Health Consultation

BNSF Hillyard Lead Site
Spokane, Spokane County, Washington
EPA Facility ID: WAD000812883

March 11, 2005

Prepared by

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

DOH 333-073 March 2005

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.

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Glossary

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.
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.
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**].
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.
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.
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.
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.
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].
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

To evaluate the potential health hazard posed to residents living near Burlington Northern Santa Fe Railway Co. (BNSF) Hillyard lead site Spokane County, Spokane, Washington, by contaminants in soil the Washington State Department of Health (DOH) has prepared this health consultation at the request of the Spokane Regional Health District. DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background and Statement of Issues

In the 1970s, the Burlington Northern Santa Fe Railway Company (BNSF) acquired the former rail yard and railroad right of way (site) from the Great Northern Railroad Company. In the 1980s, facilities at the site were demolished, and the site became vacant. The site is located between 4800 N. Ferrall Street and 5300 N Ferrall Street, in the Hillyard area within the northeastern portion of the city limits of Spokane, Washington (See figure 1). The site is bordered on the south by Wellesley Avenue and is across the street from a dross pile landfill and an asphalt plant. The site is adjacent to an active rail line and commercial activities on the west. Residential properties and vacant land lie east of the site (See figure 2).

In December 2001 and January 2002, Pacific Industrial Resources, Inc., screened and excavated approximately 13,000 cubic yards of soil for use as final cover on the Hillyard Dross landfill cap. The landfill is adjacent to and south of the site. In June 2002, Environmental Management Resources, Inc. (EMR) tested the stockpiled soil and discovered elevated lead concentrations associated with the dark sandy silt material that made up the base of the borrow pile. The overlying light colored silty gravelly sand was not contaminated by lead and was hauled to the Hillyard Dross site for use as cover material. In July 2002, about 8,640 cubic yards of lead-contaminated soil remaining in the pile was fenced and covered with polyethylene.[1, 2]

In June 2002, an additional investigation was conducted to determine the source of the lead-contaminated soil. Surface soil sampling and test pit sampling further determined the extent of the lead-contaminated soil. Lead-contaminated surface soil covers approximately 140,000 square feet and is located adjacent to Ferrall Avenue. The total volume of material remaining in the site is estimated to be 20,000 cubic yards. Soil sample analyses showed lead concentrations between 1,000 and 3,000 parts per million parts of soil (ppm), which is the same as milligrams per kilogram of soil (mg/kg). Toxicity Characteristic Leaching Procedure (TCLP), which is designed to simulate the potential for contaminant leaching in a landfill environment, predicted concentrations ranging from 0.6 milligrams per liter to 1.6 milligrams per liter (mg/l).[1, 2]

A total of 33 surface and subsurface samples was analyzed by X-ray Fluorescence (XRF) screening. Confirmatory analysis was completed on five of the soil samples using Environmental Protection Agency (EPA) method 7000 series with Atomic Absorption Spectrophotometry (AA) analysis. The XRF soil sampling results indicated that lead contamination is present at the site. Surface soil (0-6 inches below ground surface [bgs]) levels of lead ranged from 138 to 3,830 ppm. Lead concentrations in subsurface soil (24 inches bgs) were as high as 4,600 ppm. The AA confirmation analysis conducted on five of the samples showed generally higher values than did the XRF analysis. In general, laboratory analysis provides more accurate results of metal concentrations than does XRF analysis. The XRF analysis results can still be considered in making a public health decision about contamination at a site. On September 11, 2002, Environmental Management Resources Inc. formally notified Ecology that lead-impacted soil was discovered during sampling activities.

In May 2003, GeoEngineers Inc. and Foss Environmental Services Company further investigated the site to define the vertical and lateral extent of the lead contaminated soil.[3] A total of 39 test pits was completed using a systematic grid; 91 soil samples were collected and analyzed for lead and 10 samples were analyzed for arsenic, cadmium, trivalent chromium (III), and hexavalent chromium (chromium VI) (See Appendix A, Table 1).[3] Soil sample analyses showed lead concentrations between 6.49 ppm and 35,400 ppm. The concentrations for the 10 soil samples analyzed for other metals are shown in Table 1. The May 2003 laboratory analytic results will be used to evaluate metal contaminated soils at this site.

Discussion

Metals were found at levels above the Washington State Department of Ecology Model Toxics Control Act (MTCA) cleanup levels for unrestricted land use (See Appendix A, Table 2). The presence of metals (or other chemicals) above cleanup levels does not necessarily represent a threat to public health. People must be exposed to the metals which must enter the body before they can cause harm. Potential exposure pathways are through inhalation, ingestion, and dermal (skin) absorption. Metals are not readily absorbed through the skin, and as a result, dermal absorption of metals is not a concern. Ingestion is the primary route of exposure for metals, particularly with young children. Metals in dust or soil can be ingested accidentally by hand-to-mouth activity that could increase exposure. The migration of metals likely present in dust from the site is of concern considering the proximity of residences and businesses to the site. Children have been observed playing and riding bikes frequently on the site.[4, 5] EMR personnel observed bicycle and foot tracks across the lead-contaminated soil at the area.[1] These observations indicates that area residents could very possibly have been exposed through ingestion or inhalation of metal contaminated soil or dust.

Lead was investigated as the primary contaminant of concern at the site, although limited analysis for arsenic, cadmium, and chromium also revealed these metals at various depths. Lead, arsenic, and cadmium were detected above respective ATSDR comparison values or MTCA cleanup levels in near surface soils (see Appendix A, Table 1, 2, and 3). In subsurface soils (3 - 4 feet bgs), lead and arsenic were detected above respective ATSDR comparison values or MTCA cleanup levels (see Appendix A, Table 1, 2, and 3). Contaminant concentrations exceeding comparison values do not necessarily pose health threats but were evaluated further to determine whether they are at levels that could result in adverse human health effects.

Lead

Lead is a naturally occurring element found at low levels in soils. Background soil lead concentrations in the Spokane Basin range between 7 ppm and 16 ppm.[6] 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 have resulted in substantially higher levels of lead in many areas of 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 for lead exposure in children are ingestion of paint chips, contaminated soil, and house dust, and drinking of water in homes that have lead plumbing.

Children six years old and younger are particularly vulnerable to the effects of lead. Compared with older children and adults, they tend to ingest more dust and soil, absorb substantially more of the lead they swallow, and incorporate more of the lead they absorb into their developing brains. Pregnant women and women of childbearing age should also be aware of lead in their environment because lead ingested by a mother can affect her 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 micrograms of lead per deciliter (µg/dl) for every 1,000 ppm lead increase in soil or dust concentration.[7] 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 µg/dl.[8] However, evidence is growing 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 % of children in the United States 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.[9]

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.[9] 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 substantial rise in blood lead level.[10]

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 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.[11] 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 predict accurately the blood lead level of a child (or a small group of children) at a specific time. In part, this is because an individual child (or group of children) may behave differently than the average group of children the model uses to calculate blood lead levels and therefore have different amounts of exposure to contaminated soil and dust. 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 it can provide information about the hazards of environmental lead exposure.

For children who are exposed regularly 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 associated with health problems (usually 10 µg/dl).

Soil lead concentration and estimated blood lead level

The IEUBK model was used to estimate the percentage of children that could have elevated blood lead levels if they play frequently in areas that have lead contamination and exhibit typical behaviors that result in soil ingestion. 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 only likely to have regular exposure to soil containing less than the maximum amount of lead. Nonetheless, these estimates are useful in determining the potential hazard for children who may be exposed to the most contaminated areas.

The maximum concentration of lead detected in surface soil (0-12 inches) was 35,400 ppm. The calculated soil lead concentration (0-12 inches) at the 95 % upper confidence limit (UCL) is 4,090 ppm. Quantifying the health hazard at this site is difficult because no information is available about how often and where children play on the property. Although children are unlikely to be at the site every day, lead concentrations are sufficiently high in some areas to be of concern.

A more realistic exposure scenario of two days a week at the site and the 95 % upper confidence limit (UCL) was used to calculate the soil lead concentration (4,090 ppm) in 0-12 inches soil at the site. DOH assumed that children were exposed at the site for two days a week and at the 200 ppm IEBUK default level for five days a week. This exposure scenario yielded an estimated soil lead concentration of 1,311 ppm for use in the model. Using this scenario, the model predicts an average blood lead level of 11.4 µg/dl for children six years of age and under. The model also predicts elevated blood lead levels (above 10 µg/dl) in about 61 % of children who have regular exposure to soil containing 1,311 ppm lead.

Because the site is surrounded by residential properties, the possibility exists that lead will potentially migrate from the site to residential house dust or soil.

Future residential site scenario

Under a future residential site scenario and using the calculated 95 % upper confidence limit (UCL) for soil lead concentration (4,090 ppm) in 0-12 inches soil at the site. The model predicts an average blood lead level of 23.9 µg/dl for children six years of age and under. The model also predicts elevated blood lead levels (above 10 µg/dl) in about 97 % of children who have regular exposure to soil containing 4,090 ppm lead.

Arsenic

Arsenic is a naturally occurring element in the earth's soil. Background soil arsenic concentration in the Spokane Basin ranges from 1 ppm to 10 ppm.[3] The two forms of arsenic are organic and inorganic. EPA classifies the inorganic form of arsenic as a human carcinogen. Inhaled arsenic is quickly absorbed by the lungs, stomach, and intestines, and enters the bloodstream. Some arsenic entering the body is converted to a less toxic form by the liver and excreted in the urine.[12] Arsenic absorption through the skin is not normally an important pathway for arsenic from contaminated soil.

Noncancerous effects

To evaluate possible noncancerous effects from assumed ingestion exposure to the maximum level of arsenic in site soil, an exposure dose was calculated and compared with ATSDR's minimal risk level (MRL) and EPA's oral reference dose (RfD). RfDs and MRLs are doses below which adverse noncancerous health effects are not expected to occur. A level of uncertainty exists when defining an MRL or RfD because of uncertainty about the quality of data on which it is based. To account for this uncertainty, "safety factors" are used to set RfDs and MRLs below actual toxic effect levels (e.g., No Observed Adverse Effect Level [NOAEL]). This approach provides an added measure of protection against the potential for adverse health effects to occur. For acute oral exposure to arsenic, the MRL is 0.005 milligrams per kilogram per day (mg/kg/day). For chronic oral exposure to arsenic, the MRL is 0.0003 mg/kg/day.

The maximum concentration of arsenic (237 ppm) in the soil exceeds the ATSDR health comparison values of 20 ppm for children and 200 ppm for adults. An exposure scenario of two days a week at the site with exposure to 237 ppm was used in dose calculations in Appendix B (Table 4 and 5). A child would receive an exposure dose of 0.0008 mg/kg/day, which is lower than the acute MRL of 0.005mg/kg/day but higher than the chronic MRL of 0.0003mg/kg/day. An adult would be exposed to approximately 0.00004 mg/kg/day of arsenic, which is lower than both the acute MRL and chronic MRL. Because estimated doses for children and adults are below the acute MRL, noncancerous harmful effects are unlikely to occur from acute exposures. Exceeding an MRL or RfD doesn't mean that harmful effects are likely. It means that further toxicologic evaluation is necessary by comparing the estimated doses in residents to doses known to cause harmful effects. For a child, the estimated exposure dose is about two times below the NOAEL identified in chronic studies. However, the arsenic NOAEL is based on chronic exposure to arsenic in water, and not arsenic in soil. Therefore, harmful effects are unlikely in children and adults because exposures are far below levels known to cause harmful effects. Studies have shown no dermal or other effects to people exposed to arsenic in drinking water at chronic doses of 0.0004 to 0.01 mg/kg/day. Arsenic is less available in soil than in water. The actual exposure dose is likely lower, because some arsenic entering the body is converted by the liver to a less toxic form and is excreted in the urine.

Cancerous effects

EPA classifies arsenic as a Group A (known human) carcinogen by the oral and inhalation routes. The maximum concentration of arsenic in the soil (237 ppm) is 474 times above the Cancer Risk Evaluation Guide (CREG) of 0.5 ppm. To assess exposures at this site, demolition of the former facilities is assumed to have occurred in 1980 and the land has been vacant since that time. An exposure dose was calculated for a child growing to adulthood over a 23-year exposure period with two days a week exposure at the site (Appendix B. Table 6). The theoretical increased cancer risk for such a person is estimated at about 1 additional cancer in a population of 10,000 persons exposed to this level of arsenic. DOH considers this to be a low increased cancer risk.

Cadmium and chromium

Cadmium, chromium (III) and chromium (VI) concentrations were detected in soil onsite, but did not exceed their respective ATSDR health comparison values (See Appendix A - Table 3). Contaminant concentrations below ATSDR comparison values are unlikely to pose health threats, and were thus not evaluated further in this health consultation.

Other possible contaminants

Because of the nature of the site and the fact that site soil was visibly stained, other contaminants, such as total petroleum hydrocarbons (TPHs) and volatile organic compounds (VOCs), are also likely present. As a result, DOH including TPHs and VOCs in any subsequent environmental sampling is appropriate.

Child Health Considerations

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

- 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 lead exposure per body weight.
- Children are shorter than adults, therefore they have a higher possibility of breathing 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 that have contamination of their water, food, soil or air.

Conclusions

A public health hazard exists for children exposed in a two days a week exposure scenario to contaminants present at the BNSF Hillyard lead site, specifically to high concentrations of lead present in soil.

If the site becomes residential properties, future public health hazard exists for children exposed to contaminants present at the BNSF Hillyard lead site, specifically to high concentrations of lead present in the soil.

An indeterminate health hazard exists for nearby residents because of potential migration of lead from the site to residential house dust or soil.

Recommendations

1. Until the site is either cleaned or fenced, children should not be permitted access to the site. Signs should also be posted to indicate the hazards posed by the site.

2. The site should be re-sampled for TPHs and VOCs because it was formerly a rail yard.

3. DOH recommends that children who have played at the site be screened for blood lead by their local physician to determine whether exposure to lead is occurring at levels of public health concern.

Public Health Action Plan

1. DOH will follow up with Ecology to assure that subsequent environmental sampling at the Hillyard site includes analysis for TPHs and VOCs. Subsequent environmental testing results should be provided to DOH for evaluation.

2. DOH will follow up with Ecology to make sure that signs indicating the hazards at the site are posted until the site is more extensively evaluated and cleaned.

3. DOH will coordinate with Ecology to assure that subsequent sampling plans and sampling data are forwarded to DOH for evaluation. Subsequent environmental testing results should be provided to DOH for evaluation.

4. DOH will coordinate with Ecology and the Spokane Regional Health District to develop educational materials for residents about the hazards posed by exposure to lead in soil and the steps that can be taken to reduce exposure.

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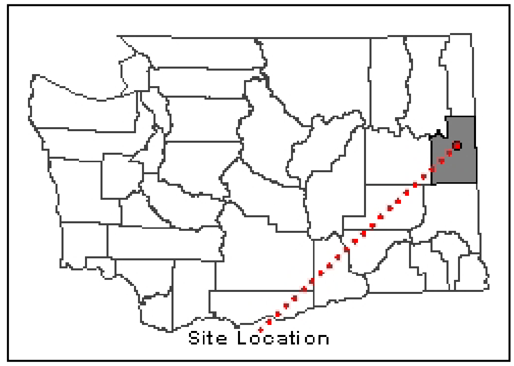
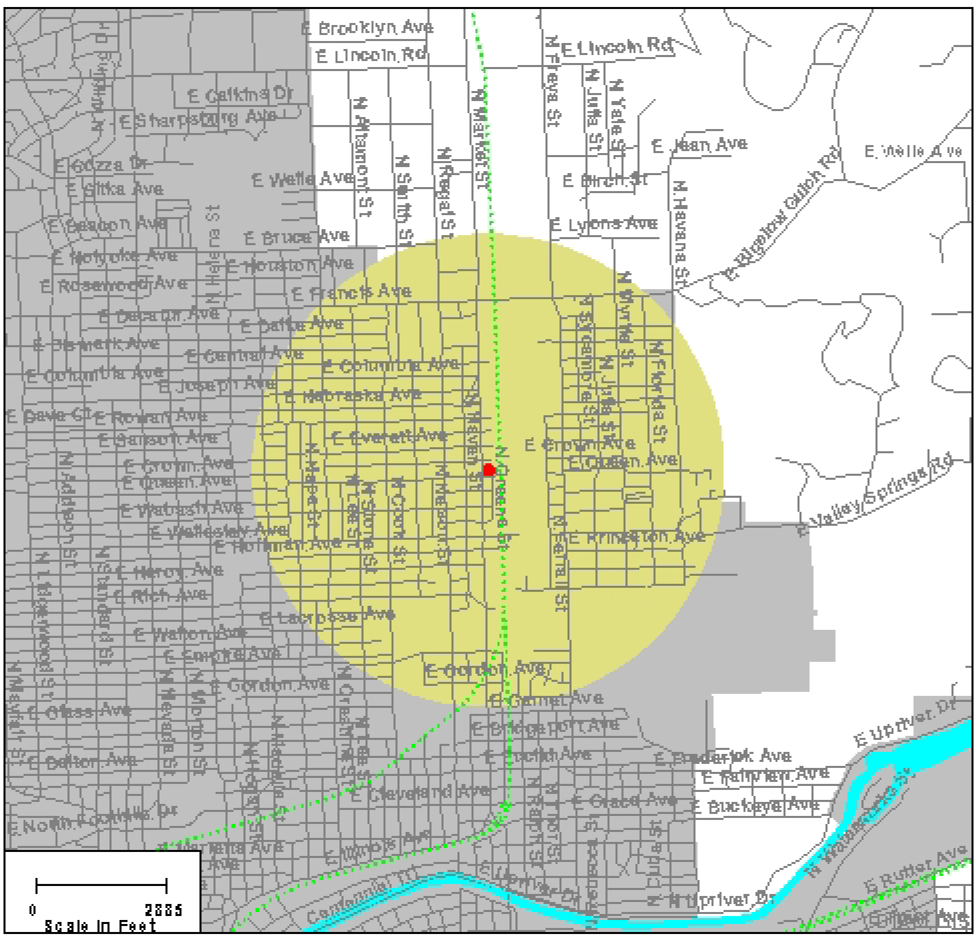
Figure 1. Demographic Statistics within One Mile of the Site* - Hillyard area, Spokane County, Washington.

Total Population	**10198**
White	**8977**
Black	**181**
American Indian, Eskimo, Aleut	**284**
Asian or Pacific Islander	**224**
Other Race	**104**
Hispanic Origin	**260**
Children Aged 6 and Younger	**1184**
Adults Aged 65 and Older	**1110**
Females Aged 15 - 44	**2314**
Total Aged over 18	**7067**
Total Aged under 18	**3131**
Total Housing Units	**4282**





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

Figure 2: Arial photograph of Hillyard area, Spokane, Washington, showing the lead contaminated site, July 16, 1995.

Appendix A

Table 1. Range of contaminant concentrations measured in soil at the Former Hillyard Rail yard site, Spokane, Washington (May 2003).

Contaminant	Sample Depth	Concentration Range (ppm)	Number of Samples
Lead	Surface (0 – 1 foot)	26.5 – 35,400	42
	Shallow (3 – 4 feet)	5.95 – 2,430	38
	Deep (6 – 9.5 feet)	7.60 - 118	11
Arsenic	Surface (0 – 1 foot)	< 5.00 – 237	6
	Shallow (3 – 4 feet)	< 5.00 – 7.27	3
	Deep (6 – 9.5 feet)	< 5.00	1
Cadmium	Surface (0 – 1 foot)	< 0.500 – 8.00	6
	Shallow (3 – 4 feet)	< 0.500	3
	Deep (6 – 9.5 feet)	< 0.500	1
Chromium (III)	Surface (0 – 1 foot)	7.50 – 43.80	6
	Shallow (3 – 4 feet)	5.52 – 13.00	3
	Deep (6 – 9.5 feet)	11.30	1
Chromium (VI)	Surface (0 – 1 foot)	1.06 – 4.04	6
	Shallow (3 – 4 feet)	< 1.00	3
	Deep (6 – 9.5 feet)	< 1.00	1

Table 2. Washington State Model Toxics Control Act Cleanup Levels for selected contaminants, Hillyard lead site, Spokane, Washington.

Contaminant	Maximum concentration (ppm)	Cleanup Level (ppm)	Screening value reference
Lead	35,400 4,090 †	250	MTCA (A)
Arsenic	237	20	MTCA (A)
Cadmium	8	2	MTCA (A)
Chromium (III)	43.8	2,000	MTCA (A)*
Chromium (VI)	4.04	19	MTCA (A)*
Chromium (total)	Not analyzed	100	MTCA (A)

MTCA (A) - Model Toxics Control Act Method A - Soil Cleanup Level for Unrestricted Land Use
MTCA (A)* - Proposed Model Toxics Control Act Method A - Soil Cleanup Level for Unrestricted Land Use
† 95 UCL instead of maximum concentration for soil 0 – 12 inches

Table 3. Maximum concentrations of contaminants detected in soil and their comparison values at the Former Hillyard Rail yard site, Spokane, Washington.

Contaminant	Maximum concentration (ppm)	Comparison value (ppm)	EPA cancer class	Comparison value reference
Lead	35,400 4,090 †	-	B2	-
Arsenic	237	0.5 20 200	A	CREG EMEG (child) EMEG (adult)
Cadmium	8	10	B1	EMEG
Chromium (III)	43.8	80,000	D	RMEG
Chromium (VI)	4.04	200	A	RMEG

EMEG – ATSDR's Environmental Media Evaluation Guide
CREG - ATSDR's Cancer Risk Evaluation Guide
RMEG – ATSDR's Reference Dose Media Evaluation Guide
† 95 UCL instead of maximum concentration for soil 0 – 12 inches

APPENDIX B

Population exposure scenarios were evaluated for soils at the Hillyard lead site Spokane Washington. Exposure assumptions given below in Table 4 were used with the following equations to estimate contaminant doses associated with soil exposure.

$$\text{Dose}_{(\text{non-cancer (mg/kg-day)}} = \frac{\text{C x CF x IR x EF X ED}}{\text{BW x AT}_{\text{non-cancer}}}$$

$$\text{Dose}_{(\text{cancer (mg/kg-day)}} = \frac{\text{C x CF x IR x EF X ED}}{\text{BW x AT}_{\text{cancer}}}$$

Table 4. Exposure assumptions for estimating contaminant doses from soil exposure at Hillyard lead site Spokane Washington

Parameter	Value	Unit	Comments
Concentration (C) – maximum	237	ppm (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 (EF)	104	Days/year	Two days a week
Exposure Duration (ED)	23 (5, 10, 8)	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		0-5 year-old child average body weight
Averaging Time$_{\text{non-cancer}}$ (AT)	1825	days	5 years
Averaging Time$_{\text{cancer}}$ (AT)	27375	days	75 years
Cancer Potency Factor	1.5	mg/kg-day^{-1}	Source: EPA

Soil Ingestion Route of Exposure – Non-cancer

Table 5. Estimated dose calculations from exposure to arsenic in soil sampled from BNSF Hillyard lead site - Spokane County, Washington.

Contaminant	**Concentration** **(ppm)**	**EPA cancer Group**	**Estimated Dose** (mg/kg/day)		
			Child	Older Child	Adult
Arsenic	237	A	0.000848	0.000079	0.0000449

Soil Ingestion Route of Exposure - Cancer

Table 6. Health risk exposure calculations for arsenic in soil samples from BNSF Hillyard lead site - Spokane County, Washington.

Chemical	**Max Concent ration** **(ppm)**	**EPA cancer Group**	**Ingested dose Exposure** (mg/kg/day)			**Cancer Potency Factor** (mg/kg-day^{-1})	**Increased Cancer Risk**			**Cancer Risk** Exposure starting at childhood *
			Child	Older Child	Adult		Child	Older Child	Adult	
Arsenic	237	A	5.66E-5	1.05E-5	8. 98E-6	1.5	8.48E-5	1.58E-5	1.35E-5	1.14E-4

* – assumes 23 year exposure beginning as a child

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.

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

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