K-STATE Research and Extension

Gardening on Brownfields: Testing Your Soil for Contaminants

Department of Agronomy | MF3192 | Brownfield Sites

Before gardening on a brownfields site, it is important to test the soil for contaminants associated with the historic use of the site. Commercial, industrial, and residential uses may leave long-lasting contaminants that are potentially harmful to human health and the environment. Heavy metals, as well as some organic pesticides, are persistent in the soil.

What do I sample for? Laboratory analysis of environmental contaminants can be expensive. To avoid unnecessary costs, narrow possible contaminants to analyze for.

While the use of leaded gasoline was phased out in the United States in the mid-1970s and finally banned by the Clean Air Act effective January 1996, lead is the most commonly found metal in soils. Lead from lead-based paint, the use of lead-containing pesticides, and industrial uses also may contribute to lead concentrations in soils.

Arsenic is prevalent in soils as well, either occurring naturally, from the decay of arsenic-containing bedrock, or introduced by the use of arsenate-containing pesticides or through industrial activity.

Always analyze for soil lead concentrations and, if the selected garden site is in an area where arsenic occurs naturally in the soil, soil arsenic concentrations should be analyzed as well — regardless of the former use of the selected garden site.

Pesticides such as DDT (dichloro-diphenyl-trichloroethane) and its breakdown product DDE (dichloro-diphenyl-dichloroethylene) are persistent in soils. Although the use of DDT was banned in the United States in 1972, DDT can still be found in soils. It was common to spray around foundations, including the foundations of residential structures, to protect against mice, rats, and other pests. Because of this, it may be advisable to sample and test for DDT and its breakdown products when garden beds are to be established close to old residences or the foundation of former residential structures.

Polycyclic aromatic hydrocarbons (PAHs) result from incomplete burning of coal, oil, gas, and other organic materials and are persistent in soil. If you suspect or know of activities that may have generated PAHs on the property where you want to garden, it is wise to test for PAHs.

The former use of a property dictates what potential soil contaminants should be analyzed for. For example, if a service station was once located on the property you selected for growing crops, you may want to have soils analyzed for potential contaminants such as lead, arsenic, cadmium, mercury, and total petroleum hydrocarbons. Depending on how much time has passed since the service station was in operation, you also may want to test for benzene, toluene, ethylbenzene, and xylenes (all constituents of gasoline, diesel and fuel oils).

Examples of soil contaminants you may encounter and their potential sources are listed in Table 1.

Table 1. *Examples of soil contaminants and their potential sources.*

Soil Contaminants	Potential Sources
Lead	Past use of lead, lead-based paint, and leaded gasoline
Other metals (such as chromium, cadmium, and mercury)	Industrial manufacturing; mercury and cadmium from waste oil; coal ashes
Arsenic	Copper/lead/arsenate pesticides; waste oil; naturally occurring locally
PCBs	Leaking transformers; capacitors; electrical equipment
PAHs	Incomplete combustion of carbon-containing fuels (such as wood, coal, diesel fuel)
Asbestos	Improper demolition or remodeling of structures: insulation; shingles; floor tiles
Persistent Pesticides (DDT, DDE)	Used in the past to spray for insects/rodents along foundations
Chlorinated solvents (TCE, PCE) and other solvents	Dry cleaning operations; former manufacturing facilities

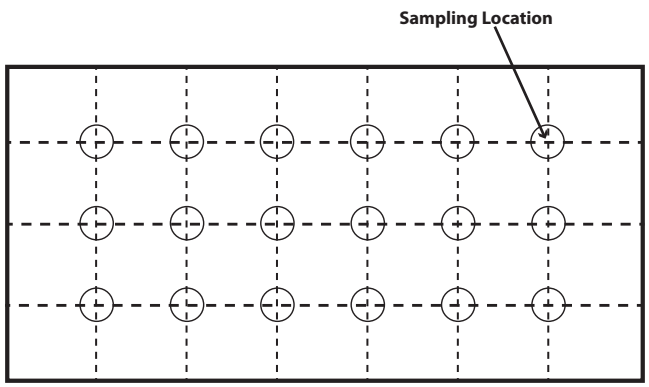
Some research regarding the previous use of a site selected for growing crops helps identify what constituents to analyze. For more information on historic site uses and their potentially associated contaminants, please see the K-State Research and Extension publication *Gardening on Brownfields: Historical Property Usage and Implications, MF3096*.

In addition, consult the K-State Research and Extension publication *Gardening on Brownfields: Obtaining Property Information and Site History, MF3078* on how to research the historical use of a property.

Where do I sample? Laboratory analyses for contaminants can be expensive. Sample only areas of the property where garden beds will be established. If at all possible you should have the garden layout planned before sampling soils. To keep costs down, consider the following sampling strategies:

- **Sample selectively:** Sample areas of the selected garden site showing stressed vegetation, low areas (where surface waters tend to pool), around residential structures, around former foundations, and at locations where historical records identify storage and/or use of potential contaminants (such as drums, above-ground storage tanks for petroleum products, pesticides, etc.).
- **Sample systematically:** If there are no discerning features on the property and the historic records do not indicate any reasons to sample selectively, consider using a grid pattern to identify sampling locations. Establish the grid pattern depending on size of the property and your sampling budget (systematic sampling tends to be a bit more expensive as you end up taking more samples than with a selective sampling approach). Grid patterns may range from 10 feet by 10 feet to 100 feet by 100 feet. Samples are taken at intersecting grid points (see Figure 1.)

Figure 1. *Example of a sampling grid. Samples are obtained at the intersection of the grid lines (dashed lines).*



- **Sample randomly:** If your budget does not allow systematic sampling, and you cannot sample selectively, you need to select random sampling locations. Obtain at least one sample per planned garden bed and, if your property abuts a street and garden beds are planned alongside that street, take a few samples within approximately 20 feet of that property boundary. You can start with a relatively small number of samples and, if the analytical results show elevated concentrations, go back and take more samples.

How many samples do I need? Your need for information and accuracy, the property size, and your budget govern how many samples you take. The more samples you take, the better you will understand the potential soil contamination levels at your property.

If you sample selectively, i.e. sample identified potential problem areas as identified visually or via historic records, you will want to take individual samples. For other areas of the property, especially when sampling on a grid, it may be adequate to obtain a number of composite samples. Gather these composite samples by collecting several individual samples and mix equal parts of each sample to form one composite sample and repeat the process until you have the area you want to sample covered. While this is more economical, it may mean a smaller, localized area of contaminated soil will not be identified as such because an average contaminant concentration over a larger area is generated.

The analysis of some constituents, such as pesticides, can be quite expensive, while analysis for metals is relatively inexpensive. If warranted, a combination of composite and individual samples could be obtained, depending on budget and need for accuracy.

To what depth do I sample? When sampling soil for contaminants, representative samples need to be taken in order to obtain good analytical results. This means the sample should be made up only from soil from the location and depth you intended to sample; no other soil should be mixed in. Sample depth should be governed by the rooting depth of the crops to be grown. Most leafy vegetables (chards, lettuce, spinach, etc.) do not exceed a rooting depth of 6 inches (≈ 15 cm) under good growing conditions, i.e. sufficient moisture and good soil structure (not too clayey or sandy). Tomatoes root deeper, averaging 1 foot under good growing conditions, and larger root crops tend to fall in the same category. Depending on what you grow, taking a soil sample from ground surface to a depth of either 6 inches or 12 inches will be sufficient.

How do I sample? The following tools are needed for sample collection: clean trowel, shovel or spade, and a clean plastic bucket (for compositing samples only). **Note**: When sampling for metals, use only steel tools. Start with clean sampling tools and clean all sampling tools with soap and water between each sample location. You do not want to carry over potential contaminants from one sample location to the next as this will influence the test results. If you touch the samples with your bare hands, make sure you clean your hands between sample locations. If you wear disposable gloves for sample collection, put on a clean pair at every sample location.

If sampling for metal analysis, use clean zipper-type sandwich bags for sample storage. For anything else, use containers provided by the laboratory that will analyze your samples. **Note:** some samples require refrigeration and storage at 39.2 degrees Fahrenheit (4 degrees Celsius), i.e. they need to be stored in a cooler filled with a bag/bags of ice immediately on collection until analysis by the laboratory. The laboratory that analyzes your samples will tell you what samples to keep cold and what sample containers to use for the specific constituents to be analyzed. Always submit the samples to the laboratory as soon as collection is finished. Be sure to ask the laboratory for instructions.

Who should take samples? If you are uncomfortable taking soil samples for environmental contamination analysis yourself, you have potentially several options.

- **Ask local government.** If the local government owns the property, ask if environmental soil sampling could be performed for the property. Your local government may have an EPA brownfields grant under which they may be able to perform soil sampling.
- **Ask the state environmental agency or regional EPA office.** Your state environmental agency and/or your regional EPA office can perform soil sampling via the Targeted Brownfield Assessments/Brownfield Targeted Assessments program. These assessments are performed free of charge, but are available only if you are an entity of local government or a not-for-profit organization. Please see *http://www.gardeningonbrownfields.org/resources/contacts.html* for a list of state and EPA brownfield contacts.
- **Ask your local health department.** Your local health department may be able to take soil samples for you.
- **Consult an environmental laboratory.** If you are using a local laboratory for sample analysis, ask if they have a technician who may be able to obtain the required soil samples. You likely will have to pay extra for this service.
- **Hire an environmental consultant.** A consultant can obtain soil samples at the property.

Soil test resources

Some universities offer soil testing for lead, other metals, and arsenic.

Brooklyn College, New York *http://www.brooklyn.cuny.edu/web/aca_centers_esac/110901_Soil_Brochure.pdf*

Cornell University, New York: *http://cnal.cals.cornell.edu/soil-testing/*

Kansas State University: for pricing: *https://www.agronomy.k-state.edu/outreach-and-services/soil-testing-lab/documents/Farmer-and-Gardener-Price-List.pdf*, for shipping and other information: *https://www.agronomy.k-state.edu/outreach-and-services/soil-testing-lab/*

Penn State Cooperative Extension: *http://agsci.psu.edu/aasl/soil-testing/environmental-soil-testing*

Rutgers University, New Jersey Agricultural Experiment Station: *http://njaes.rutgers.edu/soiltestinglab/services.asp*

University of Connecticut Soil Testing Lab: For general information:*https://soiltesting.cahnr.uconn.edu*
For pricing and other information: *https://soiltesting.cahnr.uconn.edu/price/*

University of Delaware Soil Testing Program: *http://extension.udel.edu/dstp/*

University of Maine Soil Testing Lab: *http://anlab.umesci.maine.edu/soillab_files/prices/soiltest12.pdf*

University of Massachusetts Soil and Tissue Testing Laboratory: *http://soiltest.umass.edu/services*

University of Minnesota Soil Testing Lab: For general information: *https://soiltest.cfans.umn.edu*
For pricing and other information: *https://soiltest.cfans.umn.edu/sites/soiltest.cfans.umn.edu/files/2023-03/lawn_and_garden_2023_0.pdf*

University of the District of Columbia, Washington D.C.: *https://www.udc.edu/eqtl/*

University of Vermont, Agricultural and Environmental Testing Laboratory: For general information: *https://www.uvm.edu/extension/agricultural-and-environmental-testing-lab*
For pricing and other information: *https://www.uvm.edu/sites/default/files/Department-of-Plant-and-Soil-Science/AGTesting/Misc_lab_submission_form.pdf*

University of Wisconsin: *http://uwlab.soils.wisc.edu/fees/*

Glossary

Brownfields site: Previously used, underutilized/ blighted, potentially contaminated property.

Composite sample: A sample made up of several individual samples.

Heavy metals: Any metal heavier than iron; examples of heavy metals are lead, cadmium, and mercury.

Individual sample: A sample obtained at a specific location and depth.

Metalloid: A chemical element with properties in between those of a metal and a nonmetal. Arsenic is a metalloid.

Representative sample: A sample representing only the location and depth from which it was obtained.

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