level for unrestricted land use for PCB mixtures is 1.0 mg/kg.

Soil Ingestion Route of Exposure - Cancer

Population exposure scenarios were evaluated for soils in Northport. Exposure assumptions given in Table 5 below were used with the following equations estimate contaminant doses associated with soils exposure.

$$Dose_{(non\text{-}cancer\ (mg/kg\text{-}day)} = \frac{C \times CF \times IR \times EF \times ED}{BW \times AT_{non\text{-}cancer}}$$

$$Dose_{(cancer\ (mg/kg\text{-}day)} = \frac{C \times CF \times IR \times EF \times ED}{BW \times AT_{cancer}}$$

For arsenic the following equation is used base on the Lifetime Daily Exposure (LDE) and the Unit Risk for Arsenic (URA) to calculate the Increased Cancer Risk (CR). Because children and adults are expected to have different amounts of exposure to soil, the cancer risk for each age group (0 – 6 years and 6 – 30 years) is calculated separately. Increased cancer risk for 30 years of exposure is calculated by adding the risks for adults to the risks for children:

$$LDE = \frac{C * IR * CF * EF * ED}{AT}$$

$$CR = LDE * URA$$

Table 5. Exposure Assumptions for estimating contaminant doses from soil exposure at LeRoi site Northport, Washington.

Parameter	Value	Unit	Comments
Concentration (C) – maximum	Variable	mg/kg	Maximum detected value
Conversion Factor (CF)	0.000001	kg/mg	Converts contaminant concentration from milligrams (mg) to kilograms (kg)
Ingestion Rate (IR) –adult	50	mg/day	Exposure Factors Handbook
Ingestion Rate (IR) – older child	50		
Ingestion Rate (IR) - child	200		
Exposure Frequency (EF)	350	Days/year	Two weeks vacation
Exposure Frequency smelter (EF)	52	Days/year	One day a week
Exposure Duration (ED)	30 (5, 10, 15)	years	Number of years at one residence (child, older child, adult yrs).
Body Weight (BW) - adult	72	kg	Adult mean body weight
Body Weight (BW) – older child	41		Older child mean body weight
Body Weight (BW) - child	15		0-6 year-old child average body weight
Averaging Time$_{non\text{-}cancer}$ (AT)	1825	days	5 years
Averaging Time$_{cancer}$ (AT)	27375	days	75 years
Minimal Risk Level (MRL) or Oral Reference Dose (RfD)	Contaminant-specific	mg/kg/day	Source: ATSDR, EPA
Cancer Potency Factor	Contaminant-specific	mg/kg-day^{-1}	Source: EPA

Table 6: Health risk exposure calculations for Arsenic in soil samples from Northport – Stevens County, Washington.

Chemical	Max Concentration (ppm)			EPA cancer Group	Lifetime Daily Exposure (mg/day)		Unit Risk for Arsenic (mg /day)	Increased Cancer Risk		Cancer Risk Exposure starting at childhood [a]
	Smelter*	City	Remediation Level		Child	Adult		Child	Adult	
Arsenic	336	-	-	A	0.000766	0.000834	0.2	0.0001532	0.0001668	0.00032
	-	151	-		0.0023	0.0023		0.00046	0.00046	0.00092
	-	-	20		0.0003	0.0003		0.00006	0.00006	0.00012
	-	-	100		0.0015	0.0015		0.0003	0.0003	0.0006
	-	-	230		0.0035	0.0035		0.0007	0.0007	0.0014

a – assumes 30 year exposure beginning as a child
* - 95 UCL instead of max concentration for soil 0 – 6 inches

Table 7. Cancer risk resulting from exposure to other contaminants of concern in soil samples from Northport - Stevens County, Washington.

Chemical	Max Concentration (ppm)		EPA cancer Group	Cancer Potency Factor (mg/kg-day^{-1})	Increased Cancer Risk			Cancer Risk Exposure starting at childhood [a]
	Smelter*	City			Child	Older Child	Adult	
Antimony	82	-	D	NA	NA	NA	NA	NA
	-	6						
Cadmium	52	-	B1	0.38 [b]	2.5E -6	4.58E-7	3.91E -7	3.35E -6
	-	36			1.17E -5	2.13E -6	1.82E -6	1.56E -5
Mercury	1.66	-	D	NA	NA	NA	NA	NA
	-	1.78						

a – assumes 30 year exposure beginning as a child
b – CAL – modified PRG oral cancer slope factor
* - 95 UCL instead of max concentration for soil 0 – 6 inches

Soil Ingestion Route of Exposure – Non-cancer

Table 8: Health risk calculations (non-cancer) from exposure to contaminants of concern in soil sampled from Northport - Stevens County, Washington.

Chemical	**Max Concentration** (ppm)			**Estimated Dose** (mg/kg/day)	**RfD** (mg/kg/day)	**Hazard Quotient Child**		
	Smelter*	City	Remediation Level			Smelter	City	Remediation Level
Arsenic	336	-	-	0.00064	0.0003	2.1	-	-
	-	151	-	0.0019		-	6.3	-
	-	-	20	0.00026		-	-	0.87
	-	-	100	0.0013		-	-	4.3
	-	-	230	0.0029		-	-	9.7
Antimony	82	-	NA	0.00016	0.0004	0.4	-	NA
	-	6	NA	0.000077		-	0.19	
Cadmium	52	-	NA	0.000099	0.001	0.099	-	NA
	-	36	NA	0.00046		-	0.46	
Mercury	1.66	-	NA	0.000003	0.0001 [b]	0.03	-	NA
	-	1.78	NA	0.000023		-	0.23	

b - assumes RfD for methylmercury
* - 95 UCL instead of max concentration for soil 0 – 6 inches

Certification

This Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

Alan Parham
Technical Project Officer, CAT, SPAB, DHAC
ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Roberta Ehrlwein
Team Lead, CAT, SPAB, DHAC
ATSDR