Food Safety, Soil, and Water Testing Recommendations for School and Community Gardens

Bulletin 350







Cooperative Extension

Michele Bakacs, Environmental and Resource Management Agent

Meredith Melendez, Agricultural Senior Program Coordinator

Introduction

In January 2014, legislation was adopted in New Jersey authorizing public schools to serve students the produce grown in community gardens (NJ A3019). The legislation requires that in order for the produce to be served to students, the soil and water used in the garden must been tested for contaminants and shown to be safe for growing food. In addition, the produce must have been handled, stored, transported, and prepared safely and in accordance with applicable Federal, State, and local health and sanitation requirements.

This publication provides recommendations for the process to use when determining what type of soil testing to conduct on a garden. Water testing recommendations are also provided. Lastly, good gardening practices are also recommended that can help reduce the risk of foodborne illnesses.

Soil Testing Recommendations

Below are details for conducting a site history assessment, determining risk, and suggestions for soil testing in new and previously established gardens. In addition, soil guidance values for specific contaminants are provided for comparing test results.

New Gardens

When a garden is initially being planned, the site's land use history and surrounding community should be investigated to determine if the soil may be contaminated (USEPA, 2011a). This investigation will help in determining if the site is a low or high risk for growing food crops. This investigation is also an essential element in determining how the garden is built.

Site history: The type of soil contaminants test and the extent of the testing are based on the site's history, that is, how the site was formerly used. The site's history can be determined from historical records from the local municipality or county, aerial photos, Sanborn maps, possibly through online mapping programs, by speaking with neighbors and previous landowners, and by conducting a thorough visual inspection of the property.

Determine the risk: Once the site's history is investigated, determine whether the site can be considered a low or high risk site for being exposed to contamination when growing or consuming food.

Generally, **low risk** sites are former residential properties, schools, day care centers, recreational, and agricultural areas. However, it should be noted that agricultural sites might contain a legacy of pesticides that should be evaluated. In addition, some former fruit orchards have been found to be contaminated with lead-arsenate, which was often used as an insecticide up until the 1950s. Lastly, former residential sites may have construction debris that

RUTGERS
New Jersey Agricultural Experiment Station

Rutgers, The State University of New Jersey
88 Lipman Drive, New Brunswick, NJ 08901-8525
Phone: 732.932.5000

could be contaminated with lead based paint (sold through the early 1970s) and/or asbestos. The site history analysis and visual inspection will help to reveal these problems and soil testing should be customized based on these issues.

At a minimum, soil from low risk sites should be tested for lead (Pb) using a composite sampling approach outlined in Fact Sheet 336 "Lead Contaminated Soil: Minimizing Health Risks". Testing should also include nutrients, organic matter content, and pH.

High risk sites are former industrial or commercial lots such as dry cleaners, junk yards, or manufacturing facilities. These sites are considered by the New Jersey Department of Environmental Protection (NJDEP) to be "brownfields". If establishing a new garden on a vacant lot deemed to be a high risk site, it should be investigated by a Licensed Site Remediation Professional (LSRP) who would determine the specific testing that should be conducted. More than likely a full heavy metal analysis would be conducted on these sites including arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc (see Table 1 for more information). Polycyclic aromatic hydrocarbons (PAHs) would also be necessary, which can be indicative of petroleum spills as well as asbestos if there is construction debris. A more intensive sampling approach would be conducted taking composite or separate samples from different locations on the site where contamination is suspected.

Another consideration is whether the site is within a community known to have a high risk of contaminated soil, for example, an older city where lead based paint was used on houses or a community with an industrial legacy. There is some evidence that in these types of communities clean garden soil can become re-contaminated over time from lead laden dust via air deposition (Clark et al., 2008). In these situations, it is important to test the garden soil every 3 years as well as take additional best practices including:

- Keeping beds covered in the off season to reduce the risk of recontamination;
- Scraping off the top centimeter (1/3 inch) of soil from raised beds every year and replacing with compost.

Established Gardens

How to decide what soil tests to conduct in an established garden is dependent on the answers to the following questions:

- What was the history of the site before it was a garden? Was it a high risk or low risk site?
- Was the garden soil tested when first established? What were the results?
- Where will/did the soil you are gardening in come from? If the soil is/was brought in from an outside source, did the vendor provide any soil testing information? Is the information kept on file?
- Is there soil contamination in the surrounding community? Is there a risk of garden beds becoming re-contaminated over time via air deposition?
- When was it tested last?

It is up to the garden managers to determine the most appropriate soil testing based on their unique situation. Two types of soil testing recommendations are outlined below. These recommendations are based on whether the site was found to be low or high risk for growing food.

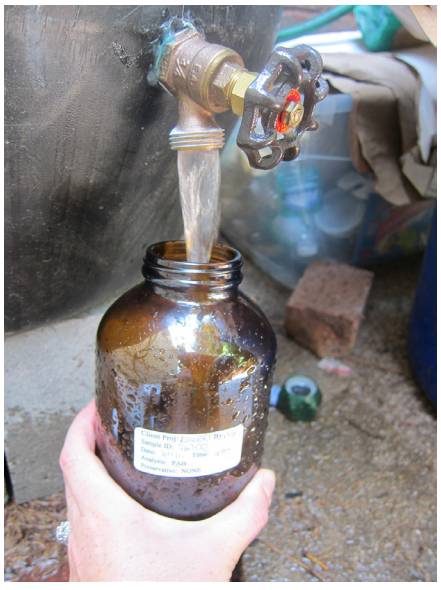
When determining the type of soil testing to conduct on an established garden, garden managers should to be able to demonstrate the following actions were taken:



Soil testing in a garden



Soil sampling



Water sampling from a rain barrel

1. The site history was properly investigated and it was determined to be a low risk or high risk site.
2. Appropriate action was taken based on determination of site risk. For example, on a high risk site, the site was remediated and appropriate steps were taken to limit exposure to contaminants such as building raised beds and bringing in clean soil.

Soil testing recommendations for established gardens on low risk sites:

If the above actions were taken, the garden beds should be tested for lead, pH, nutrients, and organic matter content every 3 years. All results should be kept on file.

Soil testing recommendations for established gardens on high risk sites:

If the above actions were taken the garden beds should be tested for arsenic, cadmium, lead, mercury, pH, nutrients and organic matter content every 3 years. All results should be kept on file.

If it is determined that the appropriate planning steps were not taken that included an investigation of the site history and risk, it may now be necessary to conduct more thorough soil testing to show that the soil does not have unsafe levels of contaminants.

Soil Standards for Comparing Test Results

There are no Federal or State standards for helping determine safe levels of contaminants for growing food in a community or school garden. The New York State Department of Environmental Conservation (NYS DEC) developed Soil Cleanup Objectives (SCOs) to help with the cleanup of sites to be used for residential land uses (Shayler et al. 2009). These values account for exposure to soil contaminants by eating home grown vegetables. New Jersey has set soil cleanup standards for residential sites, but they do not take into account contaminant exposure via eating home grown vegetables. The New York State SCOs values are more conservative, therefore we recommend they be used for comparing test results on community and school garden sites. Table 1 shows common urban soil contaminants (USEPA, 2011b) and the New York State SCO values.

Water Testing Recommendations

The quality of water used in the production of fruits and vegetables is important and should be considered in a community or school garden. Contaminated irrigation water has the ability to spread pathogens onto produce, which is often consumed raw. Ensuring that the source of the irrigation water is clean is a necessary risk reduction step. Depending on the source of the water, the garden manager may be responsible for testing the water safety.

Table 1. NYS DEC Residential Soil Cleanup Objectives for common urban soil contaminants. (ppm= parts per million)

Contaminant (symbol) and Potential Sources	Soil Cleanup Objectives (ppm)
Heavy metals from former commercial or industrial sites, treated lumber, sewage sludge, or pesticides	
Arsenic (As)	16
Barium (Ba)	350
Cadmium (Cd)	2.5
Chromium – hexavalent VI (Cr+6)	22
Chromium – trivalent III (Cr+3)	36
Copper (Cu)	270
Lead (Pb)	400
Mercury (Hg)	0.81
Nickel (Ni)	140
Selenium (Se)	36
Zinc (Zn)	2200
Polycyclic aromatic hydrocarbons (PAHs) from high traffic areas or petroleum spills	
Acenaphthene	100
Acenaphthylene	100
Anthracene	100
Benz(a)anthracene	1
Benzo(a)pyrene	1
Benzo(b)fluoranthene	1
Benzo(g,h,i)perylene	100
Benzo(k)fluoranthene	1
Chrysene	1
Dibenz(a,h)anthracene	0.33
Fluoranthene	100
Fluorene	100
Indeno(1,2,3-c,d)pyrene	0.5
Phenanthrene	100
Pyrene	100
Chemicals derived from petroleum possibly from spills, leaking storage tanks, or former gas stations	
Benzene	2.9
Ethylbenzene	30
Toluene	100
Xylene	100

Water sources that are open to the environment, such as streams or ponds (surface water sources), are at risk of contamination from wildlife, humans and rainwater runoff and should be tested regularly.

The following information discusses the various sources of irrigation water, potential risks, and frequency of water testing, if necessary.

If testing is required, in all cases it should include sampling for generic *Escherichia coli* (*E. coli*) bacteria. *E. coli* is a species of bacteria that is specific to fecal matter from warm-blooded animals such as squirrels, birds, and humans. The presence of *E. coli* indicates the potential for, not actual, presence of human pathogens. Pathogen specific tests can be conducted but are often cost prohibitive.

The current guidelines for irrigation water is 126 Colony Forming Units (CFUs) of generic *E. coli* per 100 ml average, with no one sample over 235 CFUs. Colony forming units represent the number of cells that are able to reproduce and increase the number of living *E. coli* cells. Gardeners should use these guidelines for comparing water test results. It may be necessary to treat the irrigation water if the results show contamination (meaning they are above these guidelines). Table 2 shows suggested sampling frequency, timing, and corrective actions for various water sources. Note that you may not need to actually test the water. Instead, you may just need to acquire the reporting information annually from the responsible party and keep it on file.

Water testing should be done by a certified GLP (good laboratory practice) lab. Each laboratory will provide a water sampling protocol that should be followed. The NJDEP has a listing of certified laboratories available on their website.

1. Drinking water from municipal water source

Water from a municipal authority is the safest option for ensuring safe irrigation water. In this case, water testing by garden managers is not necessary. The municipal authority is required by the Federal government to regularly test the water. The results of these tests can usually be found online for free via "consumer confidence reports" or water quality reports. These reports have information about any detected contaminants. The garden should access these reports annually and keep copies on file. More information about these reports and your local water provider can be found on EPA's Consumer Confidence report website.

2. Private well water

Garden managers would be responsible for testing if using private well water for irrigation. Well water can be another safe option for garden irrigation water, provided that the well has been maintained properly, is free from leaks and cracks, and does not have a compromised well head. Private well testing standards, health and remediation information are available on the NJDEP website. If the test results show that there is bacterial contamination of the water, the well will need to be inspected, fixed and disinfected. Details on how to properly disinfect a well can be found in FS351 Directions for Disinfecting a Home Well in New Jersey. Additional treatment options for private wells can be found at the NJDEP website.

3. Harvested rainwater

Garden managers would be responsible for testing if using harvested rainwater from a rain barrel or cistern to irrigate a vegetable garden. Water samples should be taken from the faucet or hose used for irrigation. Limited research has shown harvested rainwater to be safe for irrigating a vegetable garden when best management prac-

Table 2. Recommended water testing and treatment information for various water sources.

	Frequency	Timing	Corrective Actions
Municipal Water	Once per year	Obtain municipal water reports and keep on file (often available online)	N/A
Private Well Water	Once per year	Sample for generic *E. coli*, ideally at the beginning of the season	If test reports show contamination, treat well water before utilizing as an irrigation source. See FS351 for details.
Harvested Rainwater	Once per year	Sample for generic *E. coli* at or near the first harvest	If test reports show contamination, treat harvested water before using as an irrigation source. See FS1218 for details
Surface Water	Three times per year	Sample for generic *E. coli* at planting, at peak use, and at or near the first harvest.	Surface water should not come in contact with harvestable product. In-line treatment systems can be used to reduce generic E. coli loads in the water.



tices are used. More information on water quality and treatment of harvested water for gardens can be found in Fact Sheet 1218 Rain Barrels Part IV: Testing and Applying Harvested Rainwater to Irrigate a Vegetable Garden.

4. Surface water sources

Garden managers would be responsible for testing if surface water sources are used for irrigation. Surface water sources such as ponds, streams, rivers, lakes, or canals have a higher risk for human pathogens. Multiple-year sampling of several surface irrigation water sources in New Jersey showed high and variable levels of generic *E. coli*. These sources of water should be avoided when possible. If a surface water source is the only option, care should be taken to use drip irrigation in the garden and to avoid water coming in contact with the edible portion of the plant. This can be difficult to do when watering cans are used.

It is important to keep potentially contaminated water off the harvestable portion of the plant. Drip irrigation is an efficient method of watering and should be used whenever possible. Drip irrigation reduces the likelihood of irrigation water coming in contact with fruits and vegetables grown above the soil. Additionally, potentially contaminated water should not be used for chemical applications, hand washing, or the washing of fruits and vegetables. For extensive information on drip irrigation, refer to Penn State's Drip Irrigation for Vegetable Production.

Treatment of contaminated water is essential and possible at the garden level. The cost and amount of time for treatment is dependent upon the water source.

Gardener Food Safety Recommendations

Workers, volunteers, and students can all be a source of contamination at the garden. Gardener education about the potential for human pathogens to spread is important and should be conducted annually at the beginning of the gardening season. The following topics should be covered so each gardener understands where there is potential for a human pathogen contamination risk and the proper activities to reduce that risk. More detailed information on health and hygiene when working with produce can be found in FS1230 Worker Health and Hygiene.

1. Handwashing

The first step in reducing the spread of pathogens in the garden is proper hand washing. A hand washing station should be located at the restroom and anywhere hand washing would regularly need to take place. Research has shown that a hand washing area outside of the restroom draws attention to hand washing activities. Therefore, people are much more likely to wash their hands after using the restroom. A properly stocked hand washing station has soap, running water, and single use paper towels. Hands should be washed prior to handling fresh produce, after consuming food, after using the bathroom, and at any other time that the hands might have become contaminated. Hand sanitizers are not a substitute for proper hand washing.

Proper hand washing steps:

1. Wet hands
2. Apply soap to wet hands
3. Vigorously rub hands for 20 seconds
4. Rinse under running water
5. Dry hands with a single use paper towel

2. First Aid

A well-stocked first aid kit including single use gloves should be readily available to gardeners. All open wounds on a hand should be bandaged and then covered with a single use glove. The glove will help protect the bandage and prevent it from falling into the produce. Medical attention should be sought if necessary.

3. Harvest Containers

Gardeners should be mindful of the containers into which they harvest the produce. Clean containers should be used and gardeners should be encouraged to not reuse grocery bags to harvest and transport produce.

4. Animal Manure Based Composts

Animal manures are often used in creating composts. These composts offer an excellent source of nutrients

and organic matter for building garden soils. Care should be taken when using animal manures, as they may be a source of human pathogens. It is generally recommended that animal manures be applied to soils at least two weeks prior to planting, incorporated into the soil, and that harvesting begins no earlier than 120 days post application. Animal manure based composts should be composted using scientifically based composting practices such as the National Organic Program composting guidelines. Care should be taken to minimize the potential for raw animal manure to enter vegetable garden beds. Animal manure composting areas should be located so that there is no potential runoff during rain events. Pathways of gardeners and equipment should also be evaluated for the risk of transporting uncomposted animal manures into fruit and vegetable garden beds. Biosolid composts (from treated sewage sludge) are not recommended for use in school or community vegetable gardens.

5. Wildlife and Pets

Wildlife and domestic animals can be a source of human pathogens in the garden. Pets should be kept out of the garden. Wildlife intrusions can be common and a risk assessment for wildlife should be done each spring. Identifying the types of wildlife, where they are entering into the garden, and where they tend to feed are questions to consider. Once these questions have been answered, you can begin to reduce the wildlife risk by making changes to obstruct the wildlife from entering the garden. Prior to each harvest, the garden should be surveyed for wildlife feeding damage and remnant fecal material. If feeding or fecal material is noticed, it is advised that a 3 to 5 foot zone surrounding that area not be harvested.

6. Post Harvest Handling

Containers used for harvesting should be visibly clean and not used for other activities in the garden. Washing harvested produce should be done just prior to consumption and with potable water. Consumers should be instructed to wash the produce under cool running water for 20 seconds prior to raw consumption or preparation for cooking.

References and Resources

Authorizes public schools to serve to students certain produce grown in community gardens. 2014, NJ A3019. Retrieved from http://legiscan.com/NJ/text/A3019/2012

Bakacs, M., Haberland, M. Yergeau, S. (2013) Rain Barrels Part IV: Testing and Applying Harvested Water to Irrigate a Vegetable Garden. FS1218. New Brunswick, NJ: Rutgers NJAES Cooperative Extension; http://njaes.rutgers.edu/pubs/fs1218

Clark, H. F. Hausladen, D. M., Brabander, D. J. (2008). Urban gardens: Lead exposure, recontamination mechanisms, and implications for remediation design. Environmental Research 107 (3) 312-319

Hamel, S., Heckman, J., and Murphy, S. (2010). Lead Contaminated Soil: Minimizing Health Risks, FS336. New Brunswick, NJ: Rutgers NJAES Cooperative Extension; http://njaes.rutgers.edu/pubs/publication.asp?pid=FS336

National Food Service Management Institute (2011). Food Safety Tips for School Gardens. US Department of Agriculture; http://nfsmi.org/documentlibraryfiles/PDF/20110822025700.pdf

New Jersey Department of Environmental Protection (2012). Remediation Standards N.J.A.C. 7:26D. Trenton, New Jersey Department of Environmental Protection; http://nj.gov/dep/srp/guidance/rs

Science Communication Unit, University of the West of England, Bristol (2013). Science for Environment Policy In-depth Report: Soil Contamination: Impacts on Human Health. Report produced for the European Commission DG Environment, September 2013; http://ec.europa.eu/science-environment-policy

Toronto Public Health (May 2011). Assessing Urban Impacted Soil for Urban Gardening: Decision Support Tool - Technical Report and Rationale. Toronto: City of Toronto; http://Toronto.ca/health

Shayler, H., McBride, M., Harrison, E. (2009). Guide to Soil Testing and Interpreting Results. Ithaca, NY. Cornell Waste Management Institute; http://cwmi.css.cornell.edu/soilquality.htm

United States Environmental Protection Agency. (2011a) Brownfields and Urban Agriculture: Interim Guidlines for Safe Gardening Practices. U.S. Environmental Protection Agency, Washington, DC, EPA 560/S-11/001; http://www.epa.gov/brownfields/urbanag

United States Environmental Protection Agency. (2011b) Reusing Potentially Contaminated Landscapes: Growing Gardens in Urban Soils. U.S. Environmental Protection Agency, Washington, DC, EPA 542-F-10-011; www.clu-in.org/ecotools/urbangardens.cfm

© 2015 Rutgers, The State University of New Jersey. All rights reserved.

For a comprehensive list of our publications visit www.njaes.rutgers.edu *March 2015*

Cooperating Agencies: Rutgers, The State University of New Jersey, U.S. Department of Agriculture, and County Boards of Chosen Freeholders. Rutgers Cooperative Extension, a unit of the Rutgers New Jersey Agricultural Experiment Station, is an equal opportunity program provider and employer.

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

Rutgers, The State University of New Jersey
88 Lipman Drive, New Brunswick, NJ 08901-8525
Phone: 732.932.5000