Health Consultation

Evaluation of Soil Contamination

PROGRESS ELEMENTARY SCHOOL
710 NORTH PROGRESS ROAD

VERADALE, WASHINGTON

JUNE 21, 2007

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

Health Consultation: A Note of Explanation

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

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared by:

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

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:

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For persons with disabilities this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (voice) or 1-800-833-6388 (TTY/TDD).

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.
Absolute bioavailability	Is the amount of a substance entering the blood via a particular route of exposure (e.g., gastrointestinal) divided by the total amount administered (e.g., soil lead ingested).
Bioavailability	The fraction of lead or arsenic that is absorbed and enters the blood by whatever portal-of-entry compared with the total amount of lead or arsenic acquired.
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**].
Geographic information system (GIS)	A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contamination within a community in relation to points of reference such as streets and homes.
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.
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.
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 apparent 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.

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 EMEG is a *comparison value* used to select contaminants of potential health concern and is based on EPA's oral reference dose (RfD).
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].

Summary

This health consultation was prepared at the request of the Washington State Department of Ecology (Ecology) and the Spokane Regional Health District (SRHD) for Progress Elementary School. The purpose of this health consultation was to evaluate whether contaminants found in school playground soils pose a health concern to children and residents in the nearby community. The results of this evaluation indicate that health risks from this exposure are expected to be relatively low.

Purpose

The Washington State Department of Health (DOH) prepared this health consultation at the request of the Washington State Department of Ecology (Ecology) and the Spokane Regional Health District (SRHD) for Progress Elementary School. The purpose of this health consultation is to evaluate whether contaminants found in school playground soils pose a health concern to children and residents in the nearby community. DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background and Statement of Issues

Elevated concentrations of arsenic (As) and lead (Pb) exist in soil from historical (pre 1948) use of lead arsenate pesticide, particularly in apple and pear orchards in Eastern Washington.[1] Moderate levels of lead and arsenic are present in soils of Progress Elementary School, Spokane - Washington.

The Progress Elementary School is located in a residential area on the North East of the Spokane Valley, Spokane County, Washington (Figure 2). There are a total of 309 students in the Progress Elementary School (Kindergarten through grades 5, the age range corresponds to 5 to 12 years old). The Central Valley School District owns this property, which historically was used as an orchard land where pesticides containing lead and arsenic were used. The school yard consists of several play areas, sport fields, landscaped grounds, and parking/access areas. Play areas are generally well-maintained, with good grass cover, gravel, or other barrier to native soil (Figure 3).

Composite surface soil sampling (0-18 inches) at Progress Elementary School was conducted on April 5, 2005, and confirmatory sampling on June 23, 2005, by the state Department of Ecology and Spokane Regional Heath District. Samples collected from the school playgrounds were analyzed by Inductively Coupled Plasma (ICP) – laboratory analysis for total metals by two state certified analytical laboratories. Soil lead and arsenic concentrations were above background levels in both surface and subsurface samples. DOH used mean and UCL 95 percent values of Pb and As from both sampling dates to assess children's exposure to contaminated soils at Progress Elementary School.

Ecology's interim action levels (IALs) apply to low-to-moderate level soil contamination dispersed over a large geographic area covering several hundred acres to many square miles. For schools, childcare centers, and residential land uses, in general, Ecology considers total arsenic concentrations of between 20 and 100 milligrams per kilogram (mg/kg) and total lead concentrations of between 250 and 500 mg/kg to be within the low-to-moderate range.[1]

Concentrations from 0 – 18 inches were selected for assessment rather than data from other depths for several reasons. Soil samples were obtained by removing the sod cover and obtaining a sample from a depth of 0-6 inches and another at 12-18 inches. The distribution of contaminants in the school's playgrounds is not homogeneous across the site with some hot spots found throughout the area in surface and sub-surface soil. Also, the distribution of contaminant concentrations varied with depth from site to site, with some areas having higher concentrations at the surface and others with higher concentrations at lower depths.

The redistribution of surface-applied Pb and As within orchard soils is limited; decades after the application of arsenical pesticides, the highest concentrations of Pb and As generally remain in the top 10 inches of contaminated soils. Thus, samples composited over the 0 – 18 inch depth are likely to reflect exposure conditions at this site considering uncertainties associated with contaminant distribution. Figure 1 shows mean sample distribution of lead and arsenic at Progress Elementary School.

Discussion

Lead is below the Washington state MTCA Method A soil cleanup and Ecology's IALs, and arsenic mean soil concentration exceeds MTCA at 51 sampling locations (Table 1). This discussion will focus on potential health impacts from exposure to arsenic in soil at Progress Elementary School.

Figure 1. Mean sampling distribution at different depths, Progress Elementary School, Spokane, Washington.

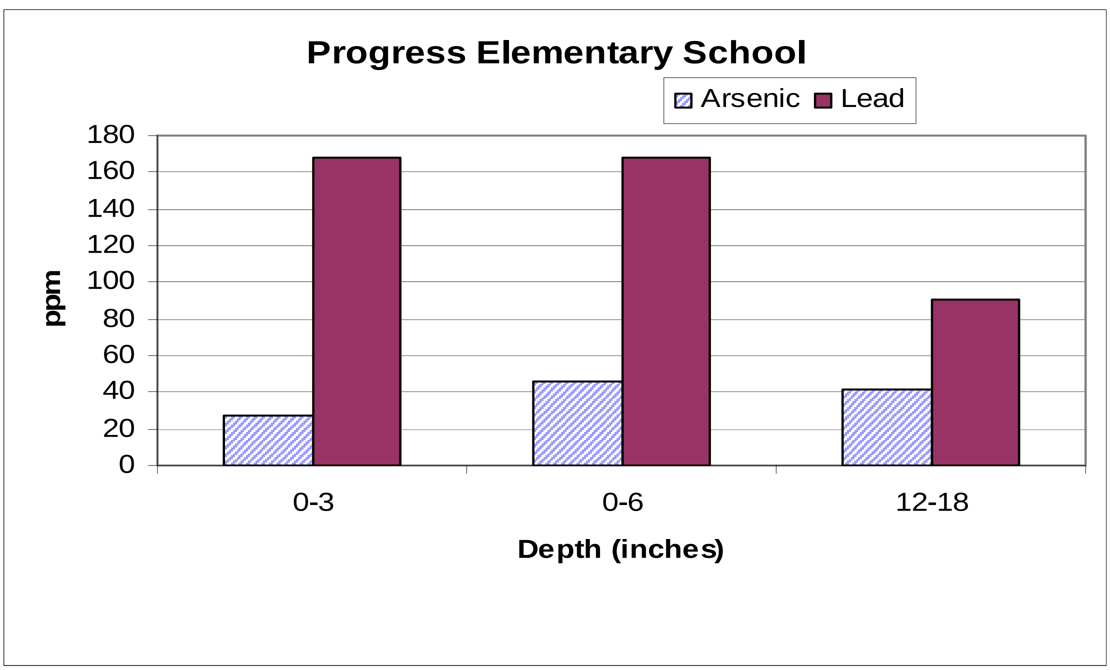

Table 1 shows a screening table for contaminants detected in Progress Elementary School.

Table 1. Range values of contaminants detected in soil and their respective comparison values (CV) at Progress Elementary School, Spokane, Washington.

Contaminant	N	Range in (mg/kg)	95% UCL (mg/kg)	Mean (mg/kg)	Non-Cancer CV (mg/kg)	Cancer C V (mg/kg)	MTCA Method A cleanup levels (mg/kg)	Ecology Interim Action Levels (mg/kg)
Lead	59	9.4 – 643	169.5	139.3	NA	NA[c]	250	500
Arsenic	59	14.3 – 106	44.1	39.6	20[a]	0.5[b]	20	100

[a] EMEG – ATSDR's Reference Dose Media Evaluation Guide (child)
[b] CREG – ATSDR's Cancer Risk Evaluation Guide (child)
[c] Lead and lead compounds are reasonably anticipated to be human carcinogen [2]
NA – Not applicable

Arsenic is the only identified contaminant of concern at Progress Elementary School. At many locations on the property, levels of arsenic exceeded the ATSDR health comparison values for arsenic (20 mg/kg for non-cancer and 0.5 mg/kg for cancer values), and the MTCA Method A cleanup levels for unrestricted land use (i.e., 20 mg/kg for arsenic). Arsenic levels did not exceed Ecology's interim action levels for schools (i.e., 100 mg/kg for arsenic) (Table 1). Contaminant concentrations exceeding these comparison values do not necessarily pose health threats but are evaluated further to determine whether they are at levels of human health concern.

No comprehensive study has been undertaken to find the levels or extent of contamination in soil on properties currently and formerly used as orchards in Spokane. Studies to correlate health problems in children with lead and arsenic exposure from old orchard lands have not been conducted.

Current exposures to Lead and Arsenic at Progress School

The presence of chemicals above cleanup levels does not necessarily represent a threat to public health. People must be exposed to the chemicals which must enter the body before they can cause harm. Potential exposure pathways are inhalation, ingestion, and dermal absorption (through the skin). Metals are not readily absorbed through the skin, so dermal absorption of lead and arsenic is not a significant concern at the concentrations found at Progress Elementary School. Ingestion of contaminated soil is expected to be 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. Pica behavior, that is, intentionally eating non-food items, may increase this exposure for some children. Pica is most common in children 1 to 2 years old, but some older children and adults also have the behavior. The potential for high levels of lead and arsenic in dust from old orchard land is not just limited to the school property, but is also possible at residences in the area.

Ingestion or inhalation of wind-blown soil or dust are additional pathways of exposure to lead and arsenic in the Spokane Valley area. Children are considered a sensitive population because they tend to ingest more soil and dust than adults and because they tend to absorb more of the lead they ingest.

The risk of harm depends on the amount and type of exposure people have to the lead and arsenic. At Progress Elementary School exposures are difficult to estimate, because they are influenced by children's behaviors and by the levels of contaminants at areas where children spend time, neither of which have been characterized very well. When such uncertainties exist, it is common practice to estimate exposures using the 95 percent upper confidence limit (95 percent UCL) of the mean of the measured sample concentrations in order to protect public health. An alternative is to use the mean of the measured sample concentrations, but that may not reliably reflect the full extent of the exposure for many children. For Progress Elementary School, risks will be calculated for both the mean and the 95 percent UCL of arsenic.

Using the 95 percent UCL instead of the mean value is considered acceptable in this case, because of the uncertainty regarding arsenic and lead levels surrounding the school fields.

While grass cover cannot be considered an adequate long-term barrier to exposure, it is expected to provide some exposure reduction until a long-term solution is implemented for this site (i.e., removal of most of the contaminated soil).

Past exposures at Progress Elementary School

Incidental ingestion of contaminated surface soil is the predominant lead and arsenic exposure pathway at contaminated playgrounds in the school. An additional exposure pathway of lead and arsenic is also the inhalation of wind-blown soil or dust from the school playgrounds. It is unknown whether past exposures (incidental or inhalation) have occurred at Progress Elementary School. Nonetheless, if conditions were similar today or worse, past exposure could have occurred. The DOH is not aware of past school playground conditions to determine whether past exposure has occurred.

Chemical specific toxicity

Arsenic

Arsenic is a naturally occurring element in the earth's soil. Background soil arsenic concentration in the Spokane Basin ranges from 1.13 mg/kg to 10.32 mg/kg.[3] EPA classifies the inorganic form of arsenic as a human carcinogen. Ingested arsenic is typically absorbed by the intestines and enters the bloodstream where it is distributed throughout the body. Inhaled arsenic is quickly absorbed by the lungs and enters the bloodstream. Arsenic is poorly absorbed through the skin, so skin contact with contaminated soil is not normally an important pathway for harmful exposure.

Cancerous effects

Arsenic has been shown to increase people's risk of developing several types of cancer including lung, bladder, skin, kidney and liver cancer. This document describes cancer risk that is attributable to site-related contaminants in qualitative terms like high, low, very low, slight and no significant increase in cancer risk. These terms can be better understood by considering the population size required for site-related exposures to result in a single cancer case. For example, a low increase in cancer risk indicates an increased risk of about one cancer case per ten thousand persons exposed over a lifetime. A very low risk is about one cancer case per several tens of thousands exposed over a lifetime and a slight risk would require an exposed population of several hundreds of thousands to result in a single case. DOH considers cancer risk to be not significant when the estimated result is less than one cancer per one million exposed over a lifetime. The reader should note that these estimates are for excess cancers that might result in addition to those normally expected in an unexposed population.

EPA classifies arsenic as a Group A (known human) carcinogen by the oral and inhalation routes. The 95 percent UCL for arsenic in the soil (44 mg/kg) exceeds the ATSDR Cancer Risk Evaluation Guide (CREG) of 0.5 mg/kg. An exposure dose was calculated for a child over a 5-year exposure period with five days a week exposure at the site (180 days per year). The calculated theoretical increased cancer risk for such an exposure is estimated at about 3 additional cancers in a population of 100,000 persons (school-age children of 5 to 6 and 7 to 12 years old) (Appendix A, Table A3). DOH considers this to be a low increased cancer risk over a short period of time (6 months - 180 days - corresponds to the school instructional calendar). The cancer risk for an adult teacher or neighborhood adult playground user would be approximately 2 cancers in a population of 100,000 persons, also considered a low increased cancer risk.

The true cancer risks at this site cannot be determined due to variability and uncertainty in several parameters. The calculated risks are estimates based on available information and could be higher or lower than the true risk.

Uncertainty

Although there is some uncertainty surrounding the magnitude of the carcinogenic potential of arsenic, there is a strong scientific basis for choosing a slope factor that is different from the value (1.5 per mg/kg-day) currently listed in the EPA IRIS database. Several recent reviews of the literature have evaluated bladder and lung cancer endpoints instead of skin cancer (which is the endpoint used for the current IRIS value):

- National Research Council (2001)[4]
- EPA Office of Drinking Water (2001)[5]
- Consumer Product Safety Commission (2003)[6]
- EPA Office of Pesticide Programs (2003)[7]
- California Office of Environmental Health Hazard Assessment (2004)[8]
- EPA IRIS Review Draft for the SAB (2005)[9]

Information provided in these reviews allows the calculation of slope factors for arsenic which range from 0.4 to 23 per mg/kg-day (but mostly greater than 3.7). The recent EPA IRIS review draft presented a slope factor for combined lung and bladder cancer of 5.7 per mg/kg-day. The slope factor calculated from the work by the National Research Council is about 21 per mg/kg-day. These slope factors could be higher if the combined risk for all arsenic-associated cancers (bladder, lung, skin, kidney, liver, etc.) were evaluated. For this Health Consultation, DOH used a slope factor of 5.7 per mg/kg-day, which appears to reflect EPA's most recent assessment.

Child Health Considerations

Children's school exposure scenarios were evaluated in this document to determine if children's exposure were of public health concern. 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 children as the most sensitive population being exposed.

It is expected that children will be present throughout the school year and may use the outdoor playgrounds and other facilities even when school is not in session. Children's activities on the school property and residential homes may result in frequent, significant exposure to soil contaminants. The implementation of interim remedial actions at the site will help reduce or prevent children from making contact with the contaminated soil that remains on-site. However, children, who are most susceptible to the contamination, may also be exposed at home where potentially high levels of lead and arsenic may be present in the soil.

Conclusions

Based on available information contained in this health consultation, DOH has reached the following conclusions:

1. Concentrations of arsenic in soil at Progress Elementary School exceed health-based comparison values including MTCA cleanup levels.

2. Although some students and staff are likely to be exposed to contaminated soil on the property, the health risks from this exposure, while not zero, are expected to be relatively low. However, because arsenic concentrations and estimated cancer risks exceed the goals specified by the health-based MTCA soil arsenic cleanup level, prudent public health measures centered on prevention are needed to ensure the continued protection of public health.

3. Ecology has chosen to be proactive and reduce risks to children by remediating soil lead and arsenic contamination. DOH supports this decision because reduction of exposure by cleaning up releases of hazardous materials is preferable to treating preventable illnesses after they occur. This cleanup effort for schools is part of the Governor's "Healthy Washington" initiative. DOH is working in partnership with Ecology to address environmental cleanup actions and long-term health risks when children play in contaminated soils.

4. Data are unavailable for additional exposure scenarios such as those at home and child day cares for the same children who attend this school. It is likely that some homes near the school were built on old orchard lands and the yards could have elevated levels of arsenic and lead. The full extent of soil contamination in residential areas that Progress Elementary School serves is unknown, because these areas have not been sampled. Consequently, DOH is unable to evaluate the added risks from lead and arsenic contamination in residential areas that may have been built on old orchard lands.

Recommendations

1. The health risks of children playing in contaminated soil at Progress Elementary School are relatively low. However, because arsenic concentrations are higher than Washington's health-protective cleanup levels, recommendations to reduce exposure are considered prudent public health practice.

2. DOH recommends discouraging children from playing in areas that have bare soil or that are known to have higher concentrations of lead and arsenic.

DOH is available to assist the school to conduct outreach and education activities, as appropriate, and provide concerned citizens with health education information. These activities may include a poster presentation to be displayed at a public location, site-specific fact sheets, or attendance at public meetings. Materials and activities will be appropriate for the age and education level of the intended audience.

Public Health Action Plan

1. The Department of Ecology is available to assist the school district with the implementation of remedial activities to reduce exposure of kids to contaminants on-site.

2. DOH, Spokane Regional Health District and school officials will conduct outreach and education activities, as appropriate, to provide concerned citizens with health education information. These activities may include a poster presentation to be displayed at a public location, site-specific fact sheets, or attendance at public meetings. Materials and activities will be appropriate for the age and education level of the intended audience.

3. Exposure to contaminants at the school and residential properties can be reduced if children and adults follow the soil safety guidelines below.

- Use plenty of soap and water
    - Wash your hands after playing or working outside, especially before eating.
    - Launder heavily soiled clothing separately.
    - Wash children's toys, bedding and pacifiers frequently.

- Garden safely
    - Wear gloves while gardening and wash vegetables before eating them.
    - Cover up exposed soil in your yard by growing grass on it or cover with mulch.
    - Avoid muddy soil that cling to clothing, toys, shoes, hands or feet.

- Mop, dust and vacuum

    - Wash anything that has come in contact with soils before entering your home.
    - Implement regular damp mopping to avoid breathing indoor housedust.
    - Vacuum carpets and rugs frequently, plus wet mop and/or wet dust all other surfaces in your home.
    - Remove shoes before entering your home to avoid tracking soil into your house.

- Keep pets clean

    - Wipe down pets before you let them inside.
    - Keep your pets clean. Brush and bathe them regularly.
    - Restrict your pets to areas of your home that are free from carpeting and upholstery. Give pets their own sleeping spots.

- Eat a healthy diet

    - Eat healthy. Foods that contain the daily recommended amounts of iron and calcium help to decrease the absorption of lead.
    - Prevent children from eating dirt.

This information will be distributed to parents and community residents living within the school boundaries of Progress Elementary School. The school district and DOH will notify them about these simple steps to reduce and limit exposure to soils at school and at home.

- DOH will be available to consult on the appropriateness and efficacy of future remedial actions.

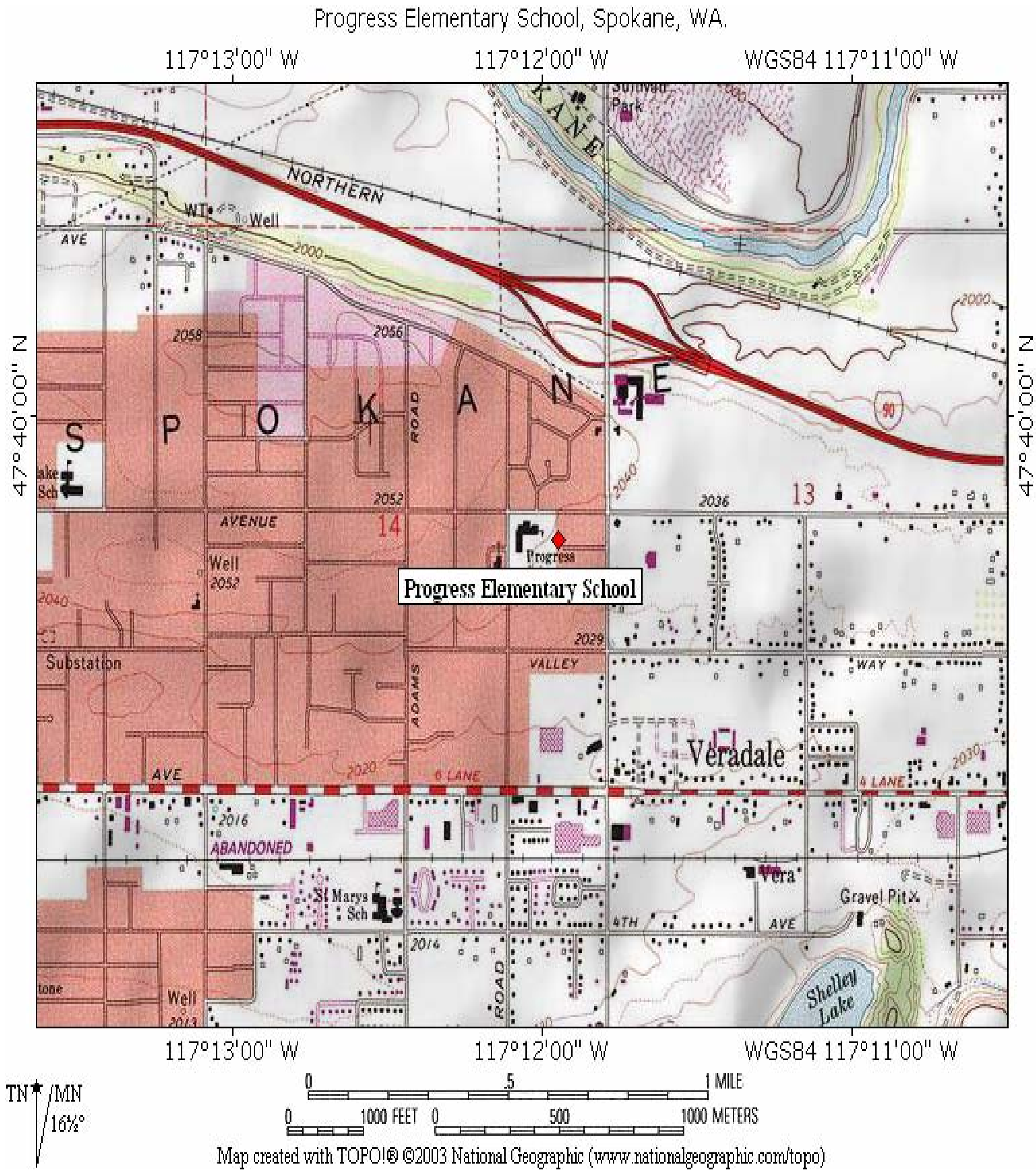

Figure 2. Map of Progress Elementary School, Spokane, Washington.

Figure 3. Aerial photo of Progress Elementary School, Spokane, Washington.

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Reference

1. Washington State Department of Ecology. 2003. Area-Wide Soil Contamination Task Force Report. http://www.ecy.wa.gov/programs/tcp/area_wide/Final-Report/PDF/TF-Report-final.pdf

2. National Toxicology Program, Department of Heath and Human Services. 11th Report on Carcinogens (RoC), Lead and Lead Compounds. 1-31-2005. 11th.

3. Toxics Cleanup Program Washington State Department of Ecology. Natural Background Soil Metals Concentrations in Washington State. 2004. 94-115.

4. National Research Council. Arsenic in Drinking Water: 2001 Update. 2001.

5. U.S. Environmental Protection Agency. National Primary Drinking Water Regulations; Arsenic and Clarifications to Compliance and New Source Contaminants Monitoring; Final Rule. 1-16-2001.

6. Consumer Product Safety Commission. Briefing Package. Staff Recommendation to Ban Use of Chromated Copper Arsenate (CCA)-Treated Wood in Playground Equipment (Petition HP 01-3). 2-1-2003.

7. U.S. Environmental Protection Agency. A probabilistic Risk Assessment for Children Who Contact CCA-Treated Playsets and Decks. 11-10-2003.

8. California Environmental Protection Agency. Public Health Goals for Arsenic in Drinking Water. 4-1-2004.

9. U.S.Environmental Protection Agency. 4-10-1998. Integrated Risk Information System, Arsenic, Inorganic. http://www.epa.gov/iris/subst/0278.htm

10. U.S.Environmental Protection Agency. Child-Specific Exposure Factors Handbook. 1-9-2002. EPA-600-P-00-002B.

11. Environmental Protection Agency. 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). http://www.epa.gov/oswer/riskassessment/ragse/pdf/2004_1101_part_e.pdf

Appendix A

This section provides calculated exposure doses and assumptions used for exposure to chemicals in soil at the Progress Elementary School site. Three different exposure scenarios were developed to model exposures that might occur at the site. These scenarios were devised to represent exposures to 1) a child (5-12 yrs old) and 2) an adult teacher. The following exposure parameters and dose equations were used to estimate exposure doses from direct contact with chemicals in soil.

Exposure to chemicals in soil via ingestion, inhalation, and dermal absorption.

Total dose $_{\text{(non-cancer)}}$ = Ingested dose + inhaled dose + dermally absorbed dose

Ingestion Route

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

$$\text{Cancer Risk} = \frac{\text{C x CF x IR x EF x CPF x ED}}{\text{BW x AT}_{\text{cancer}}}$$

Dermal Route

$$\text{Dermal Transfer (DT)} = \frac{\text{C x AF x ABS x AD x CF}}{\text{ORAF}}$$

$$\text{Dose}_{\text{(non-cancer (mg/kg-day)}} = \frac{\text{DT x SA x EF x ED}}{\text{BW x AT}_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{\text{DT x SA x EF x CPF x ED}}{\text{BW x AT}_{\text{cancer}}}$$

Inhalation of Particulate from Soil Route

$$\text{Dose}_{\text{non-cancer (mg/kg-day)}} = \frac{\text{C x SMF x IHR x EF x ED x 1/PEF}}{\text{BW x AT}_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{\text{C x SMF x IHR x EF x ED x CPF x 1/PEF}}{\text{BW x AT}_{\text{cancer}}}$$

Table A1. Exposure Assumptions for exposure to arsenic in soil at Progress Elementary School site – Spokane, Washington.

Parameter	Value	Unit	Comments
Concentration (C)	44 and 40	mg/kg	95% UCL detected value, and mean value respectively
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 [10]
Ingestion Rate (IR) – older child (5-6 yrs. old)	200		
Ingestion Rate (IR) – child (7-12 yrs. old)	100		
Exposure Frequency (EF)	180	days/year	Average days in school year
Exposure Duration (Ed)	(5-6, and 7-12)	years	Number of years at school (child, elementary school age child, adult - teacher).
Body Weight (BW) - adult	70	kg	Adult mean body weight
Body Weight (BW) – older child (5-6 and 7-12 yrs. old)	21 and 35		Older child mean body weight [10]
Body Weight (BW) – child (0.5 -4 yrs. old)	12		0.5-4 year-old child average body weight
Surface area (SA) - adult	5700	cm^2	Risk Assessment Guidance (EPA)[11]
Surface area (SA) – older child	2900		
Surface area (SA) - child	2900		
Averaging Time$_{non\text{-}cancer}$ (AT)	730, 2190, 5293	days	8 years (K-5 grades), and adult
Averaging Time$_{cancer}$ (AT)	27375	days	75 years
Cancer Potency Factor (CPF)	5.7E+00	$mg/kg\text{-}day^{-1}$	CPF are presented in Table B3
24 hr. absorption factor (ABS)	0.03	unitless	Source: EPA Chemical Specific Arsenic – 0.03 Inorganic – 0.001 Organic – 0.01
Oral route adjustment factor (ORAF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Adherence duration (AD)	1	days	Source: EPA
Adherence factor (AF)	0.2	mg/cm^2	Child, older child
	0.07		Adult
Inhalation rate (IHR) - adult	15.2	m^3/day	Exposure Factors Handbook [10]
Inhalation rate (IHR) – older child	14		
Inhalation rate (IHR) - child	8.3		
Soil matrix factor (SMF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Particulate emission factor (PEF)	1.45E+7	m^3/kg	Model Parameters

Soil Route of Exposure – Non-cancer

Table A2. Non-cancer hazard calculations resulting from exposure to arsenic in soil at Progress Elementary School site (School-age children) – Spokane, Washington.

Contaminant	Concentration (mg/kg)	Scenarios	Estimated Dose (mg/kg/day)		Total Dose	MRL (mg/kg/day)	Hazard quotient
			Incidental Ingestion of Soil	Dermal Contact with Soil			
Arsenic	39.6 [a]	Child 5-6	1.88E-04	1.63E-05	2.04E-04	3E-4	0.68
		Child 7-12	5.64E-05	9.81E-06	6.62E-05		0.22
		Adult	1.41E-05	3.37E-06	1.75E-05		0.06
	44.1 [b]	Child 5-6	2.07E-04	1.80E-05	2.25E-04		0.75
		Child 7-12	6.20E-05	1.08E-05	7.28E-05		0.24
		Adult	1.55E-05	3.71E-06	1.92E-05		0.06

[a] corresponds to the mean concentration value
[b] corresponds to the 95% UCL concentration value

Soil Route of Exposure – Cancer

Table A3. Cancer risk resulting from exposure to contaminants of concern in soil samples from Progress Elementary School site (School-age children) at – Spokane, Washington.

Contaminant	Concentration mean (mg/kg)	EPA cancer Group	Cancer Potency Factor (mg/kg-day^{-1})	Scenarios	Increased Cancer Risk		Total Cancer Risk
					Incidental Ingestion of Soil	Dermal Contact with Soil	
Arsenic	39.6	A	5.7	Child 5-6	2.86E-05	2.48E-06	3.10E-05
				Child 7-12	2.57E-05	4.47E-06	3.02E-05
				Adult	1.55E-05	3.71E-06	1.92E-05

Contaminant	Concentration UCL 95% (mg/kg)	EPA cancer Group	Cancer Potency Factor (mg/kg-day^{-1})	Scenarios	Increased Cancer Risk		Total Cancer Risk
					Incidental Ingestion of Soil	Dermal Contact with Soil	
Arsenic	44	A	5.7	Child 5-6	3.14E-05	2.73E-06	3.41E-05
				Child 7-12	2.83E-05	4.92E-06	3.32E-05
				Adult	1.71E-05	4.09E-06	2.12E-05

Certification

This Evaluation of Soil Contamination at Progress Elementary School, Spokane Washington Public Health consultation was prepared by the Washington State Department of Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodologies and procedures existing at the time the health consultation were initiated. Editorial review was completed by the Cooperative Agreement partner.

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Technical Project Officer, CAPEB, DHAC

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

Alan W. Yarbrough

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