



After the Fire: Home Garden Soil Management

After a wildfire, soils can be impacted in several ways, including chemical and heavy metal contamination; alteration of nutrients, organic matter content, and pH; an increase in erosion hazard; and altered water holding capacity and quality. The cumulative effects of these changes can modify soil productivity and biological diversity, as well as pose health risks to humans and animals. Urban soils are at an increased risk for chemical and heavy metal contamination post-fire because urban environments tend to have features and materials that release these contaminants when burned. **After a wildfire, assess, test, and remediate your home garden soils to reduce the likelihood of exposure to potentially harmful contaminants.**

Understanding Your Site

Step 1: Assess Your Site

When evaluating your soil post-fire, the first thing to do is understand the history of your site, both the natural conditions and modifications from human development. Understanding the history of your site can provide clues as to what contaminants may be present and where they might go. Consider your site's water drainage, as contaminants can move in or out of your property with water flow and irrigation. Site assessment can be done through visual inspection, combined with historical investigation.

1. **First, visually inspect the area for evidence of impacts.** For example, if the site is next to buildings built before 1978 when lead paint was banned, lead may be a potential hazard.
2. **Next, you will want to determine past land use if possible.** Past land use of the site can be accessed through public records, consulting Sanborn maps or past aerial photographs, or asking neighbors who may have been living there before you.
3. **Then, if surrounding hazardous materials are identified as potential sources of contamination, obtain a soil sample for chemical analysis** to help determine the severity of the contamination.

Understanding what your site might contain can help you interpret your soil test results and inform your remediation plan.

Step 2: Test Your Soil

Testing is critical to understanding how wildfire may have affected your soil. Laboratory soil testing is recommended, especially if the soil is currently being used or is going to be used for urban agriculture. Residents directly impacted by fire can access post-fire soil test results from their clean-up contractor or seek out testing themselves. DIY soil testing kits are not recommended for this type of testing because they cannot test for many contaminants or heavy metals that are of concern post-fire. To learn more about soil testing options, visit UC ANR's Healthy Soils for a Healthy California website (<https://ucanr.edu/sites/soils/>), UC ANR's List of Laboratories



Example of in-field soil sampling materials.
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(<https://www.sandiegocounty.gov/content/dam/sdc/awm/docs/Private%20Agricultural%20Labs.pdf>), UC Master Gardeners Soil Testing Lab resource (<https://my.ucanr.edu/sites/MGLA/files/409085.pdf>), or contact your local UCCE Soil Advisor or UC Master Gardener Program.

When collecting soil samples, be sure to wear protective clothing, facemasks, and wash your hands after handling potentially contaminated soil. The California Department of Toxic Substances Control (DTSC) recommends collecting composite soil samples for testing. A composite sample is a sample made by mixing several smaller subsamples of soil taken from different spots throughout the same area (Figure 1). This strategy helps to provide a picture of the overall condition of the soil in that area. When collecting samples the DTSC recommends:

- **Collecting a minimum of four composite soil samples** composed of several subsamples each, from different areas throughout the property.
- **Samples should be taken in the first six inches of soil** where exposure risks are more likely.
- **Label each sample bag and map the sampling locations** for your records.
- **Mix each sample thoroughly** in a bucket before placing one pound, which is roughly equivalent to half a gallon, of soil in a clean, labeled bag to be sent to the lab for testing.
- If you are testing near residential building situations (total loss, partial loss, homes still standing) post-fire, it is recommended to **test in current and future high-use areas**, including in bare dirt areas, gardens or food-growing spaces, and in children's play areas.

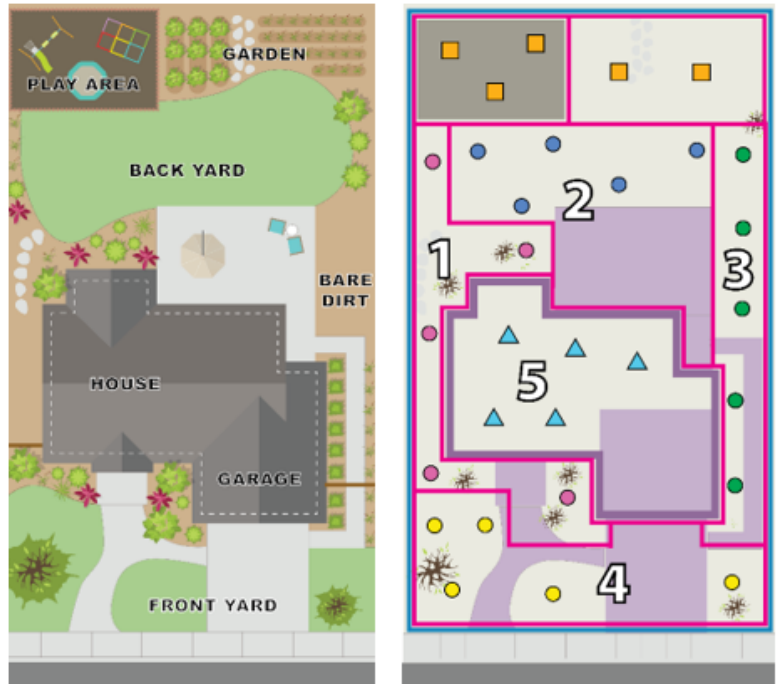


Figure 1: DTSC Residential Soil Evaluation Guidance. Circles indicate composite samples sectioned into four sampling areas. Squares indicate discrete samples in sensitive areas such as play areas and gardens. Triangles indicate samples taken in the former structure footprint. *Diagram: California Department of Toxic Substances Control.*

The U.S. Environmental Protection Agency (U.S. EPA) recommends that for urban areas, “at a minimum, the soil test should include pH, percent organic matter, nutrients, micronutrients, and metals, including lead”.¹ This level of testing is adequate for a site that has been residential or a green space. Most commercial soil labs can test for the most important heavy metals, including lead, arsenic, cadmium, chromium, and nickel. More testing may be needed for sites with a history of industrial or commercial use. These sites have the potential to be contaminated by a wider range of heavy metal and polycyclic aromatic hydrocarbon (PAH) contaminants that will require more extensive testing to detect. An EPA-recognized laboratory is the best choice for this level of testing. Laboratory soil testing varies in price depending on the services being performed. It is best to inquire directly with your prospective laboratory to get a quote or additional information.

Contaminants ^A	EPA Screening Level (mg/kg or ppm) ^B	CA DTSC Guidance Threshold (mg/kg or ppm) ^B
Arsenic	12 (SoCal max background)	12
Cadmium	7.1	7.1
Chromium (Total)	85,000	125,000
Chromium (Hexavalent) ^C	0.95	NA
Copper	3,100	3,100
Lead	200	80
Mercury	7.1	NA
Nickel	820	820
Zinc	23,000	23,000

Table 1: Partial list of heavy metals and maximum safe screening levels (SSLs). Source: UC Master Gardeners

^A Contaminants known to pose significant health and environmental risks, and commonly tested for in California.

^B The suggested concentration limits shown are based on screening levels per CAP.LA (www.cap.la)

^C Hexavalent Chromium is typically increased in soil due to fire.

Promote Safe Soils

Remediation

After determining the history and state of your soil, the next steps will depend on what your soil testing results indicate. If your soil test results indicate that no contaminants have been found exceeding acceptable levels, no immediate action is required for contaminant remediation. Most guidelines on acceptable levels of contaminants are meant for exposure through ingestion or skin contact rather than gardening. However, Table 1 illustrates what ranges of certain chemicals may be acceptable for home gardening. If your soil testing indicates that contaminants have been found at or exceeding acceptable levels, consider the following remediation strategies:



Person working with compost.

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1. **Work with your existing soil.** This is most feasible for sites with no history of industrial use and whose soil test results indicate low to moderate levels of contaminants. **Existing soil can be amended with quality soil and organic matter, and maintained at a neutral pH.**
 - Contaminants are often concentrated in the top two inches of soil and can be immobilized with a layer of organic matter or mulch until removal and remediation.¹
 - Soil pH should be maintained at or close to neutral (6.5-7.0). Soil nutrients are most available to plants at this pH, while lead and some other heavy metals are less available.²

- Add organic matter, compost, or soil known to be free of contaminants to your existing soil and continue to do so with each planting that follows. Heavy metal contaminants will bind to organic matter and may become less available to plants. Organic matter also improves soil structure, infiltration, and water-holding capacity, creating a better environment for plant roots.
2. **Immobilize contaminants.** When working with contaminated soil, immobilization is a strategy used to contain the contaminants within a certain area. The goal of immobilization is to isolate contaminants to prevent them from traveling into or out of your site, and also to reduce your own exposure to them for your own personal protection.
 - When planning how to isolate contaminants, consider the water features and water drainage on your property as contaminants can settle in those areas. Also, keep in mind that contaminated water, such as ground water used for irrigation, may introduce contaminants to the area as well.
 - Cover soils with mulch or compost, and control run-off to the best of your ability; an example of how to do this includes installing myco-wattles, which are mushroom-inoculated straw tubes, that help break down complex compounds.
 3. **Manage contaminants.** If your property burned, you will likely work with your county Office of Emergency Services to coordinate highly contaminated soil removal. For low to moderate contamination, you may be able to amend the soil or utilize bioremediation strategies for particular contaminants such as adding plants to take up toxins, or adding fungal inoculants to soils. All bioremediation needs a lifecycle analysis and safe removal of hazardous waste byproducts (e.g. post-phytoremediation composts). **Work with an advisor or remediation professional to plan a strategy for your site.**

Alternative Options

1. **Use raised beds or other containers and fill them with clean soil.** If you build your own frames, use sturdy materials that won't release contaminants into the soil, like redwood or other non-treated lumber, brick, concrete, or rocks. If your raised bed does not have a bottom barrier, consider creating one using various materials (i.e., water-permeable fabrics, rocks, etc.) to separate potentially contaminated soil from imported, clean soil.
 - When importing soil, consider purchasing topsoil or planting mix, such as those certified by the Organic Materials Review Institute (OMRI). Local urban farmers or gardeners may have additional recommendations. Some vendors may be able to provide



Examples of incorporating raised beds and other containers. PC: Evett Kilmartin

documentation that their soil has been tested. If not, you can send soil samples to the lab for testing.

- Other types of containers besides raised beds can be used as well. Some commercially available examples include growing systems that would be appropriate for smaller-scale projects, and mesh “socks” that are filled with growing medium and placed on top of the soil. Avoid using items as planting containers that could contaminate soil as they degrade over time as planting containers (e.g., tires).
2. **Remove contaminated soil.** Soil removal is the most common, yet extreme practice employed when dealing with contaminated soil. This process involves removing the existing soil from your garden site and replacing it with soil that is certified safe. The contaminated soil should be disposed of according to your local regulations or relocated elsewhere in your yard away from your garden site. While this strategy is helpful for assuaging fears of contamination, it isn't necessarily accessible, as it is an expensive process to excavate soil, remove it, and replace it.

Best Management Practices for Near-Home Garden Soil

If you are concerned about inhaling or ingesting chemical contaminants from plants, produce, or soil, use the following best management practices for interacting with soil that has been potentially affected by wildfire:

- **Wear gloves, boots, eye protection, a long-sleeved shirt, long pants, and cover your hair** when interacting with contaminated soil to prevent ingestion and direct contact.
- **Use raised garden beds and import clean soils** to avoid inhalation, ingestion, and plant intake of contaminants over time.
- **Amend soil with clean, high-quality compost** to improve soil health. Be mindful to use the appropriate amount of compost, such as a 2-6 in. cover layer.³
- **Use mulch to cover the soil** to prevent airborne soil and dust up-splash.
- **Promote good drainage and use drip irrigation to prevent up-splash**, particularly at the bottom of slopes that burned and after long wet periods. Contaminants can accumulate in these areas under wet conditions.
- **Be mindful not to track contaminated soil into your home.**
- **Wash hands before and after harvest and rinse produce before it is consumed.**



Wear gloves, a long-sleeved shirt, and other protective gear when interacting with contaminated soil.
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References and Additional Resources

¹ U.S. EPA (U.S. Environmental Protection Agency). 2011b. Evaluation of urban soils: Suitability for green infrastructure or urban agriculture. U.S. EPA Publication 905-R-11-03.

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