Washington State University
COOPERATIVE EXTENSION

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GARDENING ON LEAD- AND ARSENIC-CONTAMINATED SOILS

BY
FRANK J. PERYEA

The chemical elements lead and arsenic are potentially toxic to people. Although lead and arsenic occur naturally in the environment, their concentrations have increased, and they have become more widely distributed because of human activities. Societal concerns about excessive human exposure to lead and arsenic prompted development of new products and practices to reduce or eliminate the many industrial and residential uses of the two elements. The principal historical sources of lead (leaded gasoline, lead-based paint) and arsenic (arsenical pesticides) are now outlawed in the United States. As a result, overall human exposure to lead and arsenic is much lower than in the past; however, the legacy of environmental contamination because of past lead and arsenic use is taking on renewed importance. Recent scientific research suggests that human health, especially for infants and small children, may be adversely affected by exposure to lower levels of lead and arsenic than previously believed. Hence, taking additional steps to reduce human exposure to the remaining sources of lead and arsenic may be warranted.

Soil is a major repository for lead and arsenic released by human activities. Some soils are naturally high in lead or arsenic, but many have been artificially enriched through a variety of means. *Contaminated* soils contain total concentrations of elements exceeding the natural background level for local soils. Contamination is an intrinsic property of soil, and contaminated soils are easy to identify by chemical testing. They may or may not pose a health hazard, depending on the amount and type of contamination. *Polluted* soils contain concentrations of an element exceeding some regulatory level associated with impaired human or environmental health. The defining criteria for polluted status can change for scientific, social, economic, or political reasons. This bulletin focuses on lead- and arsenic-*contaminated* soils, based on the premise that reducing exposure to soil lead and arsenic, regardless of their concentrations, will help protect human health.

Home gardening is one of the most popular forms of recreation. Gardening puts people in intimate contact with soil and plants grown in soil. Gardening on lead- or arsenic-contaminated soil increases the likelihood of exposure to these two potentially toxic elements. This bulletin provides general information on

- Why some soils contain elevated amounts of lead and arsenic,
- How to tell if a soil contains elevated lead and arsenic concentrations, and
- How to minimize risk of exposure if one chooses to garden on such soils.

This bulletin addresses home gardening on lead- and arsenic-contaminated soils. Ingestion of lead and arsenic in drinking water or meat and fish foodstuffs, and exposure through household dust are other important routes for human exposure. Specific information about the effects of lead and arsenic on human health and reducing exposure in industrial settings and within the home can be obtained from the following:

U.S. Centers for Disease Control and Prevention, Atlanta, GA 30333 (http://www.cdc.gov), the U.S. Environmental Protection Agency (http://www.epa.gov), and from state and local public health agencies.

Lead and arsenic in the environment

Lead is a metallic element found everywhere in the human environment because of industrialization. Humans have used it in some form since prehistoric times. While lead has a multitude of beneficial uses, it has no known physiological value in humans. High levels of lead exposure can adversely affect human health.

Arsenic is classified as a metalloid (having some properties of a metal) and, like lead, occurs everywhere in the environment. Arsenic also has many beneficial uses but can cause human health problems if exposure is sufficient. Environmental contamination with arsenic because of human activities is less widespread than contamination from lead but can be of regional and local importance.

Lead and arsenic occur naturally in all soils and waters. Plants absorb soil lead and arsenic through their roots; hence, all plants contain small amounts of both elements. The relationship between soil and plant lead varies so much it is impossible to predict accurately how much lead a plant will take up when grown on a soil containing a particular amount of lead. Plant arsenic concentrations tend to increase with increasing soil arsenic, then stabilize at some maximal value at higher concentrations in soil. The exact relationships between plant and soil lead and arsenic vary with factors ranging from chemical forms of the elements in soil, soil properties, climate, soil and plant management practice, to plant species and varieties.

Sources of lead and arsenic

People in residential settings are exposed to lead from many sources. These include natural background soil lead, lead-based paint, leaded gasoline, lead-based pesticides, drinking water, aerosols and dusts from smelters and mines, hobby activities (e.g., pottery glazes; soldering; casting ammunition, fishing weights, toy soldiers and other metal objects), leaching from containers (e.g., improperly glazed ceramic ware; leaded crystal; lead-soldered cans), some food supplements, and "traditional" medicines. Industrial workers also may bring home lead-contaminated work clothes or wash such clothing with the family laundry.

In most cases, high lead contamination in home garden soils originate from four sources: paint, gasoline, insecticide, and industrial fallout.

- Lead-based paint (containing up to 50% lead) was widely used up to the mid-1940s because it was more durable than the non-lead-based paint of the day. Estimates indicate that 90% of homes built before 1940 contain lead paint. Use of lead-based paints declined during the 1950s and was banned for home use in 1978. Industrial uses of high-lead paint are still allowed. Flaking, chalking or other disturbance of lead-based paint on exterior surfaces of buildings and other structures create lead-rich dusts that fall onto nearby soil and increase soil lead content.
- Oil companies added lead to gasoline because it was an inexpensive and effective octane-booster and anti-knock compound. Combustion of leaded gasoline produced tiny lead-rich particles. About 75% of gasoline lead was emitted from exhaust pipes; oil or internal surfaces of the engine and exhaust system trapped 25%. The lead-rich exhaust dust fell directly onto soil near the road or blew a short distance first. Gasoline-derived soil lead is highest adjacent to roadways, parking areas, and driveways. Lead particle size

and soil lead concentrations drop off quickly with increasing distance from driving surfaces; however, gasoline lead often has accumulated in more distant soils near structures that interfere with wind patterns. The wind-transported lead particles struck and stuck to houses, trees, and other barriers, and eventually were washed into the soil by rain. As a result, soil lead can be high around houses not painted with lead-based paint or those not adjacent to roads. Soil lead concentrations typically are higher near heavily used roads than near less traveled roads. Some states banned leaded gasoline as early as 1986. Washington continued to allow leaded gasoline until end of 1995, when it was banned nationwide.

- Lead arsenate was a popular insecticide during the first half of the 20th century because of its low toxicity to plants and great effectiveness for controlling insect pests. The most common use was for control of codling moth in commercial apple orchards. Ranchers also used large quantities for grasshopper control baits. Smaller but still substantial amounts were used on deciduous tree fruits other than apple, in home gardens and orchards, for mosquito control, and on lawns and golf greens. Applicators used other arsenic-based pesticides for agricultural crops, turfgrass, gardens, and rights-of-way.

- Repeated applications of lead arsenate over time caused lead and arsenic to accumulate in soil. Soil lead and arsenic concentrations vary considerably in former orchard sites because applicators using hand-held sprayers applied lead arsenate individually to trees. Higher concentrations tend to occur where the former trees stood; lower concentrations appear between the former tree sites. Use of lead arsenate in apple orchards in Washington ended about 1947 when a more effective replacement pesticide was introduced. Use continued in some other states and countries through the 1960s. Lead arsenate was banned on most food crops in the U.S. in 1988 and on all food crops in 1991. Growing garden crops on soils containing lead arsenate residues raises potential problems when pre-1947 orchard land is converted to residential use.

- Soil lead and soil arsenic often are high around existing metal ore smelters and former smelter sites due to lead- and arsenic-rich ash emitted from smokestacks, or lead- and arsenic-rich dusts blown off ore and slag piles. Metal ores frequently contain arsenic, which is released during smelting as arsenic-rich gases. Soil lead and arsenic concentrations typically decrease with increasing distance from the source and are highest in the predominant downwind directions. Smelter-derived lead dust also may accumulate at the bases of structures obstructing wind flow patterns. Particulate- and gas-trapping devices and ore pile covers are now required to reduce uncontrolled releases of lead and arsenic from operating smelters. Use of smelter slag for construction and landscaping may have distributed lead and arsenic into residential areas. Soils formed on metal ore mine tailings also may be high in lead and arsenic.

Arsenic is present in coal and at much smaller concentrations in oil. Like ore smelting, combustion of fossil fuels in electrical power plants releases arsenic, which can be deposited onto nearby soil. Trapping devices now used to minimize arsenic release from fossil fuel-fired power plants may not have been used in the past. Arsenic dusts and gases also are released during cement manufacture.

- Leaching of arsenic from treated lumber can increase soil arsenic near the wood. Lumberyard use of arsenicals as wood preservatives is a specific, legal treatment.

- Soils can be naturally high in arsenic, as reported at the upper ends of some valleys in Washington's Cascade Mountains. Rocks high in arsenic release this element as the rock weathers, causing arsenic enrichment of local soil and groundwater. Volcanic emissions and hot springs associated with volcanic activity are another natural source of arsenic. Surface runoff or percolating groundwater from springs having high concentrations of arsenic can increase the soil arsenic content of nearby soils.

IDENTIFYING LEAD and ARSENIC CONTAMINATION in SOILS

Soil lead typically occurs as minerals of very low solubility or as positively charged ions strongly bound to soil particle surfaces. Lead solubility is particularly low at high soil pH and in the presence of high soil phosphorus. Lead normally has very poor mobility in soil. Most surface-deposited lead resides in the top few inches of soil unless the soil profile has been physically mixed due to tillage, digging, or some other disturbance. In this case soil lead redistribution can occur throughout the depth of mixing.

Soil arsenic normally occurs as negatively charged ions bound to soil particle surfaces or making up part of their structure. Soil arsenic is more soluble and more mobile than soil lead. Arsenic solubility and mobility usually increase in very wet or flooded soils. Soil arsenic also is redistributed in the soil by tillage. Most surface-deposited arsenic remains in the topsoil, but considerable amounts may have leached into the subsoil, particularly in sandy soils.

Former and existing land uses

Knowledge of current and past land use offers clues about possible lead and arsenic soil contamination. Most unrestricted releases of lead and arsenic from human activities occurred before the 1960s. Because land use may have changed substantially since then, current use may not accurately reflect historical use.

- Suspect soil lead contamination if the garden is within 20 feet of older buildings or other structures once painted with lead-based paints.
- Suspect soil lead contamination if the garden is within 100 feet of roadways and parking areas, particularly near high-traffic routes.
- Suspect soil lead and arsenic contamination if the garden is within 1 mile of existing or former smelters, fossil fuel-fired electrical power plants, or cement manufacturing facilities.
- Suspect soil lead and arsenic contamination if the garden is planted on a pre-1947 orchard site.
- Suspect soil lead and arsenic contamination if the garden is planted on or near tailings from current or former metal ore mines.

Soil testing

Chemical analysis of soil will confirm the presence of elevated concentrations of lead or arsenic.

Locate a soil testing laboratory and discuss requirements for soil sample size and containers before collecting samples. Washington State University Cooperative Extension can help you find suitable laboratories.

Using a nonmetal tool, such as a plastic trowel or scoop, collect samples from the top 8 inches of the garden soil at several locations within the garden. Dump them all into a plastic bucket, mix the soil samples using a nonmetal tool until they are uniformly combined. Collect a subsample or composite sample from the soil mixture (usually about one cup volume) and place it in a plastic bag or other nonmetal sample container (often provided by the testing laboratory). Label the sample with your name, date, location, and depth of sample, using a permanent marker. Deliver the composite soil sample to a testing laboratory and request analyses for *total* lead and *total* arsenic concentrations.

Collect more than one composite sample from different areas within the garden if the garden is very large or if you expect contamination patterns to vary greatly. Use common sense when devising sampling plans. For example, if a garden is adjacent to an old building where lead paint might have been used, collect one composite sample from the garden area next to the building, where soil lead might be high, and one from farther away in the garden, where soil lead might be low. Map the sampling sites so you can relate the test results to the specific locations.

Testing laboratories normally report the lead and arsenic concentrations in units of milligrams per kilogram (mg/kg) or parts per million by mass (ppm). These units are numerically identical; that is, 10 mg/kg of a substance in a soil sample is the same as 10 ppm by mass of that substance.

The Washington State Department of Ecology reported natural background soil lead and arsenic concentrations in Washington to be 17 and 7 mg/kg, respectively (*Natural background soil metals concentrations in Washington State*, Washington State Department of Ecology, Publ. #94-115, Olympia, WA, October 1994). Soil test reports indicating soil lead and arsenic concentrations above these values suggest enrichment due to human activities. Landowners offering property for sale are required by law to disclose information about known environmental contamination to prospective buyers.

Numerous interpretive standards exist for soil lead and arsenic. They often are contradictory because they reflect the varying objectives of the originating organizations and regulatory agencies. Most standards currently are undergoing review and therefore are subject to revision.

Tolerances for soil lead and arsenic concentrations associated with optimal plant growth and "safe" plant lead and arsenic levels have not been established. An out-of-print WSU extension bulletin cites a soil arsenic standard of 25 mg/kg and lower as "probably" not affecting plant growth (*Interpretation of special orchard soil tests*, Cooperative Extension Bulletin FG-28d, Washington State University, Pullman, WA, January 1983).

The Washington State Department of Ecology established residential soil cleanup standards of 250 mg/kg for lead and 20 mg/kg for arsenic (*Model Toxics Control Act Cleanup Regulation*, Chapter 173-340 Washington Administrative Code). The Washington State Department of Health estimates soil arsenic concentrations below 37 mg/kg should protect the health of children having frequent exposure to contaminated soils, and regards 175 mg/kg as safe for adults having occasional exposure to contaminated soil (*Hazards of short-term exposure to arsenic contaminated soil*, Washington State Department of Health, Olympia, WA, January 1999).

The U.S. Environmental Protection Agency has proposed soil lead concentrations of 400 mg/kg as the level of concern and 2,000 mg/kg as the hazard standard for bare soil in residential areas (*Lead; Identification of dangerous levels of lead; Proposed rule*, 40 Congressional Federal Register Part 745, June 3, 1998).

GARDENING ON LEAD- OR ARSENIC-CONTAMINATED SOILS

General considerations

People who garden on lead- and arsenic-contaminated soils are unlikely to have high enough exposure to become suddenly ill. The rare cases of acute toxic responses to soil arsenic involve a combination of atypical circumstances: highly susceptible individuals, exceptionally high-contact exposure, or the presence of highly soluble forms of arsenic in the soil. Chronic exposure to soil lead and arsenic is the principal concern. People exposed to environmental sources of lead and arsenic over long periods of time are more likely to have elevated body burdens of these elements and, consequently, increased risk of developing adverse health effects.

The potential toxicity of either lead or arsenic in plants and soils depends on many factors. People vary in susceptibility to lead and arsenic, due to genetic makeup, type and amount of exposure, general health, and age. Lead and arsenic in plants and soils occur in a variety of chemical forms, called chemical species, which have different toxicological properties. Most studies of lead and arsenic in plants and soils report only total concentrations of these elements because it is difficult to accurately and inexpensively quantify the distribution and amount of chemical species. The inherent variation among people, plants, soils, and behavioral factors greatly complicates predicting the relative lead or arsenic hazard of food plants and contaminated soils.

Lead and arsenic enter the human body primarily by ingestion. Preschool-age children are the most vulnerable segment of population for exposures to soil lead and arsenic. Factors contributing to this sensitivity include: 1) a greater likelihood for children playing in soil to place their hands and other objects into their mouths; 2) greater lead and arsenic absorption by children than by adults; and 3) greater likelihood of children having nutrient deficiencies that may facilitate lead and arsenic absorption.

People are exposed daily to lead and arsenic from a wide variety of sources, including contact with soil and home garden produce. It is not realistic for most people to quantify the contribution home gardening makes to their overall exposure. By adopting specific practices and behaviors that reduce exposure, people can reduce possible health impacts caused by gardening on lead- and arsenic-contaminated soils.

Lead and arsenic in garden crops

Lead and arsenic concentrations in crop plants grown on lead- and arsenic-enriched soils are too low to cause acute poisoning in humans. The health concern is that extra lead and arsenic in or on plants grown on lead- and arsenic-enriched soils add to total intake of these elements. Because lead and arsenic occur naturally in all soils, it is impossible to grow plants completely free of lead or arsenic.

Concentrations of lead and arsenic in soil may be 10 to 1000 times greater than their concentrations in plants growing on that soil. Because of this, failure to remove soil particles that adhere or become trapped on the outside surfaces of garden crops can substantially increase dietary lead and arsenic obtained by eating garden plants.

- Wash garden crops grown on lead- and arsenic-enriched soils with water before bringing them into the house. This removes most soil particles, reduces the lead and arsenic content of the crops, and reduces the transport of soil lead and arsenic into the home.
- Once you have brought the produce inside, wash it again carefully, using edible soap or detergent (sold at many supermarkets), water, and a scrub brush to remove remaining soil particles. Pay particular attention to crops like broccoli having rough exposed exteriors that can trap soil. Leafy plants having large surface areas (such as lettuce and swiss chard) can trap and retain large quantities of dust.
- Pare root and tuber crops (such as potatoes, carrots and radishes) and discard the parings.
- Do not compost unused plant parts, peelings, and parings for later use in the garden.

These practices will reduce the lead and arsenic content of harvested home garden produce to the lowest possible levels.

Garden plant selection

Crops respond differently to soil lead and arsenic depending on plant species and variety. Unfortunately not enough data are available to reliably rank plant species and varieties for growth, yield, and lead and arsenic uptake responses. A few general guidelines can be abstracted from the scientific literature.

The quantities of lead found in most lead-contaminated soils typically are not high enough to reduce plant growth and yield. Elevated concentrations of soil arsenic can stunt plants and reduce yields. If sufficiently high, soil arsenic can cause plant death. Arsenic in plants bonds irreversibly with energy transport molecules, interfering with their activity. Plants containing excessive arsenic effectively "run out of energy."

Green beans and other legumes appear to be most sensitive to soil arsenic contamination. They often fail to grow at soil arsenic concentrations which cause no deleterious effects on other plant species. Growth patterns of stone fruit trees such as peaches and apricots are very sensitive to elevated soil arsenic; apples and pears are less sensitive, and cherries are intermediate. Information about growth sensitivity of other crop species is sparse. The stunting effect of soil arsenic may have horticultural benefits. Although the results are difficult to predict, arsenic stunting can control the size of ornamental plants and fruit trees.

The distribution patterns of lead and arsenic among various plant parts is highly variable. Seeds and fruits typically have lower lead and arsenic concentrations than do leaves, stems or roots. Roots and tubers usually have the highest lead and arsenic concentrations, with the skin having higher lead and arsenic concentrations than does the inner flesh. The lead content of roots correlates more closely to soil lead than does lead in leaves or stems, possibly because roots tend to retain absorbed lead and not transport it higher up into the plant. Tree fruits such as apples and apricots contain very low lead and arsenic concentrations. Contamination of plant parts by lead- and arsenic-rich soil or dust can increase the apparent lead and arsenic content of that plant.

Organic arsenic compounds may be less toxic than inorganic arsenic compounds. Although comprehensive data about the distribution of chemical species in food plants are not available, preliminary reports suggest organic arsenic is predominant in fruits and vegetables, while inorganic arsenic is more common in grains. Plants grown on sands and sandy loams have higher total arsenic contents than those grown on heavier-textured soils at equivalent total soil arsenic concentrations.

Land use practice

Home gardeners can control the amount of their exposure to soil lead and arsenic by adopting different land use practices.

- **Grow Only Ornamental Plants.** Cease raising food plants to eliminate the contribution of edible garden crops to dietary lead and arsenic. Remember that contaminated soil adhering to the outside of cut plants brought inside can introduce lead and arsenic into the home.

- **Build Containers or Raised Beds.** Construct container or raised bed gardens using low lead and arsenic soil. Make sure to test the new container or bedding soil for lead and arsenic content before using it.

- Place a barrier between the uncontaminated topsoil and any underlying contaminated soil to reduce mixing and to remind you how deeply you can till the bedding soil without incorporating underlying contaminated soil. Impermeable barriers such as a concrete slab or thick plastic sheeting between the new soil and the underlying contaminated soil keep plant roots from penetrating into buried soil to absorb lead and arsenic. Provide for bed drainage if you use an impermeable barrier. Permeable barriers are less effective at isolating the bedding and underlying soils. Examples include porous herbicide-impregnated fabric or geotextile plant root barriers or a layer of flat concrete tiles placed on top of the subsoil and butted against each other before the replacement topsoil is placed on top. Plant roots likely will grow through the cracks between the tiles, permitting plants to absorb subsoil lead and arsenic and eventually to redistribute some lead and arsenic into the topsoil.

Cover the walkways between the raised beds with concrete, boards, new soil, and similar barriers to further reduce the likelihood of contact with contaminated topsoil remaining within the garden area.

Do not use arsenic-treated lumber to construct raised beds.

- **Replace Contaminated Soil.** Dig up and replace existing contaminated garden soil with soil containing low lead and arsenic levels. Test the replacement soil for lead and arsenic concentrations. If you remove all of the contaminated soil, you will not need to place barriers between the new topsoil and old subsoil. Install barriers to reduce the likelihood of recontaminating the new topsoil if the old subsoil still contains elevated levels of lead or arsenic. If you install an impermeable barrier underneath the new topsoil, you may need a drainage system.

  Depending on its lead and arsenic content, excavated topsoil may meet criteria designating it as a dangerous waste by the Washington State Department of Ecology (*Dangerous Waste Regulations*, Chapter 173-303 Washington Administrative Code) and, therefore, may require special handling for disposal. The criteria for determining if contaminated soil is a dangerous waste are complex and may require technical assistance for interpretation.

- Isolate Contaminated Garden Areas. Fence off the garden area using a lockable gate if infants or small children might enter the area and play, or otherwise come in contact with lead- or arsenic-contaminated soil.

Personal hygiene

Certain personal hygiene practices help minimize exposure to soil lead and arsenic while gardening and reduce transport of contaminated garden soil into the home. Which ones you choose to adopt depends on how much control you wish to have over exposure. Use common sense ñ walking in your garden to harvest some tomatoes for dinner does not require the same level of protection and cleanup as would spending a day on hands and knees weeding. Important factors to consider include how high the concentrations of lead and arsenic are in the garden soil, how dirty you get while gardening, and if young children live in the home.

- While gardening, do not eat unwashed produce or any other foods. Do not drink, smoke, or engage in other activities that may introduce soil into the mouth.

- Wear a dust mask or respirator in dusty environments to minimize both inhalation and ingestion of airborne soil particles.

- Keep soil moist while gardening to control dust.

- Wash all exposed body surfaces, preferably by showering, as soon as possible after gardening.

- Wash soil particles from gardening tools and supplies outside after each use and store tools outside. Tools, supplies and clothing used for gardening may pick up and transport lead- and arsenic-enriched soil particles.

- Designate certain clothing, including footwear, shirts, pants, and tight-fitting disposable gloves for gardening use only.

- Remove gardening footwearóevery timeóbefore entering the house.

- Store used garden clothing outdoors.

- Launder garden clothing outside by hand to remove adhering soil.

- Wash the garden clothing as a separate load in the general household washing machine. Running the washing machine through a subsequent clothing-free rinse cycle will further flush the inside of the machine and help reduce possible carry-over of lead and arsenic residues into the next batch of clothing.

Helpful soil amendments

Soil acidity is reported in units of pH. A pH value of 7.0 is defined as neutral. Values above 7 are termed alkaline, and values below 7 are acidic. The pH range found in natural Washington soils is about 4 to 9.

Plant lead concentrations typically decrease with increasing soil pH. Plants tend to take up the least amount of soil arsenic at neutral soil pH. Amend acidic soils contaminated with lead but not arsenic with agricultural lime (calcium carbonate or dolomite) to pH 7 or greater. Lime acid soils containing elevated arsenic concentrations but not lead to pH 7. Maintain soils containing both lead and arsenic at pH 7 to minimize plant uptake of both elements. It is difficult to reduce the pH of soils that contain free lime (also known as caliche), which have a pH of 8 or greater. Using an acidic fertilizer formulation such as one containing nitrogen as ammonium or urea will help reduce soil pH over time.

Increase soil organic matter by adding compost, manures, and other organic soil amendments. Normally, this will reduce plant uptake of soil lead and arsenic. Part of this effect appears to be simple dilution of soil lead and arsenic concentrations. Beyond some maximal amount of added organic material increases have no further beneficial effect. Test all composts and other organic amendments or choose those certified low in lead and arsenic. Avoid preparing compost using plant materials grown on lead- and arsenic-contaminated soils.

Use of phosphate-containing soil amendments such as triple superphosphate sometimes can reduce plant uptake of soil lead, by causing lead phosphate minerals of very low solubility to form. This approach does not work if soil lead already occurs as lead phosphate minerals, as it may on soils that have a history of phosphorus fertilizer application.

Adding phosphate amendments to high arsenic soils can increase plant uptake of soil arsenic. Apply phosphorus-containing fertilizers to high arsenic soils only when plant growth is restricted by lack of phosphorus. In this case the phosphorus-stimulated increase in plant biomass will dilute any extra absorbed arsenic and reduce plant arsenic concentration.

Other proposed techniques for reducing soil lead and arsenic concentrations and phytoavailability are still in the testing stage. Specific recommendations are not yet available.

SUMMARY

Lead and arsenic occur naturally in soils. Both elements are potentially toxic if present at high concentrations. Past human activities have increased the lead and arsenic content of some soils used for home gardens, sometimes to levels that create concern about human health. Geographical and historical factors give clues about the possibility of soil contamination with lead and arsenic. Soil testing can confirm higher than natural background concentrations.

Ingestion is the principal route by which lead and arsenic enter the human body. Human health is best protected by minimizing total dietary intake of these elements. People ingest lead and arsenic in water, food, soil, and housedust. Because lead and arsenic concentrations in soil are much higher than in plants, home gardeners and their families are likely to have greater exposure to lead and arsenic in soil directly or in soil particles adhering to the outside of plants than to lead and arsenic actually within garden produce. The lead and arsenic contents of plants and most soils are not high enough to be acutely toxic to people; however, they contribute to overall lead and arsenic exposure. The amount of lead and arsenic ingested increases with increasing exposure to lead and arsenic in soil. Young children generally have greater likelihood of exposure to soil lead and arsenic than do older children and adults. Children also are more likely to be harmed by lower doses of lead and arsenic.

Home gardeners can reduce the potential hazard of gardening on lead- and arsenic-contaminated soils by combining appropriate land use, horticultural, and personal hygiene practices. These practices reduce the amount of lead and arsenic in or on garden produce, and minimize direct exposure of gardeners and their families to contaminated soil.

Frank J. Peryea, Ph.D., Washington State University soil scientist and horticulturist, WSU Wenatchee Tree Fruit Research and Extension Center.

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Sept 2006 arsenic borrow 4 Port
40 ppm

Pete to NW Regional US

20 ppm is no good - not heath based

much much lower - less natural background)

< 7 ppm if heath based.

US Geological survey

- stockpile temp than return it

third RUNWAY

200 sq mile - all SeaTac airport in it

double morse of arsenic not legal

Composite sampling - so lows than reality

hot spots will be higher

Chas - 160th overpass → 1/2 hour 6/4/02 30 empty trucks went into airport
509

Roots/black
beach sand with pebbles | "incompatible"
3 mile fisteam coming off it

160th/Des Moines is where good dirt - Wetlands !

contaminate under concourse A TRACON FAA project ~760M 3 YR

8th + 160th - more than 5 degrees - its illegal } FAA Safety Item
5%

barrel - oil each year is more than year before

July 15 - Wenatchee - regional airport Joel Harrison