Health Consultation

Evaluation of Soil Contamination
Washington Schools
Eastern and Central Washington

July 1, 2008

Prepared by

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

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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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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.
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).
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.
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.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
Model Toxics Control Act (MTCA)	The hazardous waste cleanup law for Washington State.
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.
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].

Purpose

The Washington State Department of Health (DOH) conducted this health consultation at the request of the Washington State Department of Ecology (Ecology). The purpose of the health consultation is to evaluate whether soil arsenic and lead levels found by Ecology between 2003 and 2006 on playgrounds at over 100 eastern and central Washington elementary schools pose a health concern to children and residents in the nearby communities. This document outlines the steps and criteria that DOH used in determining which schools were at risk and describes recommended steps for reducing exposures including outreach and education. DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background and Statement of Issues

Lead arsenate was the primary insecticide used to control codling moth and other insects in Washington deciduous tree fruit orchards between 1905 and 1947.[1] After 1948, lead arsenate use dropped drastically and was replaced by DDT (1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane).[2] By the mid-1960s, DDT was found to cause cancer and eventually was banned.[3] Most schools in Eastern and Central Washington were built on historic orchard lands shortly after farmers ended the use of lead arsenate. Because DDT was used only for a short period of time and studies in temperate climates show that half of the DDT initially present usually disappears in about five years, Ecology has not tested for DDT at the schools, and they have no plans to sample for DDT in the future.[4]

As a result of this historical use of lead arsenate pesticide, elevated concentrations of arsenic (As) and lead (Pb) remain in soils, particularly in apple and pear orchards in Eastern and Central Washington.[1] Some of these orchards were subsequently converted to elementary school properties in Wenatchee, Chelan, Douglas, Yakima, and Okanogan counties. Most of the schools have several play areas, sport fields, landscaped grounds, and parking/access areas. Play areas are generally well-maintained at most schools, with good grass cover, gravel, or other barrier to native soil. However, some small patches of native soil, including parts of the baseball field, surrounding fences, building corners, and general playground areas contain exposed soil.

The Department of Ecology sampled soil at over 100 schools between 2003 and 2006. Initially, composite surface soil samples (0-18 inches) were collected from the school playgrounds and analyzed using field portable x-ray fluorescence (FPXRF) and/or Inductively Coupled Plasma (ICP) (Appendix A, Tables A1-A7). More recently, Ecology sampled soils from 0 to 3-inches below ground surface (bgs), 3 to 6-inches bgs, 6 to 9- inches bgs, 9 to 12-inches bgs, and up to 32 inches bgs. These locations included: undisturbed portions of the school playfields, sections of the playfields where initial soil excavations had occurred, and areas that had been remediated. Soil lead and arsenic concentrations were above background levels in both surface and subsurface samples.

Arsenic and lead levels were compared to the Washington State MTCA (Model Toxics Control Act) Method A soil cleanup level for restricted land use, Ecology's Interim Action Levels (IALs), and ATSDR comparison values (Table 1). MTCA is the toxic waste cleanup law for Washington State. 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.[5a] MTCA levels for lead are 250 mg/kg and 20 mg/kg for arsenic (Table 1). Ecology's IALs for lead are 500 mg/kg and 100 mg/kg for arsenic (Table 1).[5b] ATSDR health standards for arsenic are 20 mg/kg for non-cancer and 0.5 mg/kg for cancer values (Table 1). DOH previously evaluated potential health impacts from exposure to lead and arsenic in soil at seven schools that had levels that exceeded MTCA (i.e., the UCL 95th percentile and/or the mean value) and/or Ecology's IALs.[6,7,8,9,10,11,12]

Data quality

FPXRF sample collection and ICP analytical methods were considered of acceptable quality. FPXRF performance was checked twice with calibration, blank and reference readings during sample collection. All the readings were below the detection limit. Ecology did confirmatory laboratory analysis for soil samples after completion of the elementary schools remediation project in 2006. FPXRF soil samples were compared to ICP laboratory methods. The results of the sampling between these two methods confirmed good correlation coefficients (r^2 value) for lead and arsenic (i.e., 0.879 for lead and 0.838 for arsenic).[13]

Elementary school playgrounds

The children who attend the elementary schools use almost all of the school grounds as play areas, and members of the community use the school yard for various activities. In general, the grass cover for most schools is in good condition and well-watered during the spring and summer months; this helps reduce exposure to the contaminated soil. The irrigation systems operate almost daily from April through mid-October. There is no irrigation during the winter months. However, an increase in moisture during the fall and winter months is typical. While grass cover is expected to reduce exposure compared to bare soil, some exposure to the lead and arsenic contaminated soil is still likely to occur.[14]

Typically, areas around playground equipment are covered with gravel up to 12 inches deep, and access areas surrounding the playgrounds are paved. However, many areas have bare soil through out the school year. These include areas surrounding trees and fencelines, baseball field, and general playground areas. Top dressing and re-seeding or re-sodding is done if money is available. Resilient material such as gravel and/or wood bark covers is replaced annually or as needed if sooner.

Site visit

Staff from DOH Office of Environmental Health Assessments and Ecology visited several schools in Wenatchee, Chelan, Douglas, and Yakima in the summer of 2005 and 2006, to

observe conditions and evaluate potential for exposure to lead and arsenic in soils. Site visit priority was given to schools that had levels that exceeded Ecology's IAL's for lead and arsenic and schools that had poor grass conditions and exceeded MTCA cleanup levels. During the site visits, some school officials reported that no school or community education programs were in place to help prevent and reduce exposure to the lead and arsenic contaminated soils.

Discussion

The following steps outlines the criteria DOH used in determining which schools had a complete health evaluation and/or which schools will be targeted for outreach and education.

1. Levels of contamination: Schools with high mean and/or 95% UCL levels of lead and/or arsenic contamination will have priority. Ecology's Interim Action Levels apply to low-to moderate-level soil contamination dispersed over a large geographic area covering several hundred acres to many square miles.[5] A complete health evaluation will be conducted for schools that exceed arsenic levels of 100 mg/kg and 500 mg/kg for lead.

2. Number of samples exceeding the Washington State MTCA Method A cleanup levels for unrestricted land use: Sampling results have shown wide variation in the number of samples exceeding MTCA cleanup levels for arsenic of 20 mg/kg and 250 mg/kg for lead. Schools with 50% or more samples exceeding MTCA cleanup levels and below Ecology's IALs will be targeted for outreach and education. Schools that have widespread contamination over the entire property will also be targeted for outreach and education. Schools with one or two hot-spots (i.e., levels that exceed Ecology's IALs of lead and arsenic) will be encouraged to implement maintenance activities that reduce exposure, like frequent watering to minimize bare patches or using mulch or sod for cover.

3. At-risk population: Because children are particularly vulnerable to the health effects of lead and/or arsenic, elementary schools were given priority by Ecology[5] and DOH. Priority was also given to playfields (that have poor grass conditions), whether used by elementary school children or the community at large.

4. Site specific scenarios: The health evaluation considered students that attend the schools between kindergarten through grade five, which corresponds to the age range from five to twelve years of age.

Lead and arsenic are expected to remain in the top of the soil at former orchard areas for centuries, and very little leaches through the soil.[15] Contaminant levels can vary greatly between orchards, and from location to location within a single orchard. The highest levels are often found on ground where the chemicals were mixed. While some school properties have been tested, a comprehensive study to find the level and extent of contamination throughout central and eastern Washington has not been conducted.

Increased concern for human health risks arises when old orchard lands are converted to other land uses such as schools or residential areas where children are likely to be exposed to

contaminants in the soil. DOH has not found any reliable studies that have investigated whether or not health problems increase in people who live in areas with past lead arsenate pesticide use.

For screening evaluation purposes, DOH used the maximum and the mean value. These values were compared to the Washington State MTCA Method A soil cleanup level (Appendix A, Tables A1-A7). Contaminants were further evaluated if levels of lead and arsenic in soil at the schools exceeded these comparison values. For most schools, risks were calculated for both the mean and the 95 percent UCL of lead and arsenic. To evaluate cancer and non-cancer risks, DOH used ATSDR health standards in addition to MTCA and Ecology's IALs.

A range of concentrations from surface soil (0 – 12 inches) were selected for assessment rather than data from selected depths for several reasons. First, the distribution of contaminants in the school's playgrounds is not homogeneous across the site with 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 (Appendix B, Charts 1, 2 and 3). For example, some areas with exposed soil had elevated levels of lead and arsenic while other areas with exposed soil presented lower levels. In the same way, some grass areas presented high levels of contaminants and three feet down the levels were insignificant. Few studies have concluded that the redistribution of surface-applied lead and arsenic within orchard soils is limited; decades after the application of arsenical pesticides, the highest concentrations of lead and arsenic generally remain in the top ten inches of contaminated soils.[16] The overall pattern of distribution for lead and arsenic in the soil varies with depth at most schools. Most schools present high levels in surface and lower depths. DOH does not expect children to be exposed to contaminants in soil below ground surface (i.e., below 12 inches). Thus, for exposure scenarios DOH used composite samples over the 0 – 12 inch depth range which are likely to reflect exposure conditions at the schools considering uncertainties associated with contaminant distribution.

Lead and arsenic were the only identified contaminants of concern at all schools. Contaminant concentrations from 0 to 12 inches exceeding comparison values do not necessarily pose health threats but were evaluated further to determine whether they were at levels of human health concern. No comprehensive study has been undertaken to find the levels or extent of contamination in soil on residential properties currently and formerly used as orchards in Eastern and Central Washington.

From a total of 113 schools sampled in Wenatchee, Chelan, Douglas, Yakima, and Okanogan counties, only 51 schools had maximum and/or mean arsenic and lead levels that exceeded MTCA Method A cleanup levels for schools (Appendix A, Tables A1-A7).

Data evaluation for schools was based on levels of lead and arsenic in soil and site conditions. Areas at the school that remain bare soil throughout the school year were evaluated and potential risks were estimated.

Table 1 shows maximum and average lead and arsenic soil contamination in Eastern and Central Washington schools that exceeded MTCA Method A cleanup levels and/or Ecology's IALs.

Table 2 shows 2006 remediated vs. non-remediated schools. Most schools were remediated by a combination of deep mixing or excavation. Manson Elementary School was remediated entirely by excavation. The original contamination at Manson was a result of the import of contaminated topsoil.[17] Gilbert, Apple Valley, Robertson, Terrace Heights, Barge Lincoln, Whitney and Wilson Middle School, Nob Hill, Hoover, and McClure Elementary Schools cleanups did not get remediated due to the District's summer school schedule and the costs for the District's requirements. Ecology is willing to consider cleanup in the near future if conditions change and school districts wish to consider these Yakima schools for cleanup.[18]

Table 1. Maximum and average concentrations (from 0-12 inches) in Eastern and Central Washington Schools that exceeded MTCA levels and/or Ecology's IALs.

School name	School district	N	Highest value (mg/kg)		Average value (mg/kg)		MTCA Method A[5a] (mg/kg)		Ecology Interim Action Levels (mg/kg)[5b]		‡Non-cancer[a] & cancer[b] CV (mg/kg)	
			Pb	As	Pb	As	Pb	As	Pb	As	As[a]	As[b]
District Operations	Wenatchee	13	384	53	220	32						
Sunny Slope ES	Wenatchee	18	750	110	318	42						
Peshastin/Dryden ES	Cascade	60	249	67	63	18						
Bridgeport	Bridgeport SD	70	1,389	161	199	37						
Orondo	Orondo	36	981	139	251	30						
Chelan MS and HS	Lake Chelan	28	331	57	171	27						
Wide Hollow ES	West Valley	74	758	191	50	15						
Barge Lincoln ES	Yakima	19	595	79	189	35						
Hoover ES	Yakima	42	679	76	165	30						
Martin Luther King	Yakima	30	291	71	37	8						
Wilson Middle School	Yakima	31	506	87	82	24						
Terrace Heights ES	East Valley	35	610	97	235	32	250	20	500	100	20	0.5
Naches Intermediate	Naches	31	670	105	269	39						
Washington ES*	Chelan	6	89	17	67	14						
Lincoln ES*	Chelan	10	1,739	399	585	116						
Washington ES†	Chelan	36	1,500	318	479	114						
Lincoln ES†	Chelan	32	1,650	332	396	88						
Manson ES playfield	Manson SD	38	895	140	506	67						
Gilbert ES	Yakima	35	804	146	245	59						
Apple Valley ES	West Valley	51	1,083	124	298	48						
Robertson ES	Yakima	45	393	61	126	22						
Brewster HS	Brewster	NA	975	138	NA	NA						
North Omak ES	Omak SD	59	1,523	312	671	76						
Lewis & Clark MS	Yakima	39	133	27	49	10						
Lewis & Clark ES	Yakima	135	600	100	255	69						

Bold school names indicate that levels exceeded either Model Toxics Control Act (MTCA) or Ecology's Interim Action Levels (IALs)
N = sample size; Pb = lead; As=Arsenic
CV = comparison values; mg/kg = milligrams per kilograms, 1 mg/kg is equal to 1 part per million (ppm)

† Washington and Lincoln ES were analyzed using ICP method.
* Washington and Lincoln ES were analyzed using FPXRF method.
[a] EMEG – ATSDR's Environmental Media Evaluation Guide (child).
[b] CREG – ATSDR's Cancer Risk Evaluation Guide (child).
‡ There are not ATSDR comparison values for lead.
ES = Elementary School; IS = Intermediate School; MS= Middle School; HS= High School
SD = School District; 5a and 5b see reference below.

Table 2. Summary of schools remediated vs. schools non-remediated in the summer of 2006 in Eastern and Central Washington schools.

School name	School district (SD)	N	Highest value (mg/kg)		Average value (mg/kg)		> MTCA limits[5a] and/or IALs[5b]	> Non-cancer[b] & cancer[c] CV for As ‡ (mg/kg		Ecology's & DOH actions
			Pb	As	Pb	As		As[b]	As[c]	
Naches Intermediate	**Naches**	**31**	**670**	**105**	**269**	**39**	**Yes[a]**	**Yes**	**Yes**	*** HC**
Washington ES	**Chelan**	**6**	**89**	**17**	**67**	**14**	**No**	**No**	**Yes**	*** HC**
Lincoln ES	**Chelan**	**10**	**1,739**	**399**	**585**	**116**	**Yes[a]**	**Yes**	**Yes**	*** HC**
Washington ES	**Chelan**	**36**	**1,500**	**318**	**479**	**114**	**Yes[a]**	**Yes**	**Yes**	**† *HC**
Lincoln ES	**Chelan**	**32**	**1,650**	**332**	**396**	**88**	**Yes[a]**	**Yes**	**Yes**	**† *HC**
Manson ES playfield	**Manson SD**	**38**	**895**	**140**	**506**	**67**	**Yes[a]**	**Yes**	**Yes**	*** HC**
Gilbert ES	Yakima	35	804	146	245	59	Yes[a]	Yes	Yes	‡HC
Apple Valley ES	West Valley	51	1,083	124	298	48	Yes[a]	Yes	Yes	‡HC
Robertson ES	Yakima	45	393	61	126	22	Yes	Yes	**Yes**	‡HC
Brewster HS	**Brewster**	**NA**	**975**	**138**	**NA**	**NA**	**Yes[a]**	**Yes**	**Yes**	*****
North Omak ES	**Omak SD**	**65**	**1,523**	**312**	**671**	**76**	**Yes[a]**	**Yes**	**Yes**	*****
Lewis & Clark MS	**Yakima**	**39**	**133**	**27**	**49**	**10**	**Yes**	**No**	**Yes**	*****
Lewis & Clark ES	**Yakima**	**30**	**600**	**100**	**255**	**69**	**Yes[a]**	**Yes**	**Yes**	**† ***

* Remediated summer of 2006
Bold indicates that schools have been remediated
Model Toxics Control Act (MTCA) limits = 20 mg/kg As or 250 mg/kg Pb

HC = Health consultation. Department of Health (DOH) evaluated potential health impacts from exposure to lead and arsenic at these schools.
NA = No available
N = sample size; Pb = lead; As=Arsenic
CV = comparison values; mg/kg = milligrams per kilograms, 1 mg/kg is equal to 1 part per million (ppm)
† = ICP method, other schools were analyzed by FPXRF method. Only Washington, Lincoln and Lewis & Clark ES were analyzed by both methods.
‡ These schools have not been remediated yet. In March 2006, Ecology offered cleanup for these schools but the school district rejected the offer.[18]
[a] The maximum and/or mean value is greater than Ecology's Interim Action Levels (IALs) for either lead or arsenic.
[b] EMEG – ATSDR's Environmental Media Evaluation Guide (child).
[c] CREG – ATSDR's Cancer Risk Evaluation Guide (child).
ES = Elementary School; IS = Intermediate School; MS= Middle School; HS= High School
SD = School District; 5a and 5b see reference below.

Current exposures to lead and arsenic at schools

The presence of chemicals above MTCA Method A soil cleanup levels and/or Ecology's IALs does not necessarily represent a threat to public health. People must be exposed to the chemicals 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 the elementary schools. 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 exposure for some children. Pica[a] 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 containing arsenic and lead are additional possible pathways of exposure in Eastern and Central Washington schools. DOH is available to review data and assess this exposure pathway if additional data are collected in the future.

The risk of harm depends on the amount and type of exposure people have to the lead and arsenic. At most schools, 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. For some schools the use of the 95 percent UCL was not possible because of sample size, so DOH used the mean value. For most schools risks were calculated for both the mean and the 95 percent UCL of lead and arsenic.

Using the 95 percent UCL instead of the mean value was considered acceptable because of the uncertainty regarding arsenic and lead levels surrounding the school fields. There are many areas of exposed soil in general playground fields, and along fence and tree areas. The 95 percent UCL

[a] Pica behavior means intentionally eating non-food items. This may increase soil exposure for some children.

may be the most appropriate estimate of soil lead and arsenic levels to ensure protection of the health of children from current and past exposures.

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 these schools (i.e., removal of most of the contaminated soil).

Past exposures at Elementary Schools

Incidental ingestion of contaminated surface soil is the predominant lead and arsenic exposure pathway at contaminated school playgrounds. An additional exposure pathway of lead and arsenic is the inhalation of wind-blown soil or dust from school playgrounds. It is unknown whether past exposures (incidental or inhalation) have occurred at the schools. DOH does not have information on past school playground conditions to determine whether or not past exposures occurred.

Target schools for outreach and education

From a total of 51 elementary schools, 22 schools had 95% UCL and/or mean values for either lead and/or arsenic that exceeded MTCA Method A cleanup levels, and four schools exceeded both MTCA and Ecology's IALs (Appendix C, Tables C1 and C2). Appendix C, Table C1 shows a summary of the schools considered for outreach and education. The levels of arsenic and/or lead at these schools are classified in the low-to-moderate range based on MTCA Method A and Ecology's IALs.[5a, 5b] The distribution of contaminants in the school playgrounds is not homogeneous across these schools with hot spots found throughout the area in surface and sub-surface soil. In order to reduce or eliminate exposure to the contaminants in school playgrounds, DOH recommends actions (outreach and education) for these schools when either the mean or 95% UCL value are above MTCA Method A cleanup levels and/or in-between Ecology's IALs. The health risk from this exposure is of concern over long periods of time. The likelihood that children's exposure to lead and arsenic will lead to illness depends on the frequency with which they come in contact with the soil and the amount of soil they might ingest. For information on environmental levels and health effects of lead and arsenic see Lincoln and/or Washington Elementary schools: www.doh.wa.gov/consults.
For most children, the long-term health risks are low, but there may be children who could have been exposed to lead and arsenic frequently enough to be of concern.

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, and absorb more of the lead they swallow. Because children's brains are developing rapidly, they may be more sensitive to the neurological effects of lead than adults. 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.

Exposure reduction actions

The use of a sprinkler system to promote better grass cover in some areas has likely helped reduce exposure. However, grass may not be a reliable or permanent barrier to prevent contact with soil contaminated with lead and arsenic. While grass cover seems to limit or reduce exposure compared to bare soil, some studies indicate that exposure to contaminated soil may occur even when grass is present.[14] In terms of exposure reduction activities, DOH believes that interim remedial activities such as maintenance of grass and gravel cover and irrigation systems are unlikely to provide an effective, permanent barrier to limit exposure. Risks may arise if the covers are not well maintained over the long-term.

Child Health Considerations

Children's school and residential exposure scenarios were evaluated in previous documents 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 because they tend to ingest more soil and dust than adults.

The following factors contribute to 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 of breathing in dust and soil.
- Fetal and child exposure to lead can cause permanent damage during critical growth stages.

The 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 adjacent residential homes built on orchard lands may result in frequent, significant exposure to soil contaminants. The implementation of interim remedial actions at the school sites 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 lead and arsenic may be present in the soil.

Conclusions

Based on previous health evaluations for elementary schools in Eastern and Central Washington, DOH has reached the following conclusions (see previous health evaluations of specific elementary schools):[6,7,8,9,10,11,12]

1. Soil arsenic and lead concentrations at elementary schools exceeded health-based comparison values. Lead and arsenic levels also exceeded MTCA cleanup values, and in many areas, Ecology's IALs for schools.

2. Sampling results for many schools showed wide variation in the number of samples exceeding MTCA Method A cleanup levels of 20 mg/kg for arsenic and 250 mg/kg for lead. Thirteen schools had mean values for either lead and/or arsenic that exceeded MTCA Method A cleanup levels (Appendix C, Table C1).

3. Because the schools listed in Appendix C, Table C2 exceeded MTCA cleanup levels and/or Ecology's IALs, actions are necessary to reduce or eliminate exposure to lead and/or arsenic. Children who play at these elementary schools with contaminated, historic orchard soils may be exposed to lead and arsenic, especially in situations where they come in contact with unvegetated or bare dirt (Figures 1, 2 and 3). The health risk from this exposure is of concern over long periods of time. The likelihood that children's exposure to lead and arsenic will lead to illness depends on the frequency with which they come in contact with the soil and the amount of soil they ingest. For most children, the long-term health risks are low, but there could be some children who may be exposed to lead and arsenic frequently enough to be of concern.

   DOH conducted previous health evaluations for some schools. An example of an exposure dose for arsenic in soil was calculated for a child over a five year exposure period with five days a week exposure at the school (180 days per year). For schools listed in Appendix C (Table C1), the 95% UCL arsenic concentrations ranged between 25 to 75 mg/kg. If a child is exposed to arsenic in the soil at a concentration of 75 mg/kg, the calculated theoretical cancer risk for such an exposure is estimated at about one additional cancer in a population of 10,000 persons (school age-children of 5 to 12 years old). 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). Although the risks are very low, primarily due to levels of soil contamination, good grass cover, and other factors, still, we want to take every precaution to ensure children safety.

4. Data are unavailable for additional exposure scenarios such as those at home and child day cares for the same children who attend these schools. Homes built on old orchard lands can potentially have elevated levels of these contaminants in the soil. The full extent of soil contamination in residential areas 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. Because lead and arsenic are present in these school playgrounds at levels of health concern, DOH recommends outreach and education for these schools (Appendix C, Table C1). Schools will be encouraged to implement interim maintenance activities that reduce exposure, like frequent watering to minimize bare patches or using mulch or sod for cover.

2. Children should be discouraged from playing in areas that have bare soil or that are known to have higher concentrations of lead and arsenic.

3. DOH recommends health education efforts focused on reducing exposure for families living within the footprint of old orchard lands.

4. DOH recommends residents test their soil at homes built on former orchard lands.

5. DOH recommends soil testing at child day cares built on former orchard lands.

6. DOH recommends educating families on testing their children for lead due to the fact that some Elementary School playgrounds have lead levels above 500 mg/kg.

7. Since the presence of DDT is unknown in historic orchard's soil, DOH recommends initiating a pilot project to test soils for DDT at schools and/or adjacent residential homes built on former orchard lands.

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 children at school sites impacted by lead and/or arsenic contamination.

2. DOH, Washington Health Districts and school officials will conduct outreach and education activities, as appropriate, to provide 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 adjacent residential homes can be reduced if children and adults follow the soil safety guidelines below. Following soil safety and preventive measures can help teachers, parents, and community members minimize potential health risks from elevated lead and arsenic levels that may be present at the schools and adjacent residential homes.

- 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 house dust.
    - 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.

The above safety guideline will be distributed to parents and community residents living within the school jurisdictional boundaries of these elementary schools (i.e., schools listed in Appendix C, Table C1). The school district and DOH will notify them about the simple steps to reduce and limit exposure to soils at school and at home.

1. DOH will be available to provide consultation on the appropriateness and efficacy of future remedial actions.

2. DOH will analyze aerial photos from historical (1940s) orchard lands to identify how the footprint of former orchard lands matches residences within the school's jurisdictional boundaries. DOH will coordinate efforts with school officials to implement outreach and health education activities when susceptible populations and/or people living on old orchard lands are identified.

3. DOH will work with Ecology and the Health Districts to determine the value and need for additional efforts such as blood lead screening for children and residential soil sampling.

Summary of activities implemented at the schools

DOH and Ecology staff held numerous meetings from 2005 to 2006, to discuss Ecology's remedial action plans, as well as outreach and education activities for elementary schools that had lead and arsenic soil contamination levels exceeding Ecology's MTCA cleanup and interim action levels.

DOH discussed the analysis of aerial photos from historical (1940s) orchard lands to identify how the footprint of former orchard lands matches residences within the school's jurisdictional boundaries. DOH suggested agencies coordinate with school officials to implement outreach and health education activities.

Community outreach

Community outreach represented one of the biggest challenges because the community, school district and school officials questioned whether the levels of lead and arsenic soil contamination cause a health concern for children that attend the elementary schools. They also questioned Ecology's proposed cleanup remedial actions. The following describes some of the questions or concerns raised by citizens and school staff about lead and arsenic effects on health:

- *"Does the potential exist for soil borne contamination to cause illness in humans?"*
- *"Lead and arsenic are natural chemicals."*
- *"Lead and arsenic is only a concern if it's sprayed on you."*
- *"I lived less than a block away from Lincoln Elementary, and a couple years ago was found to have lead and arsenic in my system. Upon contacting the county, I was told there was not a source of lead and arsenic in the area."*
- *"Can there be a policy proposed to have children wash their hands after every outdoor recess?"*
- *"How many children had gotten sick from these contaminants?"*
- *"Please provide documented evidence of where a current or former student… has experienced lead/arsenic-based illness from contact with this soil."*
- *"…No documented evidence… shows harm to children and adults over the last 100 plus years."*
- *"Has anyone suffered health effects from this site or similar sites?*
- *"Unless there is a documented incident of lead or arsenic poisoning …., it would be needless to undertake the very extensive and costly cleanup action proposed."*
- *"No children in the Chelan-Douglas School District or any other school district in the Chelan-Douglas Valley have ever exhibited symptoms or lead and/or arsenic poisoning."*

- *"How much dirt would someone have to eat to cause a problem?"*
- *"Each child would have to eat a dump-truck load of this so-called dangerous soil to even be slightly in danger."*
- *"What is the quantified risk from this site?"*
- *"If Lincoln Elementary School (ES) is ranked a 1, what are the other two schools ranked?"*
- *What is the contamination level in the grass itself and does that protect people from contact with this contamination?"*
- *"How do lead and arsenic under grass cause problems?"*
- *"The Lincoln ES playfields are already planted in grass and children are not allowed to dig in the soil."*
- *"The children…do not eat the soil… - the grass forms a secure barrier layer from the dirt."*
- *"In the forty years in which I have continually driven by the school on a daily basis, I have failed to see any of the students eating the dirt or grass…"*

Outreach and education

DOH and Ecology conducted outreach and education activities, as appropriate, to provide citizens with health education information. These activities included site-specific fact sheets and educational materials to prevent exposure to contaminants at the school and nearby residential properties. Materials and activities were appropriate for the age and education level of the intended audience.

Public health messages

DOH and Ecology developed health messages and materials that addressed answers to the risk perception questions raised about school cleanups and health effects. DOH also distributed Fact Sheets and Dirt Alert brochures to educate people about how to follow soil safety guidelines, and conducted presentations on local radio programs to reach Hispanic residents living within the footprint of old orchard lands as well as farm workers and families.

Figure 1. When we arrived at the school, no kids were in the area and pine needles were evenly strewn about. When we left, the school a half-hour later, the boys in the right photo had gathered them together, dirt and all. Kids DO play in the dirt.

Figure 2. Here are two more examples of kids playing in the dirt. The left photo shows artifacts while the right shows kids in the area. Even though the levels of lead and arsenic soil contamination at one of the schools did not seem to be particularly alarming, the amount of exposed dirt and child activity at the site raised some concern.

Figure 3. High use areas, such as these baseball fields, raise concerns because of the exposed soil and the amount of activity and exposure at the sites. Note the orchard being removed in the background of the left photo. In a short while, the fading memory of an orchard and the remaining soil contamination will be left to remind the new landowners of the area's toxic past.

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Appendix A

Table A1. Summary table of schools located in Chelan County, Washington.

School name	School district (SD)(Chelan County)	N	Highest value (mg/kg)		Average value (mg/kg)		> MTCA limits	DOH Recommended actions[x]
			Pb	As	Pb	As		
Morgan owing ES	Lake Chelan	30	35	11	16	10	No	NA
Vale ES	Cashmere	31	171	29	30	8	Yes	NA
Osborn ES	Cascade		63	12	24	5	No	NA
Peshastin/Dryden ES	Cascade	60	249	67	63	18	Yes	O & E
Beaver Valley	Cascade	20	14	4	12	8	No	NA
Cashmere MS	Cashmere	20	130	19	39	7	No	NA
Icicle River MS	Cascade	21	24	4	15	4	No	NA
Chelan MS and HS	Lake Chelan	28	331	57	171	27	Yes	O & E
Glacier Valley Alt. HS	Lake Chelan	4	43	4	28	4	No	NA
Cashmere HS	Cashmere	15	118	24	74	14	Yes	NA
Entiat School District	Entiat	30	943	89	70	13	Yes	NA (single hot spot)
Cascade HS	Cascade	15	22	5	12	4	No	NA
Cascade School District Rec Field	Cascade	20	20	4	10	4	No	NA
Chelan Football field	Lake Chelan	20	141	26	72	13	Yes	NA
Cashmere School field	Cashmere	22	81	19	49	12	No	NA
Washington ES	Chelan	6	89	17	67	14	Yes	* HC
Lincoln ES	Chelan	10	1,739	399	585	116	Yes	* HC
Washington ES	Chelan	36	1,500	318	479	114	Yes	† HC
Lincoln ES	Chelan	32	1,650	332	396	88	Yes	† HC
Wenatchee HS	Wenatchee	48	141	40	71	22	Yes	†
Westside HS	Wenatchee	10	174	67	108	45	Yes	†
Wenatchee HS	Wenatchee	30	75	20	40	15	No	NA
Westside HS	Wenatchee	4	74	18	74	18	No	NA

Model Toxics Control Act (MTCA) limits = 20 mg/kg As or 250 mg/kg Pb
O & E = Outreach and education
HC = Health consultation
NA = No Action; mg/kg = milligrams per kilograms, 1 mg/kg is equal to 1 part per million (ppm)
† = ICP method
10 Elementary Schools exceeded MTCA method A cleanup levels
DOH =Department of Health, X = See guidelines at the beginning of the discussion section above

Table A2. Summary table of schools located in Chelan-Douglas County, Washington.

School name	School district (SD) (Chelan-Douglas County)	N	Highest value (mg/kg)		Average value (mg/kg)		> MTCA limits	DOH Recommended actions[x]
			Pb	As	Pb	As		
Cascade ES	Wenatchee	48	36	6	17	3	No	NA †
Columbia ES	Wenatchee	10	78	14	48	12	No	NA
Columbia ES	Wenatchee	4	93	32	79	26	Yes	NA †
District Operations	Wenatchee	4	94	19	74	16	No	NA
District Operations	Wenatchee	13	384	53	220	32	Yes	O & E †
Eastmont Junior HS	Wenatchee	2	21	16	21	13	No	NA
Mission View ES	Wenatchee	14	54	19	40	12	No	NA
Orchard Middle School	Wenatchee	4	35	15	28	14	No	NA
Pioneer Middle School	Wenatchee	6/9‡	90	19	50	14	No	NA
Rock Island ES	Wenatchee	4	88	14	34	13	No	NA
Eastmont HS	Wenatchee	29	20	4	11	3	No	† NA
Eastmont Junior HS	Wenatchee	19	222	39	83	18	Yes	† NA
Grant ES	Wenatchee	22	39	7	23	3	No	† NA
John Newberry ES	Wenatchee	21	220	66	43	9	No	† NA
Kenroy ES	Wenatchee	17	11	3	10	3	No	† NA
Lee ES	Wenatchee	22	260	71	75	16	Yes	† NA
Mission View ES	Wenatchee	6	100	29	64	22	Yes	† NA
Orchard Middle School	Wenatchee	12	330	91	139	48	Yes	† *
Pioneer Middle School	Wenatchee	18/19‡	280	81	88	23	Yes	† NA
Rock Island ES	Wenatchee	11	169	23	62	9	Yes	† NA
Sterling Middle School	Wenatchee	31	39	15	21	5	No	† NA
Sunny Slope ES	Wenatchee	18	750	110	318	42	Yes	† O & E

Model Toxics Control Act (MTCA) limits = 20 mg/kg As or 250 mg/kg Pb
O & E = Outreach and education
mg/kg = milligrams per kilograms, 1 mg/kg is equal to 1 part per million (ppm)
HC = Health consultation
NA = No Action; N= sample size; Pb = lead; As=arsenic
† = ICP method
* Scheduled for remediation, summer 2008
‡ Sampling size for As and Pb respectively
9 Elementary Schools exceeded MTCA method A cleanup levels
DOH = Department of Health, X = See guidelines at the beginning of the discussion section above

Table A3. Summary table of schools located in Chelan-Douglas County, Washington.

School name	School district (SD) (Chelan-Douglas County)	N	Highest value (mg/kg)		Average value (mg/kg)		> MTCA limits	DOH Recommended actions[x]
			Pb	As	Pb	As		
Bridgeport	Bridgeport SD	70	1,389	161	199	35	Yes	O & E
Mansfield	Mansfield	28	23	LOD	17	LOD	No	NA
Palisades	Palisades	20	20	5	11	4	No	NA
Orondo	Orondo	36	981	139	251	29	Yes	O & E
Waterville School District Facilities	Waterville	31	206	28	27	5	No	NA
Manson ES	Manson SD	17	179	28	41	7	Yes	NA
Manson ES playfield	Manson SD	38	895	140	506	67	Yes	* HC
Manson HS	Manson SD	21	498	88	158	28	Yes	NA

MTCA = Model Toxics Control Act; HC = Health consultation
NA = No Action
mg/kg = milligrams per kilograms, 1 mg/kg is equal to 1 part per million (ppm)
N= sample size; Pb = lead; As=arsenic
LOD = Lowest detection limit
O & E = Outreach & Education
* School remediated summer of 2006
4 Elementary Schools exceeded MTCA method A cleanup levels
DOH = Department of Health, X = See guidelines at the beginning of the discussion section above

Table A4. Summary table of schools located in Okanogan County, Washington.

School name	School district (SD) (Okanogan County)	N	Highest value (mg/kg)		Average value (mg/kg)		> MTCA limits	DOH Recommended actions[x]
			Pb	As	Pb	As		
Methow Valley ES	Methow Valley SD	28	21	LOD	9	LOD	No	NA
Methow Valley Rec. field	Method Valley SD	18	20	10	8	4	No	NA
Brewster ES	Brewster	Na	630	152	Na	Na	Yes	NA
Brewster HS	Brewster	Na	975	138	Na	Na	Yes	*
Brewster soccer field	Brewster	Na	1,052	113	Na	Na	Yes	NA
Virginia Grainger ES	Okanogan	29	19	4	10	4	No	NA
Okanogan Junior/Senior HS	Okanogan	31	71	9	17	4	No	NA
Tonasket ES	Tonasket	33	34	5	17	4	No	NA
Tonasket MS and HS	Tonasket	26	46	4	19	4	No	NA
Lake Roosevelt HS and Wright ES	Grand Coulee	22	22	LOD	Na	Na	No	NA
Lake Roosevelt HS	Grand Coulee	22	23	LOD	Na	Na	No	NA
Nespelem School	Nespelem	30	28	4	15	4	No	NA
Omak Alternative HS	Omak SD	24	34	14	15	7	No	NA
Omak MS and HS	Omak SD	29	115	7	27	4	No	NA
North Omak ES	Omak SD	60	1,523	312	228	43	Yes	*
Tonasket Baseball field	Tonasket	15	21	9	16	4	No	NA
Tonasket Track field	Tonasket	10	24	4	13	4	No	NA

Schools remediated in the summer of 2006
MTCA = Model Toxics Control Act, MTCA limits = 20 mg/kg As or 250 mg/kg Pb
Na = No available
mg/kg = milligrams per kilograms, 1 mg/kg is equal to 1 part per million (ppm)
LOD = Lowest detection limit
NA= No Action; N= sample size; Pb = lead; As=arsenic
* remediated summer 2006
4 Elementary Schools exceeded MTCA method A cleanup levels
DOH = Department of Health, X = See guidelines at the beginning of the discussion section above

Table A5. Summary table of schools located in Yakima County, Washington.

School name	School district (SD) (Yakima County)	N	Highest value (mg/kg)		Average value (mg/kg)		> MTCA limits	DOH Recommended actions[x]
			Pb	As	Pb	As		
Marcus Whitman	Highland	37	25	9	12	5	No	NA
Tieton Intermediate School	Highland	32	68	18	21	5	No	NA
Highland Junior High and HS	Highland	40	72	20	21	6	No	NA
Ahtanum ES	West Valley	30	50	12	19	LODs	No	NA
Cottonwood ES	West Valley	39	61	15	17	5	No	NA
Mountain View ES	West Valley	34	123	41	15	6	No	NA
Summitview ES	West Valley	53	104	26	28	6	No	NA
Wide Hollow ES	West Valley	74	758	191	49	11	Yes	O & E
Apple Valley ES	West Valley	51	1,083	124	298	48	Yes	HC
West Valley Middle School	West Valley	32	177	34	79	15	No	NA
West Valley HS	West Valley	28	149	47	53	13	No	NA
West Valley Junior HS	West Valley	32	162	31	78	17	No	NA

MTCA = Model Toxics Control Act, MTCA limits = 20 mg/kg As or 250 mg/kg Pb
LOD = Lowest detection limit
NA= No Action
mg/kg = milligrams per kilograms, 1 mg/kg is equal to 1 part per million (ppm)
O & E = Outreach and education
2 Elementary Schools exceeded MTCA method A cleanup levels
HC = health consultation
DOH = Department of Health, X = See guidelines at the beginning of the discussion section above

Table A6. Summary table of schools located in Yakima County, Washington.

School name	School District (SD) (Yakima County)	N	Highest value (mg/kg)		Average value (mg/kg)		> MTCA limits	DOH Recommended actions[x]
			Pb	As	Pb	As		
AC Davis HS	Yakima	26	112	25	34	7	Yes	NA
Adams ES	Yakima	28	290	24	37	6	Yes	NA
Barge Lincoln ES	Yakima	19	595	79	189	35	Yes	O & E
Eisenhower HS	Yakima	30	262	48	90	22	Yes	NA
Discovery Lab ES	Yakima	28	121	12	26	5	No	NA
Garfield ES	Yakima	24	328	60	62	12	Yes	NA
Gilbert ES	Yakima	35	804	146	245	59	Yes	HC
Hoover ES	Yakima	42	679	76	165	29	Yes	O & E
Lewis & Clark MS	Yakima	39	133	27	49	10	Yes	*
Martin Luther King	Yakima	30	291	71	38	12	No	NA
McClure ES	Yakima	28	189	46	68	19	Yes	NA
McKinley ES	Yakima	22	110	37	55	16	Yes	NA
Nob Hill ES	Yakima	27	206	30	71	14	Yes	NA
Ridgeview ES	Yakima	29	91	15	36	7	No	NA
Robertson ES	Yakima	45	393	61	126	22	Yes	HC
Roosevelt ES	Yakima	27	86	19	27	6	No	NA
Stanton Alternative School	Yakima	31	30	5	17	4	No	NA
Washington Middle School	Yakima	51	207	35	36	10	Yes	NA
Whitney ES	Yakima	30	373	43	94	20	Yes	NA
Wilson Middle School	Yakima	31	506	87	82	23	Yes	O & E
Lewis & Clark ES	Yakima	30	600	100	176	43	Yes	† *

* Schools remediated in the summer of 2006
MTCA = Model Toxics Control Act, MTCA limits = 20 mg/kg As or 250 mg/kg Pb
HC = Health consultation
NA = No Action
mg/kg = milligrams per kilograms, 1 mg/kg is equal to 1 part per million (ppm)
O & E = Outreach and education
† ICP method
17 Elementary Schools exceeded MTCA method A cleanup levels
DOH = Department of Health, X = See guidelines at the beginning of the discussion section above

Table A7. Summary table of schools located in Yakima County, Washington.

School name	School District (SD) (Yakima County)	N	Highest value (mg/kg)		Average value (mg/kg)		> MTCA limits	DOH Recommended actions[x]
			Pb	As	Pb	As		
East Valley Central School	East Valley	57	103	21	23	5	Yes	NA
East Valley Intermediate School	East Valley	35	250	45	80	16	Yes	NA
East Valley HS	East Valley	35	60	15	30	6	No	NA
Liberty Bell JR SR HS	Methow Valley	20	27	10	13	5	No	NA
Moxee ES	East Valley	32	35	9	17	8	No	NA
Naches HS	Naches	31	179	29	27	6	Yes	NA
Naches Intermediate	Naches	31	670	105	269	39	Yes	* HC
Naches MS	Naches	30	66	17	12	5	No	NA
Naches Primary School	Naches	62/31†	72	14	23	5	No	NA
Terrace Heights ES	East Valley	35	610	97	235	32	Yes	O & E

Total schools = 113
* Schools remediated in the summer of 2006
MTCA = Model Toxics Control Act, MTCA limits = 20 mg/kg As or 250 mg/kg Pb
HC = Health consultation
NA = No Action; N= sample size; Pb = lead; As=arsenic
mg/kg = milligrams per kilograms, 1 mg/kg is equal to 1 part per million (ppm)
O & E = Outreach and education
† N = Pb and As respectively
5 Elementary Schools exceeded MTCA Method A cleanup levels
DOH = Department of Health, X = See guidelines at the beginning of the discussion section above

Appendix B

Chart 1. Distribution of lead and arsenic in soil at different depths Lincoln Elementary School, Wenatchee, Washington.

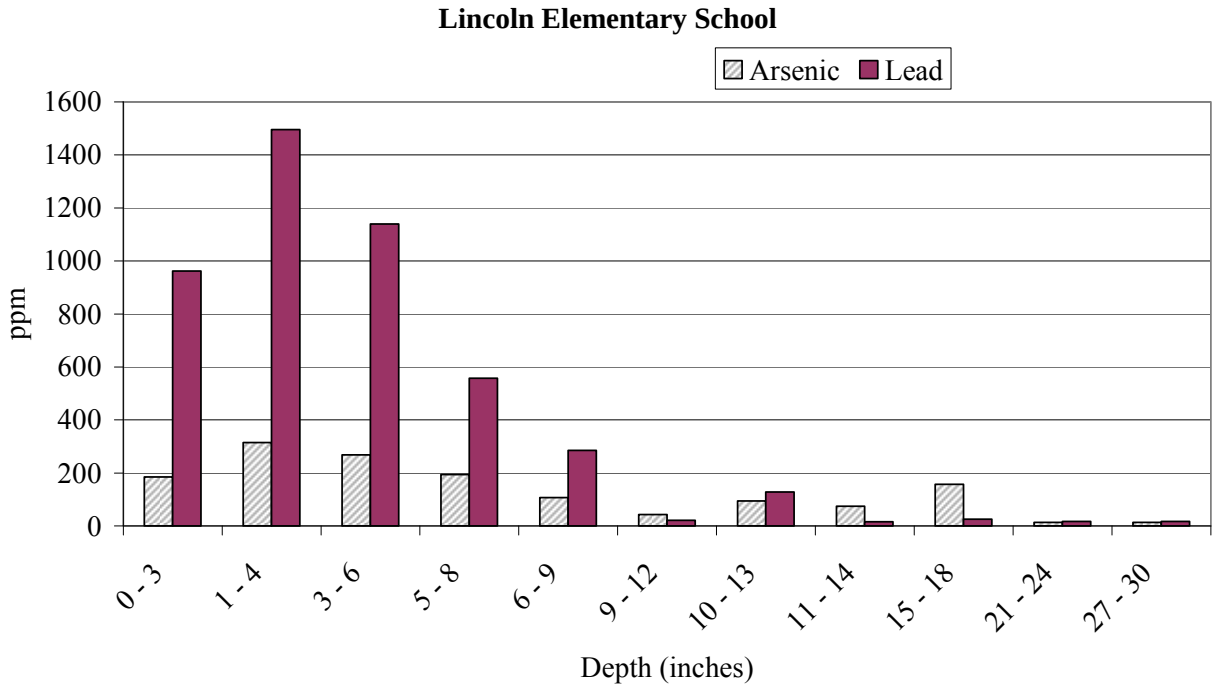


Chart 2. Distribution of lead and arsenic in soil at different depths Lewis & Clark Elementary School, Wenatchee, Washington.

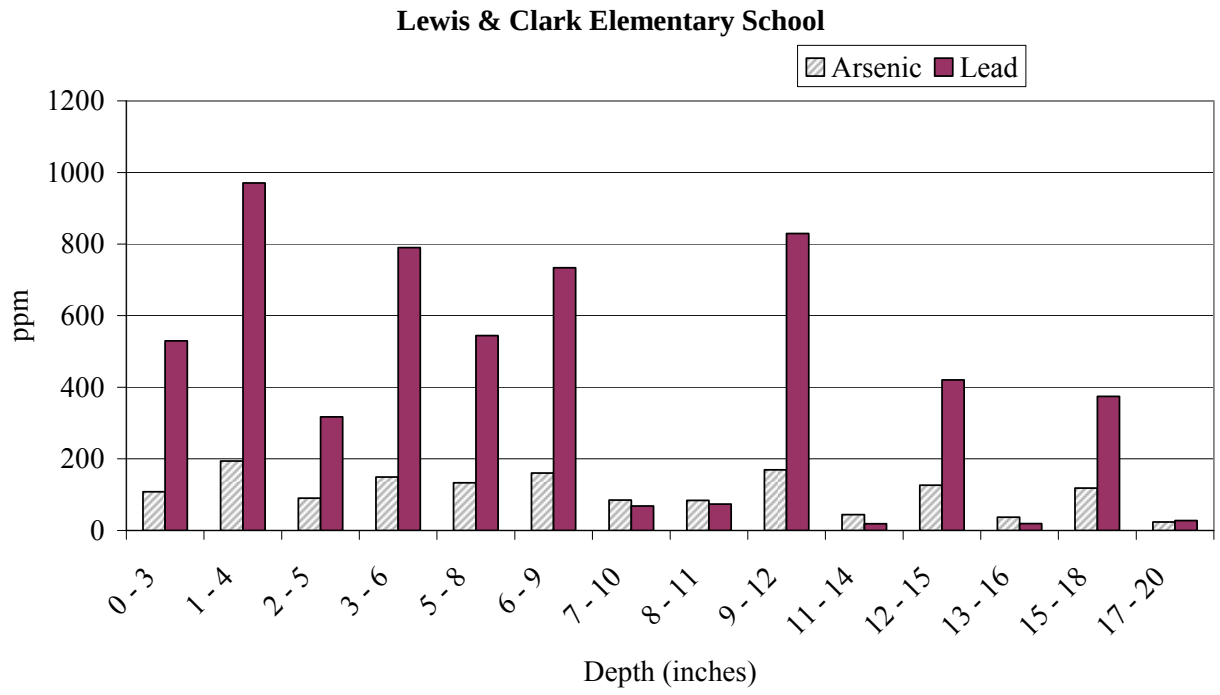
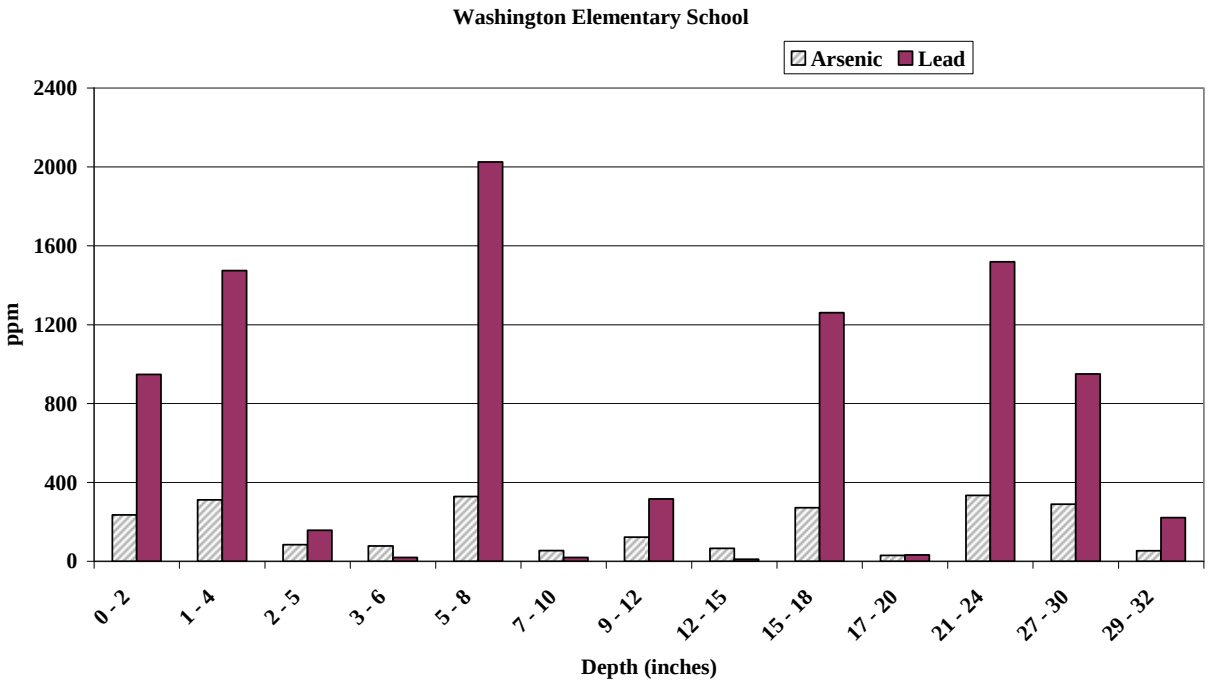


Chart 3. Distribution of lead and arsenic in soil at different depths Washington Elementary School, Wenatchee, Washington.



Appendix C

Schools that exceeded MTCA and/or Ecology's IALs

Table C1. 95 % UCL and mean values for lead and arsenic at Eastern and Central Washington schools that exceeded MTCA Method A cleanup levels and will require outreach and education.

School name	School district (SD)	N	UCL 95% (mg/kg)		Average value (mg/kg)		> MTCA limits[a]	> Ecology's IALs[5b] for Pb and/or As[b]	DOH recommended actions[x]
			Pb	As	Pb	As			
District Operations	Wenatchee	9	--	--	220	32	Yes	No	O & E †
District Operations	Wenatchee	4	--	--	74	16	Yes	No	O & E
Sunny Slope ES	Wenatchee	18	458	50	318	42	Yes	No	O & E †
Peshastin/Dryden ES	Cascade	60	73	25	63	18	Yes	No	O & E
Bridgeport	Bridgeport SD	70	337	41	199	37	Yes	No	O & E
Orondo ES	Orondo	36	322	36	251	30	Yes	No	O & E
Chelan MS and HS	Lake Chelan	28	198	31	171	27	Yes	No	O & E
Wide Hollow ES	West Valley	74	122	28	50	15	Yes	No	O & E
Barge Lincoln ES	Yakima	19	287	47	189	35	Yes	No	O & E
Hoover ES	Yakima	28/ 56*	225	42	165	30	Yes	No	O & E
Wilson Middle School	Yakima	31	109	29	82	24	Yes	No	O & E
Terrace Heights ES	East Valley	35	299	39	235	32	Yes	No	O & E
Gilbert ES	Yakima	35	378	75	245	59	Yes	No	HC, O & E ‡
Apple Valley ES	West Valley	51	360	56	298	48	Yes	No	HC, O & E‡

13 Elementary Schools levels that exceeded MTCA method A cleanup levels
† ICP method
O & E = Outreach and education
* N = Pb/As respectively; N= sample size; Pb = lead; As=arsenic
-- Sample size too small to calculate UCL 95% (N= less than 20 samples)
[a] The 95% UCL or the average is greater than MTCA limits for either lead or arsenic.
[b] The 95% UCL or the average is greater than Ecology's IALs for either lead or arsenic.
HC = Health consultation; mg/kg = milligrams per kilograms, 1 mg/kg is equal to 1 part per million (ppm)
‡ Cleanup was not conducted at these schools; therefore, outreach and education is necessary.
X = See guidelines at the beginning of the discussion section above

Table C2. Summary of elementary schools remediated in the summer of 2006, and schools targeted for outreach and education in Eastern and Central Washington.

School name	School district (SD)	N	UCL 95% (mg/kg)		Average value (mg/kg)		> MTCA limits[a]	> Ecology's IALs[5b] for Pb and/or As[b]	DOH Recommended actions[x]
			Pb	As	Pb	As			
Naches Valley Intermediate	Naches	31	324	59	269	39	Yes	No	* HC
Washington ES	Chelan	6	NA	NA	67	14	Yes	No	* HC
Lincoln ES	Chelan	10	NA	NA	585	116	Yes	Yes	* HC
Washington ES	Chelan	36	895	196	479	114	Yes	Yes	† *HC
Lincoln ES	Chelan	32	1,193	165	396	88	Yes	Yes	† *HC
Manson ES playfield	Manson SD	38	601	81	506	67	Yes	Yes	* HC
Gilbert ES	Yakima	35	378	75	245	59	Yes	No	HC, O & E
Apple Valley ES	West Valley	51	360	56	298	48	Yes	No	HC, O & E
Robertson ES	Yakima	45	169	31	126	22	Yes	No	HC ‡
Brewster HS	Okanogan	NA	NA	NA	** 975	** 138	Yes	Yes	*
North Omak ES	Omak SD	59	756	85	671	76	Yes	Yes	*
Lewis & Clark MS	Yakima	39	NA	NA	49	10	Yes	No	*
Lewis & Clark ES	Yakima	135	483	90	255	69	Yes	No	† *

11 Elementary Schools levels that exceeded MTCA method A cleanup levels
4 Elementary Schools exceeded both MTCA and Ecology's IALs.
* Remediated summer of 2006
MTCA limits = 20 mg/kg As or 250 mg/kg Pb
O & E = Outreach and education
HC = Health consultation; N= sample size; Pb = lead; As=arsenic
NA = No available; mg/kg = milligrams per kilograms, 1 mg/kg is equal to 1 part per million (ppm)
† = ICP method
-- Sample size too small to calculate 95% UCL (N= less than 20 samples)
** It represents the highest value detected for this school that exceeds MTCA and Ecology's IALs
‡ = This school was classified as no apparent public health hazard
[a] The 95% UCL or the average is greater than MTCA limits for either lead or arsenic.
[b] The 95% UCL or the average is greater than Ecology's IALs for either lead or arsenic.
X = See guidelines at the beginning of the discussion section above

Certification

The Washington State Department of Health prepared this Evaluation of Soil Contamination at Elementary Schools in Washington, Washington Public Health consultation 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.

Technical Project Officer, CAPEB, SPAB, DHAC

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

Team Lead, CAPEB, SPAB, DHAC, ATSDR