# **Understanding Your Soil Test Results**

## Community Engagement Core, Duke University Superfund Research Center

## Which soil contaminants did we test for, and why?

We screened your garden soil for a variety of known contaminants that may be present in soil. These contaminants include: 6 heavy metals (arsenic, cadmium, chromium, lead, mercury, nickel) and petroleum-derived compounds (total petroleum hydrocarbons; benzene, toluene, ethylbenzene and xylene, also called BTEX; gasoline range organics; diesel range organics; and EPA priority polycyclic aromatic hydrocarbons or PAHs). We also tested the pH (acid/base level) of your soil, because soil pH can affect how some contaminants move through soil. We chose to test your soil for these specific contaminants because they are common soil pollutants, especially in urban areas. It is important to know whether these compounds are present in your garden to help prevent children and adults from being exposed to contaminants that can affect health.

What do my results mean?

Your soil results are presented in a table below. Note that soil contaminant levels are typically expressed in parts per million (ppm), a typical way to express contaminant levels in the environment. For example, a value of 1 ppm means that there is 1 part of contaminant present for 1 million parts of soil in the sample, by weight. Table 1, below, provides context to guide the interpretation of your results by providing the background level of metals in the environment in North Carolina and guidance values from NC and from New York State. Table 2 provides guidance values about petroleum based compounds.

Background levels are generally how much of each metal you would expect to find naturally occurring in soils. The background level presented here is based on a study from 2007 by the U.S. Geological Survey that evaluated 83 samples using the top 5 centimeters of soil at various locations across North Carolina.1 The PSRG guidance level for NC is based on EPA’s Regional Screening Levels for soil and represents the lowest health protective level for cancer or non-cancer health effects. The New York guidance values were developed for New York State and take into account rural soil background levels there, and they consider home vegetable gardening as a pathway for soil exposure. The NC values do not consider background levels, as they are directly adopted from U.S. EPA values.

**Table 1: Soil Cleanup, Guidance Values, and Background Levels in Soil**

|  |  |  |  |
| --- | --- | --- | --- |
| **Heavy Metal** | **NC Preliminary Soil Remediation Goal (PSRG), Residential Health Based (ppm)2** | **New York State Brownfield Cleanup Program – Soil Cleanup Objectives (ppm)3** | **NC Background Level (ppm)\*1** |
| Arsenic | 0.68 (Inorganic Arsenic) | 16 | 3.7 |
| Cadmium | 14.2 | 2.5 | 0.16 |
| Chromium | 24,000 (Cr III, insoluble salts);  0.3 (Cr VI) | 22(VI); 36 (III) | 32.42 (total Cr) |
| Lead | 400 (“lead and compounds”) | 400 | 21.33 |
| Mercury | 2.2 (elemental); 4.6 (mercuric chloride and other salts) | 0.810 | 0.06 |
| Nickel | 134 (nickel carbonate) | 140 | 11.56 |

\*Background levels are based on a USGS study of 83 samples across NC from the top 5 cm of soil.

**Table 2: Soil Cleanup, Guidance Values, and Background Levels in Soil**

|  |  |  |  |
| --- | --- | --- | --- |
| **Petroleum Compounds** | **NC Action Level (2010), ppm** | **NC Action Level (Current), ppm** | **Background level (ppm)** |
| DRO | 10 | 100 | N/A\*\* |
| GRO | 10 | 50 | N/A\*\* |

\*\*Petroleum based compounds are not naturally occurring in surface soils, and as such, there is no background level.

## What did we find?

We can use one of the four following descriptions for each of the chemicals we tested for in your soil. You will find similar color coding in your results table for Below Detection, Below Guideline, and Above Guideline:

* **Below Detection Limit:** This means that the compound was either not present, or present at a level that is below the limits of what the instrument can find in the soil. If we take the most conservative (health-protective) approach to this result, the compound may be present, but at a level that is very low. The instruments we use can detect concentrations that are far below the background levels, or levels that you would commonly find in the environment in a given area.
  + **Action Suggested:** Continue to use good gardening practices to limit exposure, such as wearing gloves, hand washing, washing tools and shovels, scrubbing and washing produce, and leaving shoes outside after working in the garden.
* **Below Guideline Value**: This means that the compound was present at a level that is below health-based guideline values. Health-based guideline values are established to consider long-term exposure to environmental contaminants. Populations such as women and children are considered when developing these guidelines because they are especially vulnerable to developmental health effects. There is no safe level of exposure to certain contaminants, like lead. So, even with results below guideline values, you can still limit exposures by washing your hands, washing produce, and leaving shoes outside after gardening.
  + **Action Suggested**: Continue to use good gardening practices to limit exposure, such as wearing gloves, hand washing, washing tools and shovels, scrubbing and washing produce, and leaving shoes outside after working in the garden.
* **Above Gardening/Residential Guideline Value:** This means that the contaminant was present at a level that is above health-based guidance values, indicating that there is a potential health risk from exposure to this contaminant. Keep in mind that these health-based guideline values typically are formulated by the most extreme assumptions about your exposure, such as daily exposure to this compound over a long amount of time (usually many years), and your individual risk from exposure to this contaminant may not be as extreme. If you are interested, we would like to conduct additional testing for the contaminant(s) above this guideline value in order to better understand the contaminant levels at your specific site.
  + **Action Suggested:** Incorporate good gardening practices, listed above, to minimize exposure to this contaminant. Consider adding soil amendments to reduce the likelihood of contaminant exposure, keeping in mind that best practices differ according to which contaminant is present at your site. These best practices are explained for each contaminant in the fact sheets included in the following pages of this packet. Consider using remediation strategies at your garden site to remove or decrease the contaminant concentrations in your soil.

## Additional Resources

Your soil testing results, a map of the sampling locations, and fact sheets about each of the contaminants that were detected above guidance values are included in the following pages of this packet. In addition, below are some further resources to help you understand the issue of soil contamination in community gardens.

* Duke University Superfund Research Center website “Resources for North Carolina Community Gardeners”: <http://sites.nicholas.duke.edu/superfund/gardens/>
* North Carolina Cooperative Extension, “Minimizing Risks of Soil Contaminants in Urban Gardens”: <https://content.ces.ncsu.edu/minimizing-risks-of-soil-contaminants-in-urban-gardens>
* NC Cooperative Extension general gardening website: <https://gardening.ces.ncsu.edu/>
* North Carolina Community Garden Partners - Resources on Contaminants: <http://www.nccgp.org/resources/tag/contaminants/>

**Questions?**

Email Bryan Luukinen, Senior Program Coordinator for the Duke University Superfund Research Center: [bryan.luukinen@duke.edu](mailto:bryan.luukinen@duke.edu).

**References**

1. Smith, D.B., Cannon, W.F., Woodruff, L.G., Solano, Federico, Kilburn, J.E., and Fey, D.L., 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, 19 p., <https://pubs.usgs.gov/ds/801/>

2. NC DEQ. Preliminary Soil Remediation Goals (PSRG) February, 2018. NC Department of Environmental Quality. Raleigh, NC. Available at: <https://files.nc.gov/ncdeq/Waste%20Management/DWM/risk_based_remediation/Feb2018_PSRGs.pdf>

3. NYSDEC/NYSDH. New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document. New York State Department of Environmental Conservation/Department of Health. September, 2006. Albany, NY. Available at: <http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf>

# Soil Sampling Results (example)

All values in parts per million (ppm)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Metals | Sample 1 | Sample 2 | Sample 3 | Guideline Level | NC Background (USGS, 2013) |
| Arsenic | 2.00 | 1.44 | 1.60 | 0.68 | 3.7 |
| Cadmium | 0.15 | 0.10 | 0.10 | 14.2 | 0.16 |
| Chromium | 12.5 | 8.04 | 8.05 | (III) = 24,000  (VI) = 0.3 | 32.42 |
| Nickel | 4.06 | 3.54 | 2.99 | 134 | 11.6 |
| Lead | 18.6 | 18.8 | 20.4 | 400 | 21.3 |
| Mercury | <0.050 | <0.050 | <0.050 | Elemental = 2.2; Chloride and salts = 4.6 | 0.060 |
| pH | 6.47 | 6.62 | 6.37 | N/A | N/A |
| Petroleum Hydrocarbons | Sample 1 | Sample 2 | Sample 3 | Guideline Level |  |
| BTEX | <0.97 | <0.93 | <1.8 | Benzene = 2.9; TEX = 100 |  |
| GRO | <0.97 | <0.93 | 1.1 | 10 |  |
| DRO | 7.7 | 10.8 | 6.3 | 10 |  |
| Benzo[a]pyrene | <0.039 | <0.037 | <0.035 | 1 |  |

Key: Below Guideline, Below Detection, and Above Guideline