Compost Education Centre

Factsheet Series

Soil Contamination

#11

The Healing City Soils program is a partnership between the Compost Education Centre and Royal Roads University. The program offers home gardeners free soil testing for heavy metals as well as information and workshops to better understand, manage, and build healthy soil for healthy gardens.

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Whether you are already growing food or would like to begin a garden, it's a good idea to learn more about your soil so that you can grow food safely.

Urban soils are often compacted and nutrient deficient, and can sometimes contain heavy metals and other contaminants as a result of historical industrial activity, past and present land use and proximity to pollution sources (e.g. a major road). Soil contaminants may get into or onto our veggies and fruits and have negative health effects over the long term.

Gardeners can take many simple and inexpensive actions to reduce their exposure to urban soil contaminants. Soils can be managed, improved and made healthy again so that you and your garden can thrive.

Should I be concerned about soil contamination?

It is likely that the soil in any urban setting will contain some level of heavy metal and organic contaminants, and long-term exposure may have health risks, particularly for children. Lead and other heavy metals in soil can enter the human body through inhalation or ingestion of dust and soil on vegetables and, to a lesser extent, through the consumption of produce grown in contaminated soil, as some plants uptake certain heavy metals. For this reason, it is a great idea to learn more about your soil and:

- **Establish the level of concern.** Assess your site and learn about its history. If your site was an infill area, an orchard, a landfill, a commercial property, or near a railway, it can likely be considered a "medium concern." If it was or is near a gas station, printing shop, dry cleaner, autobody shop, rail line, industrial site, renovated old homes, demolished buildings, or had garbage dumped or burnt, it may be considered "higher concern." Read more about how to establish levels of concern in the City of Toronto's "Guide for Soil Testing in Urban Gardens," available online (see resources on page 4). You can find out more about your site history by talking to your neighbors and visiting the City of Victoria's Archives (located at City Hall). Check out our online map of soil test results gathered to date to get a sense of contamination levels in your neighborhood: http://www.compost.bc.ca/healing-city-soils
- **Test the soil.** For information on how to take a soil sample, see links in the Additional Resources section on page 4. You can send soil samples to the following accredited labs in Victoria and Vancouver:
    - **Healing City Soils:** https://www.compost.bc.ca/healing-city-soils, cost for heavy metals test: free (testing happens in the spring, eligible municipalities vary each year)
    - **Maxxam Analytics:** http://maxxam.ca, 250-385-6112, cost for heavy metals test: $100
    - **BV Upstream Minerals:** http://acmelab.com, 604-253-3158

- **Take action to reduce risks:** See Factsheet #12: Best Practices for Urban Gardening, for details on how to grow food safely and Factsheet #13: Backyard Bioremediation, for options for remediating your soil if you do have contamination.

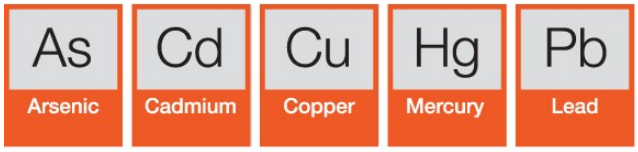
What is a soil contaminant and where does it come from?

A soil contaminant is an element (e.g. lead) or a chemical (e.g. diesel oil) present in the soil at a level that poses health risks to soil, plant, animal or human health. Contaminants can end up in your soil or on your plants through the air (dust, exhaust), water (rain, groundwater), and direct deposition (from on site or nearby polluters). Soil contaminants include:

Heavy metals

Heavy metals are those elements which are toxic to humans at certain concentrations, including arsenic, copper, lead, mercury, nickel, chromium, cadmium, zinc and aluminum. Some of them, like zinc and copper, are necessary or beneficial to living organisms in small concentrations but are toxic above a certain concentration; others, like lead, cadmium, and mercury serve no known biological function and are always toxic. Heavy metals are naturally occurring and can be found in rocks, soil systems and bedrock. In some places a certain metal may be naturally present in higher concentrations, as is the case with arsenic in Victoria region. The majority of heavy metal contamination arises from human activity: metal mining and smelting, agrochemical fertilizers and pesticides, sewage sludge, oil and gas operations and fossil fuel burning, improper waste disposal, and fill used in residential development.

Unlike chemical contaminants, heavy metals cannot be broken down and can continue to build up in soils. However, their characteristics may change so that they can be more or less easily taken up by plants or animals. Many of the practices that gardeners already use in their gardens (such as mulching and feeding the soil with organic matter and compost) can limit the potential for soil contaminants to be taken up in food crops.

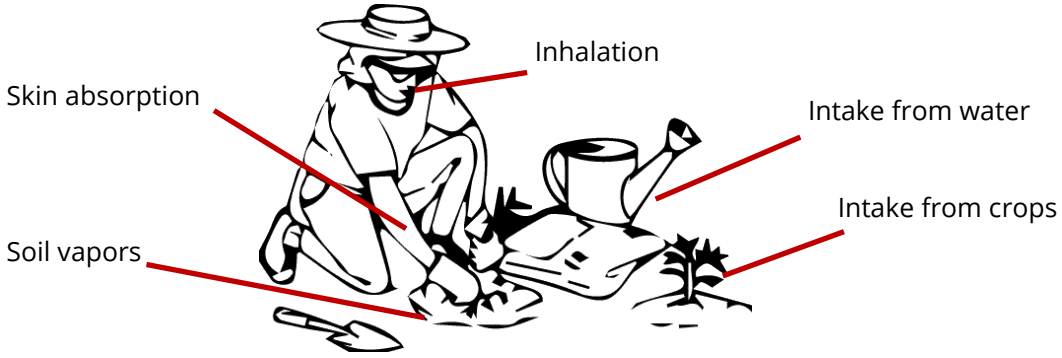


Chemicals/Organics

Chemical contaminants (also known as organic contaminants) are carbon-based, meaning they are derived or manufactured from something that was once alive (e.g. oil and gasoline, which are the remains of plant and animal matter that were compressed for millions of years, then pumped out of the earth and processed). Polyaromatic Hydrocarbons (PAHs) and other petroleum hydrocarbon contaminants, solvents like trichloroethylene (TCE), dioxins and Polychlorinated Biphenyls (PCBs) are a few chemical/organic contaminants of note.

Although Healing City Soils did not test for chemical/organic soil contaminants, it's important to note that they can be present in urban soils, particularly on or near historical or present-day auto and machine repair shops, old or leaky oil tanks, busy roads or highways, landfills and dumps, beneath electrical stations and wires, and places where there were building fires or demolished buildings. If you're concerned your soil may have this type of contaminant, you can get a soil test done or read Factsheet #13: Backyard Bioremediation for ideas and options for remediation.

Routes of Pollutant Intake



Understanding Soil Contaminant Test Results

Is my soil contaminated?

Your soil test results typically include the allowable 'limits' for each contaminant tested. Various environmental agencies, including the Canadian Council of Ministers of the Environment (CCME), have published soil quality guidelines to help protect environmental and human health. The maximum acceptable level is the highest concentration at which diverse health effects cannot be seen in the exposed receptor. Soil that is considered contaminated has levels of a particular element (such as lead or arsenic) that are higher than the guidelines for agricultural use. Allowable limits vary greatly by country, city and agency. Here we've compared CCME agricultural guidelines with urban garden soil values put out by Toronto Public Health:

Metal	Arsenic (As)	Lead (Pb)	Mercury (Hg)	Nickel (Ni)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Zinc (Zn)
CCME (agricultural)	12	70	0.6	45	1.5	50	63	150
TPH (urban garden)	11	34	2.7	34	1	5	180	500

These are all measured and described in units of "ppm," or "parts per million". A level of 1 ppm means that for every million "parts" of soil by dry weight, there is 1 part of the chemical being measured. On some soil tests, levels of metals are described in units of "µg/g" which is the same as ppm, essentially meaning "micro-grams per gram."

Allowable levels of lead are often given at 100-400 ppm. However, if you see that your soil has 140 ppm lead, this is the total lead found in the soil sample, not the amount of lead that is available to get into your plants and affect your health.

We cannot make assumptions that metals are in one of the most toxic and available chemical forms, as this is not always the case with metals in garden soil. The behavior of metals in the environment (including tendency to be taken up by plants, toxicity to plants and potential for health effects of human exposure to those metals) depend on their chemical form. For example, some forms of metals can readily dissolve in water (soluble) and therefore can enter plants or the human body more easily than forms that cannot easily dissolve (insoluble). Human and plant toxicity depend upon the amount of metal that enters the body or plant– this has to do with what is called "bioavailability."

Biological Availability (Bioavailability):

The bioavailable portion is the amount of a substance (heavy metal or chemical) that can directly affect plants, animals or humans because it can be taken up by their bodies. Usually, not all of a contaminant found in soil is biologically available: the bioavailable portion may be only a small fraction of the total amount. Site conditions affect how tightly the contaminant is held by soil particles and how soluble it is (how much of it will dissolve in water). Greater solubility usually means that more of the contaminant is bioavailable, but this also means that the contaminant is more likely to leach out of the soil.

Other soil characteristics and site conditions that affect the bioavailability of a contaminant include:

- Soil texture and clay content
- pH (acidity) of the soil
- Amount of organic matter in the soil
- Moisture levels
- Temperature
- Presence of other chemicals

Gardeners can alter and manage most of these soil characteristics and limit the chance that heavy metals will be taken up by their food crops or enter their bodies.

Soil Chemistry Terminology:

Adsorption: to adhere or become attached (e.g. become attached to a soil particle)

Solubility: how fully a contaminant will dissolve in water

Mobility: how mobile a contaminant is in the soil: Will it move when water flows through? Will it move into roots and up into plants?

Binding: to become attached chemically, or immobile/not likely to dissolve in water or uptaken by plants

pH - a measure of acidity (low pH) or alkalinity/basicity (high pH). This number indicates, on a scale of 0 to 14, the acidity/alkalinity of a solution like soil. If the pH is 7, it is neutral. A number above 7 is alkaline or basic; a number below 7 is acidic. This measurement is important because of its relationship to the availability of plant nutrients and bioavailability of contaminants. Most plants prefer a neutral soil, somewhere in the range of 6 – 7. Keeping your pH neutral helps to make nutrients available to your plants while also helping to "lock up" heavy metals in your soil, making them less available to your plants.

Electrical Conductivity (EC) - is a measurement that correlates with soil properties that affect crop productivity, including soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics.

Organic matter: refers to the plant and animal materials that exist in the soil: the remains of what was once alive. It is important to be continually adding organic matter to improve soil structure and replace the micronutrients that plants need to thrive. Addition of organic matter can also help reduce exposure to some contaminants and increase the likelihood that others will stay "bound up" in the soil.

Should I stop growing food if my soil has heavy metals or other contaminants in it?

Please don't! In the unlikely case that your soil has high levels of heavy metals or other contaminants, you can still grow food safely in raised beds. If you have low to moderate levels of contamination, there are best practices for gardening that can help you grow food safely, reduce your exposure to contaminants, and remediate your garden soil. More detailed information and instruction on what you can do to grow food safely if you have or are concerned you may have soil contamination is offered in Fact Sheet #12: Growing Food Safely.

Additional Resources:

- Factsheets about heavy metals: Agency for Toxic Substances and Disease Registry (ATSDR): http://www.atsdr.cdc.gov/toxfaqs/index.asp.
- Cornell Waste Management Institute fact sheets, "Sources and Impacts of Contaminants": http://cwmi.css.cornell.edu/sourcesandimpacts.pdf
- City of Toronto "Guide for Soil Testing in Urban Gardens": https://www1.toronto.ca/City%20Of%20Toronto/Toronto%20Public%20Health/Healthy%20Public%20Policy/Environmental%20Pollutants/Files/PDF/guide_for_soil_testing_2013.pdf

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