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Evaluating and Reducing Lead Hazard in Gardens and Landscapes

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Lead contamination of the environment is an important human health problem. This publication is designed to help homeowners evaluate and manage lead hazard in their landscape or garden. We explain:

- How soils get contaminated with lead
- How to test your soil for lead contamination
- How to reduce exposure to soil lead

This publication does not address indoor lead hazards or provide a comprehensive lead risk assessment. See "More common questions about lead" (page 4) and the resources listed under "More information" (page 6) for more background information on lead.

Where does lead come from?

Lead exists naturally in soils at levels of 10 to 50 parts per million (ppm). Higher levels may indicate lead contamination. Because of human-caused lead additions to soil, urban and residential soils often have higher lead levels than "native" soils.

Areas near existing or former smelters, tailings from metal ore mines, fossil fuel-fired electrical power plants, or cement factories often have elevated soil lead levels.

Lead-arsenate sprays were commonly used for pest control in fruit and nut orchards from about 1910 to the 1950s. If your home is located on an old orchard site, soil lead and/or arsenic concentrations may be elevated.

Outside of industrial areas and old orchards, lead inputs to the soil come from widespread use of leaded paints and from lead in gasoline. Sites with a longer history of human influence generally carry greater risk of lead contamination. Lead concentrations were highest in paints prior to 1960. Leaded gasoline was used in Oregon until 1996.

What happens to lead in soil?

Lead accumulates in the top 1 to 2 inches of soil unless the soil has been disturbed by excavation for building or by tillage for landscaping and gardening. In soil, lead is held tightly on the surfaces of very fine clay and organic matter particles, which tend to stick to skin and clothing. It also is found in airborne soil dust. Almost all of the lead in soil is in solid form. It does not dissolve readily in water.

How can I find out if lead in my landscape or garden is a problem?

The best way to find out if lead levels in your garden or landscape are high enough to be a problem is to collect soil and have it analyzed for lead content. See "Soil tests for lead" (page 4) for more information.

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How are people exposed to lead in the yard and garden?

Here are some things to look for.

- **Play areas.** Children are at greatest risk for lead poisoning, so always look carefully at areas where children might play. Bare soil areas carry the highest risk of lead exposure.
- **Property adjacent to heavily traveled streets and roadways.** Lead exposure might be a problem near older, high-traffic streets. Newer streets and subdivisions, as well as less traveled roads, are less likely to be significantly contaminated from lead exhaust emissions.
- **Planting beds and gardens adjacent to a house, shed, or other structure.** Lead in soil might come from old paint flaking off the house. Consider when the house was built; houses built before 1960 probably have a lead contamination problem right next to the house. The older the house and/or the more coats of paint that were applied to the house, the higher the likelihood of a contamination problem. Farther from the house, the chances of lead contamination are lower.
- **Pets.** Pets often dig in the soil. They can carry contaminated dust into the house or onto the hands of people playing with them.

Do fruits and vegetables accumulate lead?

In general, plants do not absorb significant quantities of lead. Studies have shown that lead does not readily accumulate in the edible parts of vegetable and fruit crops (e.g., corn, beans, squash, tomatoes, strawberries, and apples).

External lead on unwashed produce is a greater concern. Higher concentrations are more likely to be found on surfaces of leafy vegetables (e.g., lettuce) from lead-laden dust and on the surface of root crops (e.g., carrots, horseradish) if soils are contaminated.

Does washing fruits and vegetables remove lead-laden dust?

To remove dust, remove outer leaves of leafy crops, peel root crops, then wash vegetables in water or water containing vinegar (1 percent). It is especially important to wash produce that has large surface areas that can trap a lot of dust (for example, broccoli, lettuce, kale, kohlrabi, radishes, cauliflower, and Swiss chard). Thoroughly rinse the produce with clean water to remove any vinegar or dust residue.

What can I do to decrease lead hazard in the yard and garden?

In general, strategies to minimize lead hazard focus on reducing dust exposure. Good practices include covering bare ground, locating your garden away from contaminated soil, and applying soil amendments as recommended by soil testing.

Covering bare ground. You can protect people (especially children) from exposure to lead in soil and dust by covering the soil surface with a perennial groundcover, dense turfgrass cover, or heavy organic mulch (Figure 1). Consider planting flowers, fruits, vegetables, and ornamentals that are perennials and do not require frequent digging or tillage. You can minimize bare soil in the vegetable garden by planting transplants and then mulching immediately.

Garden location. Locate gardens that require frequent cultivation (e.g., vegetables and annual flowers) as far from busy streets or highways and older buildings as possible.

Figure 1. Groundcovers can reduce exposure to lead in soil and dust.

Soil amendments. You can decrease the bioavailability (toxicity) of lead in soil by several soil management practices: (1) maintaining a near-neutral soil pH, (2) adding phosphorus when soil tests indicate a need, and (3) adding organic matter. Fortunately, these practices are also good for most plants. These practices, however, are less effective at reducing lead hazard than is covering the soil surface.

Before adding soil amendments, collect soil samples and send them to an agricultural testing laboratory for nutrient analysis, including phosphorus (P), potassium (K), acidity/alkalinity (pH), and lime requirement. (See "Soil tests for lead," page 4, for more information.)

Soil pH. Soil pH is a measure of how acidic or alkaline a soil is; 0 is very acid, 7 is neutral, and 14 is very alkaline. Lead uptake by plants is reduced by liming acid soils. A target garden pH of 6 to 6.5 is ideal for most crops and will minimize plant uptake of lead. The lime requirement test (a routine soil analysis available from agricultural laboratories) determines how much lime you need to add to increase pH to this level. To be most effective, lime must be incorporated into the soil by tilling or spading. It usually takes 3 to 6 months for the lime to react with the soil to increase pH.

Some plants prefer soils with low pH (e.g., blueberry, rhododendron, and azalea). For these plants, use heavy mulching to cover bare soil and reduce lead hazard.

Phosphorus. Phosphorus reacts with lead to form insoluble compounds, reducing lead's toxicity. If your soil test phosphorus value is low to medium, add phosphorus. Phosphorus can be supplied via manures, composts, or as fertilizer.

Organic matter. In soils with high lead levels, adding organic matter (Figure 2) will enhance the formation of organic compounds that bind lead, making it less available in the soil water and reducing its ability to form dust. When adding organic matter, also maintain the soil pH above 6.5.

Many organic matter sources can be used. Suggestions for organic matter sources can be found in Oregon State University (OSU) Extension publication EC 1561, *Improving Garden Soils with Organic Matter*.

Figure 2. Organic matter additions to soil will help bind lead to the soil, making it less available in water and dust.

Figure 3. Raised beds can be filled with uncontaminated soil.

What other options exist for gardening on sites with high lead concentrations?

For intensive gardening (with bare soil and frequent tillage), the following options can eliminate or substantially reduce lead hazard.

- Place barriers (e.g., solid plastic covers or geotextile covers) between uncontaminated and underlying contaminated soils to reduce mixing.
- Use raised beds filled with uncontaminated soil (Figure 3).
- Grow plants in containers using uncontaminated soil.
- Replace contaminated soil with uncontaminated soil. This option may require a permit from the Oregon Department of Environmental Quality (DEQ) for handling and disposal of lead-contaminated soils.

Soil tests for lead

If you suspect high levels of lead in your soil, we recommend that you have the soil tested. A number of laboratories in the Pacific Northwest analyze soils for lead content. Oregon State University Extension publication EM 8677, *Laboratories Serving Oregon: Soil, Water, Plant Tissue, and Feed Analysis,* includes a list of laboratories; look for laboratories that test for heavy metals. Confirm that the lab uses sample preparation and analysis methods approved by the United States Environmental Protection Agency (USEPA).

To take a soil sample, collect 15 to 20 subsamples from the area of concern. For methods and tools to use, see OSU Extension publication EC 628, *Soil Sampling for Home Gardens and Small Acreages*.

For play areas, sample to the depth at which children may be exposed to the soil, usually ½ to 1 inch deep. For garden soils, sample from the surface to 3 or 4 inches. Mix the subsamples thoroughly in a plastic container, place about 1 cup of the mixed soil in a clean container, and submit to a laboratory.

Soil test interpretation for garden and bare soils

There are no USEPA or state guidelines developed specifically for garden soils. State and USEPA regulations address play areas for children, high-contact areas for children, and bare soil areas in the landscape. (See "More common questions about lead" below for details.) Based on the state and federal rules and data on lead uptake by vegetables collected in other regions (see "More information"), we suggest the guidelines shown in Table 1.

More common questions about lead

What is lead and why is it dangerous?

Lead (Pb) is a heavy metal important for industrial uses such as building construction. It is found in paints, lead-acid batteries, bullets, solder, pewter, and fusible alloys.

The major effect of lead on children is brain damage; thus, it can cause long-term effects rather than acute toxicity. You might not see any symptoms to suggest lead poisoning. The critical age for children is 6 months to 6 years.

In adults, lead can harm the heart; kidneys; and reproductive, nervous, and hematological (blood) systems. Adult lead poisoning normally occurs from exposure to lead used in the workplace or outdoors. Workers may inhale lead dust and fumes or may swallow lead dust while eating, drinking, or smoking on the job. Adults also can be exposed during hobbies and activities where lead is used. Those exposed may bring lead dust home on their clothes and bodies, thus exposing family members.

If you have reason to suspect lead-related health problems, contact your physician. Your local health department and/or the Oregon Department of Human Services can also assist you in evaluating lead hazards and remedying them.

Table 1. Recommended gardening practices based on results of soil test for lead.

Soil lead test (ppm)	Recommendations
Less than 50	Little or no lead contamination in soil. No special precautions needed.
50 to 400	Some lead present from human activities. Grow any vegetable crops. Choose gardening practices that limit dust or soil consumption by children.
400 to 1,200	Do not grow leafy vegetables or root crops. (These crops carry the highest risk of lead contamination.) Choose gardening practices that limit dust or soil consumption by children.
Greater than 1,200	Not recommended for vegetable gardening. Mulch and plant perennial shrubs, groundcover, or grass. Use clean soil in raised beds or containers for vegetable gardening.

What does soil contaminated with lead look like?

Lead-contaminated soil does not look or smell different than normal soil and does not change with time. Lead does not break down in the soil, so it must be removed, or the soil must be made "lead safe."

What is a "pica" child?

Some children consume large quantities of soil. Pica is a medical condition typically defined as the persistent eating of non-food items for at least 1 month. Pica children may crave and eat dirt, clay, chalk, lead paint chips, laundry starch, dish washing soap, and many other non-food substances. If the non-food item is lead-contaminated soil, these children are at risk of being poisoned by lead.

What about lead in water?

As lead pipes corrode, they release lead into water. If you have leaded pipes, consider testing the water for lead content. The major hazard in using water that contains lead comes from drinking the water.

Lead-contaminated drinking water is most common in very old homes. Lead pipes were used for interior plumbing in many homes built in the early 1900s. Lead piping was also used for many connections between homes and public water supplies. In 1986, the use of lead pipes for drinking water supplies was banned in the United States.

When copper pipes replaced lead pipes, lead solder and flux were often used to join the pipes. Lead solder is a major cause of lead contamination in drinking water today. Chrome-plated household faucets may be another significant source of lead contamination, as they contain 3 to 8 percent lead.

Although lead does not readily dissolve in water, corrosive water (which has a very high or very low pH) can dissolve lead from pipes, solder, or fixtures. Water with a high mineral content may offer some protection from lead pipes or solder, as mineral buildup on the inside of pipes prevents contact between water and the lead pipes or solder.

EPA has established an "action level" of *15 parts per billion* (15 ppb) for lead in tap water. If your water tests above this level, remove lead piping and/or solder or make sure the pH of your water is not corrosive (especially well water).

The amount of lead delivered to soil via irrigation usually is quite small relative to the amount of lead present in soils. If your water contains significant amounts of lead, consider replacing pipes or keeping water off edible plant parts by use of drip irrigation.

What regulatory standards apply to lead concentrations in soil near residences?

USEPA has established the following bare residential soil lead standards (from *Lead; Identification of Dangerous Levels of Lead; Final Rule, 40 Congressional Federal Register Part 745.65,* January 2001):

- Building perimeter and yard: 2,000 ppm
- Bare soil play areas and high-contact areas for children: 400 ppm
- Average for bare soil in the rest of the yard (based on the average of all other samples collected): 1,200 ppm
- If the lead level is 5,000 ppm or above, paving or abatement (elimination of lead) is required.

Oregon Administrative Rules (OAR) Chapter 333 regulates the certification of individuals and firms engaged in lead-based paint activities. It is slightly more restrictive than the federal standards set by USEPA. Under OAR 333-069-0015(68), the definition of soil lead hazard "means bare soil on residential real property or on the property of a child-occupied facility that contains total lead equal to or exceeding 400 parts per million in a play area or average of 1,200 parts per million of bare soil in the rest of the yard based on soil samples."

What data have been collected on residential lead hazards in Oregon?

A study conducted in Multnomah County by the Oregon Department of Human Services in 2001 found that on properties with homes built before 1930, bare soil play areas often had lead concentrations above the USEPA limit of 400 ppm. However, only 1 to 2 percent of the children referred for blood lead level testing showed levels of concern.

Should I be concerned about lead levels in soil amendments?

Currently available information suggests that most fertilizer and soil amendment products do not significantly increase health risks for the most susceptible individuals (small children who eat soil). Fertilizer and agricultural amendment manufacturers are required to test products for lead and to submit the results to the Oregon Department of Agriculture (ODA) or the Washington Department of Agriculture. Fertilizer and amendment analyses are available on the ODA website (http://oregon.gov/ODA/).

More information

Publications

Gardening on Lead and Arsenic-contaminated Soils. Washington State University Extension publication EB1884. http://cru.cahe.wsu.edu/

Improving Garden Soils with Organic Matter. Oregon State University Extension publication EC 1561. http://extension.oregonstate.edu/catalog/pdf/ec/ec1561.pdf

Laboratories Serving Oregon: Soil, Water, Plant Tissue, and Feed Analysis. Oregon State University Extension publication EM 8677. http://extension.oregonstate.edu/catalog/pdf/em/em8677.pdf

Lead and Copper Rule. U.S. Environmental Protection Agency, Office of Water, WH550A. EPA 570/9-91-400, June 1991.

Lead Contamination in the Garden. Ohio State University Extension publication HYG-1149-93. http://ohioline.osu.edu

Lead in the Home Garden and Urban Soil Environment. University of Minnesota Extension Service fact sheet FO-2543-GO. http://extension.umn.edu

Lead in Residential Soils: Sources, Testing, and Reducing Exposure. Penn State University Extension publication. http://cropsoil.psu.edu/extension/

Multnomah County Health Department Program, Design and Evaluation Services, in cooperation with the City of Portland Water Bureau. http://www.co.multnomah.or.us/health/lead/

Soil Sampling for Home Gardens and Small Acreages. Oregon State University Extension publication EC 628. http://extension.oregonstate.edu/catalog/pdf/ec/ec628.pdf

For more lead-related information in Oregon

Lead-based paint (frequently asked questions). http://www.oregon.gov/DHS/ph/leadpaint/faqs.shtml

Training professionals to identify and control lead in residential paint, dust, and soil. http://ccee.oregonstate.edu/wrltc/

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