EPA

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REUSING POTENTIALLY CONTAMINATED LANDSCAPES:

Growing Gardens in Urban Soils

This fact sheet provides communities and individuals with general urban gardening information about:

- **Common contaminants that can be found in urban soil.**
- **Ways to identify contaminants and reduce exposure.**
- **Improving soils and growing plants in mildly contaminated soil.**
- **Additional resources and technical assistance.**

Introduction

Communities throughout the country are turning to urban agriculture and gardening as a reasonable option to increase their access to healthy, nutritious, and low-cost produce. Some of the sites that communities are using for urban gardens were previously home to industrial and commercial operations. A garden on abandoned land can become a new community asset by improving the visual look of a neighborhood and potentially increasing nearby property values. Community gardens provide many benefits, including healthier lifestyles by increasing activity levels, providing fresh produce, growing community pride, and nurturing social interactions and cooperation among people.

For communities interested in gardening on a site that might be contaminated, it is important to first determine the health and suitability of the soil at the site. It is a common gardening practice to test soil for characteristics such as pH and nutrient availability. When creating a garden on land with an industrial or commercial history, it is highly recommended that communities consider the site's land use history and test the soil accordingly for potential contamination. Knowledge of soil health and potential contamination are keys to helping communities identify and correct problems so that each urban garden is safe and productive.

The possibility of contamination at a garden site should not keep you from planning an urban garden there. This fact sheet presents steps that you can take to find out and address potential contamination at your site to help create a safe and healthy garden for your community.

More information for the urban gardener on soil science, soil amendments, plants, contaminants and their health effects, and additional links is available on EPA's CLU-IN website: www.clu-in.org/ecotools/urbangardens.cfm.

U.S. Environmental Protection Agency
Office of Superfund Remediation and Technology Innovation

Soil Quality

Q: Why Is Healthy Soil Important for Your Garden?

A: Healthy soil is essential for plants to grow in your garden. When a property has been used for industrial or commercial activities, the soil is often nutrient deficient, highly compacted and potentially contaminated. These soils can be improved and made healthy again so that your garden plants can grow and thrive. Healthy soil holds water and contains beneficial organisms, plant nutrients, and organic matter.

Soil Nutrients

Soil nutrients are vital for healthy soil and must be available for plants to grow. Soil tests will help you determine the existing nutrients available in your soil and indicate which nutrients and nutrient amounts need to be added. Mineral nutrients such as nitrogen, phosphorus, potassium (NPK), and calcium can occur naturally in the soil, but often need to be applied to maintain a healthy balance. Soil nutrients may be added in various forms, including: fertilizer and lime (available in most gardening stores) and organic matter such as grass clippings, leaves, and compost.

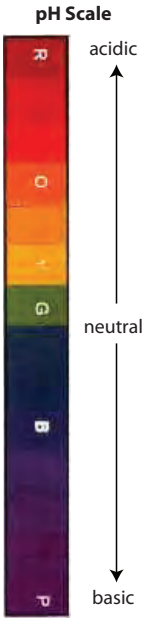
Physical Properties of Soil

The physical properties of soil determine how well nutrients are available to plants. Soil contains a combination of sand, rock, silt, clay, air, and organic matter, which affects its ability to hold nutrients and water.

You can improve the physical quality of your soil by leveling and loosening the soil and adding organic matter such as compost and manure. These additions can increase the amount of water that sandy soils can absorb or hold and can improve the drainage of clay soils.

Soil pH

Soil pH affects the amounts and types of nutrients available to plants through their roots. The pH scale goes from 0 to 14; a pH of 7 is neutral. A lower number means a more acidic soil, while a higher number means a more basic or alkaline soil. Certain nutrients are less available to plants in soils where the pH is too low or too high. When a soil's pH is near neutral, nutrients are more readily available to plants, and microbial populations in the soil increase. A soil test will tell you the pH of your soil. Based on this information, you will be able to determine whether soil amendments (soil additions) are needed to change the pH of your soil to meet your gardening needs. You can raise the pH of soil by adding lime or wood ash. You can lower the pH of soil to make it more acidic by using fertilizers containing ammonium-nitrate or specialty fertilizers for "acid-loving" plants that contain ammonium sulfate or sulfur-coated urea.



For more information on amendments that can be used to improve soil quality, see Techniques for Addressing Soil Contamination in the Resources section in this fact sheet, page 11.

Contaminants

A soil contaminant is an element or chemical present in the soil at a level that could possibly pose health risks. In a few areas of the country, element levels may be naturally high. In many cases, human activities have increased the soil levels of many elements and chemicals and also spread them out more widely. Lead, cadmium, arsenic, zinc, and polycyclic aromatic hydrocarbons (PAHs) are contaminants commonly found in any urban environment. In addition, other contaminants can also be found in areas near former commercial or industrial properties. Table 1 lists sources of contamination that are commonly found on sites with a commercial or industrial history.

Table 1. Common Sources of Contamination[1]

General Source	Examples of Previous Site Uses	Specific Contaminants
Paint (before 1978)	Old residential buildings; mining; leather tanning; landfill operations; aircraft component manufacturing	Lead
High traffic areas	Next to heavily trafficked roadways or highways; near roadways built before leaded fuel was phased out	Lead, zinc, polycyclic aromatic hydrocarbons (PAHs)
Treated lumber	Lumber treatment facilities	Arsenic, chromium, copper
Burning wastes	Landfill operations	PAHs, dioxins
Contaminated manure	Copper and zinc salts added to animal feed	Copper, zinc
Coal ash	Coal-fired power plants; landfills	Molybdenum, sulfur
Sewage sludge	Sewage treatment plants; agriculture	Cadmium, copper, zinc, lead, persistent bioaccumulative toxins (PBTs)
Petroleum spills	Gas stations; residential/commercial/industrial uses (anywhere an aboveground or underground storage tank is or has been located)	PAHs, benzene, toluene, xylene, ethyl benzene
Pesticides	Widespread pesticide use, such as in orchards; pesticide formulation, packaging and shipping	Lead, arsenic, mercury, chlordane and other chlorinated pesticides
Commercial/industrial site use		PAHs, petroleum products, solvents, lead, other heavy metals (such as arsenic, cadmium, chromium, lead, mercury and zinc)
Dry cleaners		Stoddard solvent and tetrachloroethene
Metal finishing operations		Metals and cyanides

EPA's Toxic Release Inventory (TRI) can provide information to communities about sites where contaminants were released into the environment. The Envirofacts database allows users to enter location information, such as zip code, address or county location, to get information about releases in their area. The database is available online at: www.epa.gov/enviro.

1 Adapted from Heinegg, A., Maragos, P., Mason, E., Rabinowicz, J., Straccini, G. and Walsh, H. (2000) Urban Agriculture and Soil Contamination, available at: http://cepm.louisville.edu/Pubs_WPapers/practiceguides/PG25.pdf.

What Are Soil Background Levels?

Background levels are the naturally occurring levels of elements and chemicals found in any soil. Background levels differ depending on the region of the country in which you live. In some areas background levels for certain elements and chemicals may be higher. Contact your local extension service or state environmental agency (see Technical Assistance in the Resources section, page 10) for help in learning more about elemental background levels for the soil in your neighborhood.

More information on soil background levels in the United States is available at: http://pubs.usgs.gov/of/2005/1253/pdf/OFR1253.pdf.

Contaminants continued

Q: How Do I Know if My Property is Contaminated?

A: You can conduct a formal environmental assessment (study) of the land you are interested in using for urban gardening. There are two types of assessments: Phase I and Phase II Environmental Assessments. A Phase I assessment includes a review by a trained environmental professional of historical site uses, interviews with neighbors and, if possible, site owners, and a visual site inspection to determine the potential for and type of contamination at a site. If a Phase I assessment determines that there is potential for contamination at the site, a Phase II assessment is conducted to sample for contaminants and locate any impacted areas.

For more information on Phase 1 and Phase 2 assessments, contact your local and state environmental agencies. Some local governments may even be able to provide you with a Phase I or Phase II environmental assessment or have qualified environmental professionals on staff who can conduct the assessment.

Q: What if My Community Needs Help with Site Assessments, Sampling or Cleanup?

A: Federal funding is available to government entities to conduct brownfields (property where reuse may be complicated due to on-site contamination) assessments. Working with local officials to apply for an EPA brownfields grant can provide money for your community to assess or clean up the property you are interested in as well as address other properties.

What you need to know to get started in applying for brownfields grants can be found at: www.epa.gov/brownfields/grant_info/assess/assessment_factsheet.pdf.

Biosolids

Biosolids are the nutrient-rich organic materials resulting from the treatment of sewage sludge (the name for the solid, semi-solid or liquid untreated residue generated during the treatment of domestic sewage in a treatment facility). When treated and processed, sewage sludge becomes biosolids, which are tested for safety to be recycled and applied as fertilizer to improve and maintain productive soils and stimulate plant growth. Only biosolids that meet the strictest state and federal standards can be approved for use as a fertilizer.

More information on how biosolids have been used to solve problems on potentially contaminated lands is available at: www.cluin.org/ecotools/soil.cfm.

More information on biosolids is available at: http://water.epa.gov/polwaste/wastewater/treatment/biosolids/genqa.cfm.

More information for the urban gardener on soil science, effects, and additional links is available on EPA's CLU-IN

Exposure Pathways

Q: How Could I Come into Contact with Contaminants while Gardening?

A: An exposure pathway is the way that a contaminant comes into contact with people. If a site assessment concludes that contaminants are present, the next step is to think about potential contaminant impacts as you work the soil to garden or eat the food you grow. There are two human exposure pathways to soil contaminants: the *soil-to-human pathway* and the *soil-to-plant-to-human pathway*.

Soil-to-Human Exposure Pathway

While gardening, the greatest risk of exposure to contaminants is from contaminated soil getting into your mouth or by breathing in contaminated dust. For example, children playing in the garden may directly eat soil through hand-to-mouth play, or people may eat plants without first washing them to remove soil and dust. Skin contact (dermal exposure) with soils containing contaminants such as PAHs, chromium and trichloroethylene (TCE) can pose health risks.

Soil-to-Plant-to-Human Exposure Pathway

Some edible plants do take up and accumulate contaminants. A plant's uptake of contaminants depends on many factors, including the type of plant and the pH and organic content of the soil. However, research shows that there is minimal risk of exposure from eating plants grown in contaminated soils. To reduce concerns of exposure from eating plants, wash produce thoroughly before eating to remove potential soil contamination. Root vegetables have a higher potential for accumulating contaminants. In some cases, it may be prudent to avoid growing edible plants in soils with high contaminant concentrations.

What Are EPA Soil Screening Levels (SSLs) and Can SSLs Be Used as Limits for Urban Gardening?

EPA's SSLs were developed to determine if the soil at Superfund (program that allows EPA to clean up hazardous waste sites) sites warrants further study, investigation or *possibly* cleanup depending on how a site is being used (for example, for residential or commercial purposes). These screening levels look at several *soil-to-human* exposure pathways, including: direct ingestion, dermal exposure, and inhalation. EPA's general guidance states that if an SSL is not exceeded for a pathway of concern, the user may eliminate that pathway from further investigation. While EPA does not have SSLs for gardening, some states may decide that residential SSLs are appropriate to use for gardening purposes, or they may establish appropriate levels specific to each site.

Wise Urban Gardening

In general, the benefits of urban gardening greatly outweigh the risks. By following the recommendations and best practices listed below, you will decrease your likelihood of exposure to contaminants that are commonly found in urban soils located on sites with past industrial and commercial uses.

Q: What Can I Do to Lower the Chances of Coming into Contact with Contaminants that May Be in Present in my Soil?

A: If you find that the soil in which you want to garden is contaminated, you may want to first consult with your state and local environmental agencies and EPA's Technical Assistance to Brownfields (TAB) program (see Technical Assistance in the Resources section, page 10) to learn about how to find professional site cleanup specialists who can recommend the best techniques for reducing high levels of contaminants. The following techniques are commonly used to eliminate exposure to soil contaminants:

- **Build raised beds.**
- **Use soil amendments to stabilize contaminants in soil.** Adding a thick layer of organic matter to your soil provides a physical barrier to contamination. Soil amendments may reduce mobility or bioavailability of contaminants. Soil amendments improve the overall soil quality for growing plants and are a good addition to any soil.
- **Remove all contaminated soil and replace it with clean soil.** Make sure the replacement soil is clean by asking the supplier for proof that the soil that was tested to be contaminant-free.
- **Use of phytotechnologies,** which utilize plants to extract, degrade, contain or immobilize contaminants in soil. However, using phytotechnologies to clean up contaminants can take many years, is not effective for every contaminant, and generally requires special handling for the disposal of plants used. Information on specific contaminants that can be remediated using phytotechnologies is available at: www.cluin.org/download/remed/phytotechnologies-factsheet.pdf.

More information for the urban gardener on soil science, effects, and additional links is available on EPA's CLU-IN

Build Raised Beds and Container Gardening

Building raised beds and growing plants in containers is the most common way to reduce the chances of coming into contact with contaminants in urban gardens. These gardening techniques are preferred because the clean soil and organic matter used to build the raised beds creates a physical barrier between the gardeners/plants and possible contamination in the ground soils. Raised beds can be built for permanent or seasonal use.

How to build raised beds:

- Place a layer of landscape fabric on top of the ground soil before adding the clean soil and organic matter. The fabric layer creates a barrier beneath the soil in the bed that prevents plant roots from entering the ground soil below the bed.
- Build a frame to hold the clean soil for a permanent raised bed. Ask for non-treated lumber when getting wood to build the frame.

See the National Gardening Association's how-to video on "Making a Raised Bed Garden," available at: www.garden.org/howtovideos/index.php?page=video2.

Even when you are using raised bed and container gardens to address contamination, airborne contaminants, soil dust, or soil splashback from other areas may still enter the raised beds. Consider covering walkways and other areas of exposed soil with mulch, grass, or other groundcover to help reduce dust migration and splashback onto crops and protect against human exposure when gardening.

Bioavailability

The risks associated with contaminant levels in soil may also be much lower than expected based on test results because of the bioavailability of the contaminant in the soil. Bioavailability of a contaminant is the amount of contaminant that can be taken up by your body. It depends on the characteristics of the site and the soil. Treatment of soils rich in lead with phosphate and compost may reduce the bioavailability of soil lead.

Phytotechnologies and Lead

Q: Lead is a common contaminant in urban soils. Can I use phytoremediation to remove lead from the soil at my site?

A: No. Phytoremediation of lead in soils is ineffective since lead is generally not available for plant uptake.

soil amendments, plants, contaminants and their health website: www.clu-in.org/ecotools/urbangardens.cfm.

Best Practices in the Garden

Building raised beds and mulching pathways is an excellent way to reduce the chance of coming into contact with potential contaminants. The recommendations below can add another layer of protection if you have raised beds or decide to do in-ground planting.

- Locate gardens away from old painted buildings and roads with heavy traffic.
- Use a thick layer of organic material such as compost or mulch. Place landscape fabric between ground soil and new, clean soil.
- Watch over small children to stop them from eating soil through hand-to-mouth play.
- Wash hands immediately after gardening and before eating to avoid accidentally eating soil.
- Wear gloves as a barrier between your hands and the soil.
- Throw away the outer leaves of greens, especially from the bottom of plants, before washing. Soil particles are most likely to be located on the outer leaves of leafy plants.
- Wash produce using running water.
- Avoid bringing contaminated soil into the home by:
    - Cleaning tools, gloves and shoes before bringing them indoors.
    - Putting highly soiled clothes in a bag before bringing them indoors and washing them promptly in a separate load.
    - Washing off excess dirt from crops, especially root crops and leafy vegetables, before bringing them indoors.
- Peel vegetables, especially root vegetables, which are in direct contact with soil.

More information for the urban gardener on soil science, effects, and additional links is available on EPA's CLU-IN

Steps You Can Take to Reduce Potential Risk from Contaminants When Growing Vegetables:

- Add high rates of compost and other organic soil amendments to the soil (up to 50:50 by volume) in order to dilute soil contaminant concentrations, improve the physical properties of soil and plant growth, and make contaminants less available for plants to take up.
- Garden in raised beds or containers to separate the garden from the contaminated soil.

To learn about safe levels of soil contamination and the cleanup requirements of sites used for gardening or farming in your area, contact your state environmental agency or cooperative extension services.

Contact information is provided under *Technical Assistance* in the *Resources* section, page 10.

Choosing Crops

In general, plants that produce fruiting bodies (for example, tomatoes, squash, apple and pear trees, and berries) are most appropriate for growing in potentially contaminated soil. Root and tuber crops (for example, carrots, potatoes and onions) are often the least appropriate plants to grow in potentially contaminated soil, as the edible portions of the crops are in direct contact with the soil. Vegetables with large outer leaves (for example, cabbage, lettuce and collard greens) are easily contaminated by dust and soil splashback, so careful washing of these plants is necessary.

Conclusion

There are many effective ways to reduce or eliminate any risk from gardening on potentially contaminated land. Gardening provides many benefits to communities and individuals. The information in this fact sheet is designed to help you understand the steps that your community can take to create healthy garden conditions for growing a variety of delicious and nutritious crops. So go dig, plant, harvest and enjoy!

soil amendments, plants, contaminants and their health website: www.clu-in.org/ecotools/urbangardens.cfm.

Case Study
LIBERTY LANDS
Philadelphia, Pennsylvania

Twenty years ago, the Northern Liberties neighborhood was the only zip code in Philadelphia without a community green space. Several tanneries contaminated the neighborhood. EPA conducted removal actions and cleaned up the site. Neighborhood residents worked with the City of Philadelphia to find resources for reusing the site. EPA provided soil testing and other technical assistance to ensure that the site was safe for reuse as a park and community garden. Hundreds of hours of donated time, monthly meetings, outreach and fundraising efforts resulted in Liberty Lands community park becoming a reality. The park opened in 1996 and includes 37 garden plots and a composting area, an herb and butterfly garden, a children's playground, open space for community events, and community art and sculpture. The park is at the center of a revitalized community, surrounded by new residential and commercial redevelopment.

For more information, visit www.epa.gov/brownfields/success/libertylandspass.pdf.

Resources for Urban Gardeners

Technical Assistance

1. Local agricultural cooperative extension services can help with interpreting soil quality results (i.e., pH and nutrients testing) and provide a list of local environmental departments or laboratories that test for soil contaminants. U.S. Department of Agriculture extension services are listed online at: www.csrees.usda.gov/Extension/index.html.

2. EPA's Technical Assistance to Brownfields (TAB) program can help with questions regarding Phase I and Phase II Environmental Assessments. The TAB website is available at: www.epa.gov/brownfields/tools/index.htm#tab. In addition, several TAB providers have experience working with communities to explore urban agricultural opportunities. These providers include:
   - Kansas State University: www.engg.ksu.edu/chsr/outreach/tab.
   - Center for Creative Land Recycling (especially in California and Colorado): www.cclr.org.

3. State and tribal brownfields programs may be able to help with information specific to your state or tribe. To find your state brownfields program, visit: www.epa.gov/brownfields/state_tribal/state_map.htm. To find your tribal brownfields program, visit: www.epa.gov/brownfields/state_tribal/tribe_progs.htm.



Additional Resources

General Information

More information about creating an urban garden is available at: www.epa.gov/brownfields/urbanag/.

More information on soil science, soil amendments, plants, contaminants and their health effects, and additional links can be found on EPA's CLU-IN website, available at: www.clu-in.org/ecotools/urbangardens.cfm.

Soil Quality

More information on soil health is available at:

- EPA's Hazardous Waste Cleanup Information website: www.clu-in.org/ecotools/soil.cfm.
- Cornell's Waste Management Institute website: http://cwmi.css.cornell.edu/soilquality.htm.
- Local agricultural cooperative extension services website: www.csrees.usda.gov/extension.

Contaminants

The EPA Sector Notebook Series is a set of profiles containing information on specific industries. The notebooks can help your community identify types of contaminants often associated with specific commercial and industrial land uses. The notebooks are available at: www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/index.html.

EPA's Toxics Release Inventory System provides useful information about the history of individual sites: www.epa.gov/tri/.

Information about the health effects of particular contaminants is available at:

- The Agency for Toxic Substances and Disease Registry (ATSDR): www.atsdr.cdc.gov/substances/index.asp.
- EPA's Integrated Risk Information System (IRIS): www.epa.gov/IRIS.
- The Risk Assessment Information System: http://rais.ornl.gov.

In addition, EPA's Superfund Redevelopment Initiative website has a web page where reuse questions can be submitted: www.epa.gov/superfund/programs/recycle/contact/index.html.

Techniques for Addressing Soil Contamination

For more information on techniques for addressing soil contamination:

- EPA fact sheet: *Soil Amendments for Remediation, Revitalization and Reuse Tools: Fact Sheet*, available at: www.clu-in.org/download/remed/540R07013.pdf.
- EPA paper: *The Use of Soil Amendments for Remediation, Revitalization and Reuse* available at: www.clu-in.org/download/remed/epa-542-r-07-013.pdf.
- EPA paper: *Urban Agriculture and Soil Contamination: An Introduction to Urban Gardening* available at: http://cepm.louisville.edu/Pubs_WPapers/practiceguides/PG25.pdf.
- EPA fact sheet on brownfields redevelopment and local agriculture available at: www.epa.gov/brownfields/success/local_ag.pdf.
- EPA's fact sheet on phytotechnologies, available at: www.cluin.org/download/remed/phytotechnologies-factsheet.pdf.

Funding Opportunities

More information on funding sources for brownfields assessment, cleanup, revolving loans and environmental job training is available at: www.epa.gov/brownfields/grant_info/index.htm.

EPA's fact sheet on how to apply for Brownfields Assessment Grants is available at: www.epa.gov/brownfields/grant_info/assess/assessment_factsheet.pdf.

Learning about and taking steps to assess and address potential contamination can help you to ensure that your urban garden area is safe and productive. You can reap the benefits for years to come.

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