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Soils in Urban Agriculture: Testing, Remediation and Best Management Practices for California Community Gardens, School Gardens, and Urban Farms

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Urban agriculture, including community and school gardens, and small farms in cities, has become a popular means of obtaining fresh local produce. San Francisco, San Diego, Los Angeles and several other California municipalities have changed policies to facilitate these activities.

Soils are an important consideration for individuals, community groups, and local governments becoming involved in urban agriculture. In many situations, urban soil has been contaminated and degraded by past uses and activity, including industry, unauthorized dumping, construction, heavy nearby traffic, and adjacent buildings where lead-based paint has been applied.

Elevated levels of lead in particular are fairly common in urban soils, and pose health risks, especially to young children who can ingest soil while playing or helping in gardens. Ongoing exposure to lead can cause damage to the nervous system and interfere with brain development, along with creating other health

problems. Arsenic, cadmium, copper, zinc and other naturally occurring trace elements in soils can also be elevated to unsafe levels by various past land uses.

Although soil degradation and contamination are important concerns and should be addressed, they are not always a problem with urban agriculture sites. A study conducted at several Los Angeles area community gardens by University of California researchers found that "in nearly all cases concentrations of trace elements were well within natural ranges" (Hodel, D.R. and A. C. Chang, 2002). In contrast, a study conducted in San Francisco found that "a majority of the gardens exceeded the California Human Health Screening Level for arsenic, cadmium, and lead" (Gorospe, 2012).

Even where there are elevated levels of lead or other metals or contaminants in soil, relatively little is absorbed by plants that can be harmful to humans, although this varies depending on the soil condition and the plant characteristics. Accidentally swallowing or inhaling contaminated soil and dust is the most likely way urban farmers will be exposed to unsafe levels of lead or other contaminants. This can happen easily, for example, when people put their fingers in their mouths without thinking.

Beyond heavy metals, other sources of soil contamination and soil hazards might include solvents found at sites with a history of manufacturing use, various petroleum based chemicals – common at previous gas station sites and other industrial sites, chlorinated pesticides and residual herbicides on former agricultural lands or public landscaped areas, saline soil, and issues where a contaminant may not be harmful to people, but may prevent plant growth or production. Physical debris such as lumber, concrete, wire, broken glass or discarded syringes can also create hazards for the urban farmer.

Clearly, there are no easy answers. Each site and situation is unique. However, putting in place reasonable policies and encouraging sustainable practices will help to ensure that participants and those who consume urban agriculture products are not exposed to unsafe levels of lead or other heavy metals and contaminants. This publication outlines strategies for urban soil contamination assessment, remediation, and municipal policy around safe soils for urban agriculture, and offers additional resources for further exploration. This publication does not cover soil fertility or other important soil science topics, although resources are listed on page 10. Instead, the goal is to provide an overview of issues unique to urban soil use for food production.

Soils Assessment for Urban Agriculture

Site Selection: Overall soil conditions should be a consideration when selecting a site for urban agriculture. If plants, even weeds, are growing abundantly on the site, this is a good indication that the soil will be able to support crops. If soil is reasonably easy to dig, this is a positive sign as well. The presence of plant roots and earthworms can indicate soil health. However, note that these indicators do not guarantee that soil is uncontaminated. When assessing potential sites, be aware that properties with considerable amounts of trash and rubble, or with obvious dead spots where plants do not grow, may pose greater challenges. Heavy herbicide or pesticide use may have even sterilized the soil on a site. *A simple test for evaluating soil fertility is to plant bean seeds*

in soil from the site, perhaps in a pot or some biodegradable paper cups, and compare their germination and growth with an equal number of beans grown in purchased potting soil. It is also advisable to dig a hole one-to-two feet deep in several places to assess the type of debris on the site.

Site History: It is important to learn as much as possible about the history of a proposed site and how it has been used in the past. Walking around the site may provide some clues. Adjacent older homes with peeling paint, paint chips or evidence of sandblasting indicate potential soil lead contamination. Any building built before 1979, with old or peeling paint, may be a hazard due to use of lead-based paint. Proximity to a freeway or heavily trafficked road is also a source of lead. Although leaded gasoline has not been in use since the 1980s, lead particles in vehicle exhaust may have settled from the air into the soil.

Talking to the property owner and neighbors is a good strategy, as neighbors are often familiar with past use of the property. It may also be necessary to do some internet or library research. For example, at some public libraries it is possible to access Sanborn maps, which were used in the past by insurance companies to determine the risk involved with insuring individual properties. These maps can provide information about prior uses of a proposed site. These are available at public libraries, and may be available online through some libraries. Old aerial photographs, which can sometimes be found in local libraries or online, can help identify a site's history as well.

The local city hall may also have some of these aerial photographs accessible in their archives. There is also a fee-for-service website, ***http://www.historicalaerials.com***, which includes aerial maps of various regions of California where the history of a site can be researched. The county tax assessor's office and city hall are important sources of tax records and permits that have been obtained for the property, which can help uncover past uses of the site. Potential sites can be checked on the California Department of Toxic Substances website at ***http://www.envirostor.dtsc.ca.gov/public/*** to see if there are any documented issues or ongoing cleanup activity associated with the property.

Some examples of prior uses of sites that may have caused soil contamination are parking lots, junkyards, auto repair/auto painting, carpentry, machine shops, dry cleaners, gas stations, railroad yards, and illegal dumping. The history of the site will help to determine what kind and how much soil testing is necessary. **A site that has been primarily residential or used as green space is generally lower risk. A site that has had past industrial or commercial uses should be more carefully analyzed.**

Soil Testing

Having soil tested at a laboratory is always recommended. This should be considered a basic cost of starting any urban agriculture project. The cost will depend on the size of the proposed site, the number of soil samples needed, and the type of analysis conducted by the lab.

Soil test kits sold at hardware stores or garden centers provide some basic estimates of soil fertility, but are not suitable for assessing soils at a potential urban agriculture site, as they do not provide information about soil contaminants.

Selecting a Soil Testing Lab: Finding a university or commercial lab to do soil testing is not difficult; performing an internet search for your region or state

should result in several choices. In many publications, the Cooperative Extension service is listed as a resource for testing soil. However, the University of California Cooperative Extension does not offer soil testing. Some other state land grant universities accept out of state soil sample submissions by mail at very reasonable prices, including University of Massachusetts at Amherst and Penn State University.

When selecting a soil testing lab, here are some questions to ask when talking to the labs:

1. Do you participate in the North American Proficiency Testing Program (NAPT – this program assures that soil test analyses are being performed using validated testing methods).
2. Which tests do you recommend for an urban agriculture site with no site history?
3. Do you recommend any specific tests for sites with a history of industrial or commercial use?
4. Do you perform tests for elevated levels of heavy metals and other contaminants– in particular, those listed in the California Code of Regulations Title 22: *Inorganic Persistent and Bioaccumulative Toxic Substances*?
5. What costs are involved for testing?
6. What is the recommended procedure for taking soil samples?
7. Is it okay for people to call the lab for advice and information?
8. Is a narrative provided with the soil test results? Is there an extra charge for this?
9. Do you provide remediation recommendations with the soil tests?
10. What is your turnaround time?

The US Environmental Protection Agency recommends that for urban areas, "at a minimum, the soil test should include pH, percent organic matter, nutrients, micronutrients, and metals, including lead" (See EPA Publication No. 905R1103, "Evaluation of Urban Soils: Suitability for Green Infrastructure or Urban Agriculture"). This level of testing is adequate for a site that has been residential or green space. Most commercial soil labs can test for the most important heavy metals, including not only lead, but also arsenic, cadmium, chromium and nickel.

More testing may be appropriate for a site with a history of industrial or commercial use, which might include CAM-17 testing (CAM stands for California Administrative Manual. CAM 17 refers to the list of 17 metals specified in the manual: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc). An EPA-recognized laboratory is the best choice for this level of testing.

It is possible that other types of tests may be necessary, such as testing for PAHs (polynuclear aromatic hydrocarbons), a class of potentially toxic byproducts of incompletely burned garbage, oil, wood, coal or other organic materials. These accumulate in soils and can be a concern on a site that has been a car wash, parking lot, road and maintenance depot, vehicle services site, or where coal, oil, gas or garbage were burned on site.

In many situations, staff members at soils labs are great sources of information. They are generally willing to talk on the phone about appropriate testing based on site history. However, there are instances where additional support may be necessary.

Resources for brownfields soil assessment: According to the California Department of Toxic Substance Control (DTSC), "brownfields are properties that are contaminated, or thought to be contaminated, and are underutilized due to perceived remediation costs and liability concerns." In some cases involving former industrial or manufacturing sites, old gas station sites, and some other situations, expert assistance may be necessary. Some sites may have cleanup issues beyond what a community project can accomplish without technical expertise and a significant budget. Some sites may be too expensive to test and remediate. Help may sometimes be available, though, through state and local brownfield programs. California DTSC oversees a voluntary cleanup program for brownfield sites. Some cities have brownfields programs that may be able to provide guidance, resources and perhaps even help secure funding for cleanup. Although urban agriculture is not yet a common reuse for brownfield sites, this is an area for further exploration. Local offices of the USDA Natural Resources Conservation Service (NRCS) may also be able to provide technical assistance and guidance on a case by case basis.

Taking Soil Samples: Laboratories generally provide an online instruction sheet on how to sample the soil, prepare the sample, and mail it to the lab. Once a lab has been selected, review its website for instructions, or speak to a staff member on the telephone. Detailed instructions on collecting soil samples are also available in several of the resources listed on page 10. It's important to review these instructions, since poorly collected or unrepresentative soil samples may not provide good information.

Generally, it's essential to approach soil testing with a plan in mind. By making a simple map of a proposed site, and noting areas with different characteristics, it is possible to decide how many samples to collect.

Mapping sampling area.

1. If there is an area where plants are not growing, or the soil is discolored, that area should be sampled separately.
2. An area of the site adjacent to a building with peeling paint should be sampled separately.
3. For each area to be sampled, it is usually appropriate to take five to seven sub-samples which will be mixed together to create a composite sample.
4. Samples should be taken from the top four to six inches of soil.
5. Any litter, leaves, grass, or anything else covering the soil should be removed before sampling. The sub-samples can then be mixed together thoroughly in a clean bucket to form a composite sample.
6. For each distinct area of the site, this process should be repeated.
7. Keeping track of sampling location is important. Once results come back, it will be necessary to refer to records that clearly show where on the site samples were taken.

Transporting samples.

1. A clean plastic resealable bag that holds approximately two cups (1 – 1 ½ lbs.) should be used to transport the soil sample.
2. Removing most of the air from a double-bagged sample is a good precaution to prevent spillage.
3. Some labs also supply sample jars, which may be free with testing.
4. The soil sample does not need to be refrigerated, but keeping it in the shade or a cool, dry place until shipping or delivery to the lab can be beneficial to achieving accurate test results.
5. Wet samples should not be shipped – inaccurate testing may result.
6. Soil samples can be dried prior to shipment by keeping the bag open in a dry and well-ventilated place or by spreading the soil in a thin layer on clean butcher or waxed paper, and allowing it to dry at room temperature.

Interpreting Soil Test Results: Some soil labs provide a narrative report with recommendations. Most labs are receptive to phone calls with questions on interpretation, upon receipt of test results. Results of soil testing indicate if plant nutrients are low and need to be raised for best plant growth, and if soil pH needs to be adjusted. The soil test can also indicate if there are higher than acceptable levels of heavy metals, or other contaminants, depending on what tests were requested.

Heavy metals are the most commonly tested, and there is more guidance available about heavy metals, especially lead, than for many other contaminants. Even so, there is not one standard as to what constitutes safe levels of heavy metals in urban agriculture. Most guidelines that exist are created for residential use scenarios and contact with soil through skin exposure or accidental ingestion, rather than formulated for gardening or farming. Still, they provide some guidance about what's acceptable.

One standard to consider is the California Human Health Screening Level (HHSL), which is used by the City and County of San Francisco, and the City of San Jose, in their guidance on lead hazard assessment for urban gardens and farms. For lead, the HHSL is 80 parts per million (ppm). Anything lower is considered "below the level of concern for human health." Another standard is the US EPA's Soil Screening Levels (SSLs) for residential use, which consider lead to be a hazard at levels of 400 ppm or more. In 2013 the EPA's Technical Review Workgroup (TRW) for Lead provided a bit of clarification specifically for gardening, and deemed soil lead at less than 100 ppm to be "low risk" for home-grown produce. The HHSL levels for heavy metals and other potential contaminants are listed in the chart at ***http://www.oehha.ca.gov/risk/chhsltable.html***, and some of the most common are listed in Table 1 along with the corresponding SSLs. The EPA's TRW chart with specific, tiered soil lead recommendations for gardening is available in Table 2. **It is important to note that these standards are advisory only. Check with local municipalities (or school districts for school-based projects) to find out if more specific requirements have been established.**

Remediating Soils

If soil testing indicates that there are higher than acceptable levels of lead or other heavy

metals, there are strategies to mitigate the problem.

Working with existing soil: Many times, urban farmers automatically plan for raised beds to avoid potential soil problems. However, raised beds do have some drawbacks, including the cost of materials, obtaining quality "clean" soil to fill them, and the fact that plant roots dry out faster in raised beds, potentially increasing irrigation needs. When possible, it's more economical to plant in the existing soil. If the site has been residential or green space, without a history of industrial use, and soil test results are borderline, it may be possible to work with existing soil by following some best management practices.

1. Turn over the soil deeply and thoroughly. Contaminants are often concentrated in the top two inches of soil, and can be diluted through digging and mixing.
2. Maintain the soil pH at or close to neutral, 6.5 to 7.0. Soil nutrients are most available to plants at this pH, while lead and some other heavy metals are less available.
3. Add organic matter to the soil, and continue to do so each planting season. By adding soil amendments and compost, the soil will hold water and nutrients more effectively, and heavy metals will bind to organic matter and become less available to plants. Organic matter improves soil structure, infiltration and water-holding capacity, creates a better environment for plant roots and slowly releases plant nutrients. Adding organic matter also helps to dilute soil contaminants.

Soil Removal: The most cautious strategy, perhaps most likely to be considered when dealing with a brownfield site, is to remove existing soil from the growing area, and replace it with soil that is certified safe. However, this is an expensive strategy, and is out of the range of what most community groups or individuals can afford. Contaminated soil has to be disposed of according to law, and this can prove expensive, in addition to the costs involved with excavating soil, removing it, and bringing in clean soil.

Raised Beds: A more common approach is to build raised beds and fill them with clean soil. A study of backyard, school and community garden soils in San Francisco showed that raised bed gardens had significantly lower levels of arsenic, cadmium, and lead than in-ground gardens (Gorospe, 2012). Another study, conducted in Chicago, measured significantly less lead in raised bed gardens than in-ground gardens (Witzling et. al, 2010).

To create raised beds, urban farmers can build frames of redwood or other lumber, brick, concrete, rocks, or any other sturdy material that won't leach contaminants into the soil. Treated lumber should be avoided since lumber treatments may cause leaching of copper or other metals into the soil.

Water-permeable fabrics can be applied as a barrier between the on-site soil and the imported soil used to fill raised beds. Landscape fabric is liquid- and air-permeable, unlike black plastic. Landscape fabrics are made from various materials, including nonwoven polypropylene, woven fabric, biodegradable paper mulch, or flexible geotextile fabric.

Once the frame has been lined with landscape fabric it should be filled with "clean" soil. One way of ensuring clean soil is to purchase OMRI (Organic Materials Review Institute) -certified topsoil or planting mix. OMRI performs an independent review of products intended for use in certified organic production, handling, and processing. OMRI reviews producer-submitted products against the National Organic Standards and generates a list of acceptable products. See the OMRI Crop Products list at [***http://www.omri.org/sites/default/files/opl_pdf/crops_category.pdf***](http://www.omri.org/sites/default/files/opl_pdf/crops_category.pdf). Some products that are not OMRI listed may still meet USDA organic rules; the producer may have decided against the expense of being reviewed by OMRI. Local urban farmers or gardeners may have recommendations on potential sources of quality soil. Some vendors may be able to provide documentation that soil has been tested, and if not, the soil could be sent to a lab for testing to be sure that it is not contaminated.

Other Containers: There are other types of containers besides raised beds. Some are commercially available growing systems that are self-watering for smaller-scale projects. Others are mesh "socks" that are filled with growing medium and placed on top of the soil. These types of "instant gardens" may be especially appropriate for short term projects.

Although tires are sometimes used as planters, this practice is not recommended, since tires can contaminate soil with leached metals as they degrade over time.

Asphalt Removal: Sometimes, especially at school sites, there is no open ground available, and gardens are constructed over blacktop, or asphalt is removed in order to have a garden.

Asphalt removal, also known as "depaving", can convert an unused paved area into a garden space. This is a sizeable project to undertake, especially if doing it manually with the help of volunteers. If a professional company is hired to do the job, though, asphalt removal can be a major expense.

Many sites have created successful urban agriculture projects through depaving. For example, in 2006, volunteers removed 5,000 square feet of asphalt from the grounds of Carthay Center Elementary School in Los Angeles and created a thriving garden – the Garden of Possibilities – which is a centerpiece for the entire community. To improve the hardened clay soil, tons of soil, mulch and compost were donated and tilled into the soil by volunteers. The garden is a great success for the school; the students now participate in a year-round garden science program. The garden consists of raised beds and in-ground beds, as well as a stone fruit orchard, citrus orchard, tropical garden, butterfly garden and poetry garden.

If a site plan calls for asphalt removal, it is important to test for heavy metals and other contaminants prior to removal. Testing soil beneath asphalt requires cutting triangular holes in the asphalt with a hand-held concrete saw to expose the soil. The asphalt triangles can then be removed along with any subgrade debris or stones in order to obtain a sample (Replacing pavement triangles and adding sand or pea gravel is necessary afterwards to prevent a tripping hazard). If soil tests show heavy metals above recommended levels, rather than removing the asphalt, raised beds or large containers might be considered for gardening.

Choosing Ornamentals over Food Crops: Some sites not appropriate for growing food might still be perfect for ornamental trees and shrubs, or a wildflower meadow. Not every site needs to be a food production site, but can serve other purposes in the community, such as green space and beautification.

Best Management Practices

There are several practices that make sense in many urban agriculture settings, whether gardening in the soil, raised beds, or other containers, even where soil testing does not indicate problems.

1. Remove any debris from the site, such as trash, metal, wood, and tires. Use care in removal and disposal of these materials, being aware of and following any pertinent regulations.
2. Mulch paths and walkways between planting beds. It is also possible to use a landscape fabric then cover the fabric with mulch. Mulch will not only keep weeds in check and conserve water, it will also help keep dust that may contain lead or other contaminants from getting on crops or other surfaces that participants may touch.
3. Wear gloves while working on the site.
4. Facilitate hand washing. Hand washing immediately after working in the urban farm is important. Incorporate a hand washing station into the urban farm, and train participants to use it frequently. Handwashing is important for everyone but even more so for children, who tend to put their fingers in their mouths.
5. Thoroughly wash produce before storing, cooking and eating. Remove older, outer leaves of lettuce or leafy greens before eating. Peel root vegetables before eating.
6. Wear closed-toe footwear while working on the urban farm. If possible, remove shoes worn while at the farm before entering the home.

Municipal Policies for Soil Testing and Urban Agriculture

As urban farming in all its forms becomes more popular, municipalities are beginning to consider a variety of policies related to land use for this purpose, including requirements for soil testing and remediation. Generally, the decision faced by municipalities is whether to require soil testing and a remediation plan where appropriate, or to make recommendations and provide educational materials on best practices. Requiring soil testing can create challenges for municipalities if they do not have staff available and qualified to review and evaluate soil test results and remediation plans. Some municipalities require soil testing for contaminants (and sometimes other soil properties) for community gardens. Anyone contemplating establishment of such a garden or farm should check with the local city or county environmental health or parks and recreation department or other jurisdiction.

It is important to ensure that policies do not create insurmountable barriers for urban agriculture. Many community groups pursuing community gardens or other urban agriculture projects have limited funds to conduct extensive site analysis for contaminants and any resulting remediation.

At the same time, contamination of urban soil is an important environmental health consideration. It is possible to have urban agriculture that is both safe and cost-effective. **Soil testing is extremely important and should be facilitated and encouraged by municipalities.** Ideally, this would include subsidizing the cost of soil testing and providing assistance with interpretation of soil tests and development of simple remediation plans. Minimally, it would involve a list of best practices, such

as some of those in this publication, that urban farmers would agree to implement at their site.

Education is important in any case. Many best management practices, such as adding organic matter and managing soil pH are important strategies for ensuring safe soils, but are not practical to handle via policy. Cities and counties should explore forming partnerships with the local UC Cooperative Extension office to provide educational resources and training on soil management for urban agriculture. UC Cooperative Extension has trained Master Gardener Volunteers available who may be able to help provide education at the local level.

Cities should also foster a connection between their own brownfields program, if one exists, and urban farmers. Municipal brownfields programs should be encouraged to work with urban farmers to identify potential sites and support testing and remediation for urban agriculture projects. This strategy is being used successfully in several US cities, including Milwaukee, Wisconsin and Kansas City, Missouri.

TABLE 1.

Advisory Levels to Guide Interpretation of Soil Test Results for Heavy Metals in parts per million (ppm)[1]

Inorganic Chemicals	California Residential HHSLs	US EPA SSLs
Arsenic[2]	.07	.4
Cadmium and compounds	1.7	70
Chromium III	100,000	120,000
Chromium VI	17	230
Lead and lead compounds	80	400
Nickel and compounds	1,600	1,600
Zinc	23,000	23,000

[1] These state and federal soil screening level standards are for advisory purposes only. Please refer to page 6 for details.

[2] The screening numbers for arsenic are for contamination resulting from human activity. Concentrations of naturally occurring arsenic may be far above the screening number. When levels of arsenic at a site are a concern, the agency with authority over remediation decisions should be consulted.

TABLE 2.

EPA TRW Lead Committee Recommended Best Management Practices for Gardening in Lead Contaminated Areas (reprinted from publication #OSWER 9200.2-142)			
Soil-Lead Concentration (ppm)	**Category**	**Recommendation: Gardening Practices**	**Recommendation: Choosing Plants[a]**
<100	Low risk	No specific remedial action needed. Wash hands, produce, clothes (good gardening and housekeeping practices).	No restrictions of crop types.
>100–400 [b] 400 - 1200	Potential risk	Increasing use of good gardening and house- keeping practices as described in Table 3. Relocate garden to lower risk garden areas. Increasing use of soil amendments (e.g., compost, clean fill), barriers (e.g., mulch), and other remedial measures up to and including raised beds and containers. Ensure gardeners wear gloves and use tools to reduce soil contact and ingestion.	Decrease planting of root vegetables or relocate root crop planting to lower risk areas. Increase use of soil amendments and barriers to reduce soil deposition onto leafy vegetables. Increase planting of fruiting vegetables, vegetables that grow on vines, and fruit trees.
>1200	High risk	All of the above good gardening and housekeeping practices. Raised beds, soil containers, soil replacement (i.e., excavate contaminated soil and replace with soil containing low lead concentrations) are strongly recommended.[c] Consider finding other locations for garden. Restrict child access to only established safe areas. Restrict all gardening by or for children in contaminated soils.	Select plants with shallow roots for raised beds or areas with replacement soil to ensure that roots do not reach contaminated soil that is left in place, if any, otherwise, no restrictions.

[a] Source: Hemphill et al., 1973; Moir and Thornton, 1989; U.S. EPA, 1995; U.S. DOE, 1998; Jorhem et al., 2000; Heinegg et al., 2000; Finster et al., 2003; Pichtel and Bradway, 2008; Shayler et al., 2009; Leake et al., 2009; Chaney et al., 2010; Nabulo et al., 2010; U.S. EPA, 2011a; U.S. EPA, 2011b; Säumel et al., 2012

[b] While 400 ppm lead in soil is considered an appropriate screening level for residential soil-lead, the TRW recommends that 100 ppm be used as the low end of the range of soil lead concentrations to mitigate exposure to lead in soil when gardening is an important exposure pathway. Lacking the information to support a quantitative approach for estimating risk for gardening scenario to support establishing acceptable concentration of lead in garden areas, best professional judgment was used to establish the low end of the range. This soil concentration is below the 400 ppm soil screening level for lead because the gardening exposure pathway includes other sources of lead exposure not sufficiently accounted for in the soil screening level. The basis for the Soil Screening Level (SSL) is children playing in lead contaminated soil and some other exposures, with the predominant source of exposure from direct soil ingestion or ingestion of soil manifested as house dust. Scientific limitations when it was developed did not allow the SSL for lead to adequately account for consuming home-grown produce. In developing an acceptable concentration of lead in soil for home garden exposures, the same child receptor would be exposed if accompanying the adult in the garden and also exposed through consumption of lead in and on the produce grown in the soil. Hence, the garden-based level is lower than the SSL and reasonable steps to mitigate exposure to lead while gardening in soil lead concentrations between 100–400 ppm would be appropriate. The TRW acknowledges that background soil lead concentrations in some communities may exceed the guidance values recommended for garden areas. Mitigation may be necessary for those communities.

[c] Twenty-four (24) inches of clean soil cover is generally considered adequate for gardening; however, site specific conditions should also be considered. A 24-inch barrier normally is necessary to prevent contact of contaminated soil at depth with plant roots, root vegetables, and clean soil that is mixed via deep rototilling. Raised garden beds could cost effectively add 24 inches of clean soil (U.S. EPA, 2003).

Where Can I Get More Information?

Basic Soil Science

The California Master Gardener Program's "Garden Web" offers a helpful list of common questions and answers on basic soil science, including soil texture, structure, pH, salinity, nutrients, and fertilizers. http://ucanr.org/sites/gardenweb/Vegetables/?uid=26&ds=462

UC Davis Soil Web

The UC Davis Soil Web is a useful online tool that can give clues to past disturbances, soil removal, fill dirt additions, etc. in many areas of California. For more information, please visit http://casoilresource.lawr.ucdavis.edu/soilweb/.

Brownfields Reuse

Although urban agriculture is not yet a common reuse, the California Department of Toxic Substances Control (DTSC) offers helpful information about brownfields and California's voluntary cleanup program at http://www.dtsc.ca.gov/SiteCleanup/Brownfields/index.cfm#CP_JUMP_13298.

"Re-Use: Creating Community-Based Brownfield Redevelopment Strategies" is a website and downloadable guidebook that provides details on the reuse of brownfield sites, including agricultural use of remediated brownfields, and is a helpful guide to community engagement, funding, site assessment and cleanup of contaminated sites. The guidebook includes a case study of a brownfields site converted to a successful urban farm. http://www.planning.org/research/brownfields/.

Soil Quality/Soil Health

The USDA Natural Resources Conservation Service has a great website with a variety of resources, including assessment cards to use to evaluate soil. See http://soils.usda.gov/sqi/index.html.

Soil Testing and Remediation for Urban Agriculture

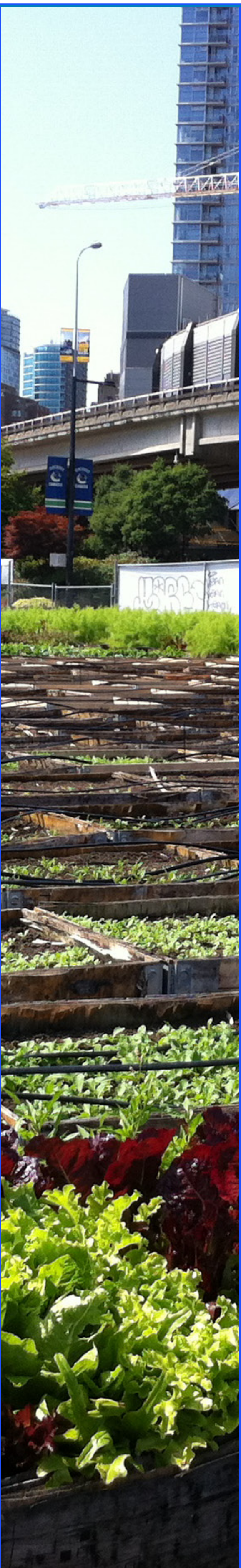
Cornell University's Waste Management Institute has great information on soil testing and remediation. http://cwmi.css.cornell.edu/soilquality.htm#soil.

"Heavy Metals and Gardens" offers multilingual resources for urban California residents on soil testing, interpreting results, and remediation. https://sites.google.com/site/healthygardeners/home.

The Organic Materials Review Institute (OMRI) provides lists of certified organic soil and soil amendment sources. This can help in identifying possible sources of certified clean soils and amendments. http://omri.org.

Policy-Related Resources on Urban Agriculture and Soil

"Seeding the City: Land Use Policies to Promote Urban Agriculture" is a downloadable toolkit focuses on policy best practices for urban agriculture, with helpful model comprehensive plan language on various aspects of farming in cities, including soil testing. http://changelabsolutions.org/sites/default/files/Urban_Ag_SeedingTheCity_FINAL_%28CLS_20120530%29_20111021_0.pdf



"Dig, Eat, and Be Healthy: A Guide to Growing Food on Public Property" is a guidebook that offers strategies for negotiating the use of public land for growing food, including types of agreements and specific suggestions on how to handle the issue of soil testing in such agreements. It includes a helpful section on school gardens. ***http://changelabsolutions.org/sites/default/files/Dig_Eat_and_Be_Happy_FINAL_20130610_0.pdf***

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