Advancing Food Systems: Managing Urban Soils Ecosystems in the Transformation of Urban Ag. And Innovative Production.

Kefeni Kejela, PhD

Resource Soil Scientist, USDA/NRCS – Bedford, PA

Telephone: 717-836-9073

Kefeni.kejela@usda.gov

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URBAN SOILS

- **Natural soil** is defined as a dynamic natural body that is made up solids, liquids, and gases, occurs on the earth's surface, contains living matter, and supports or is capable of supporting plants.
- **Urban soil** is defined as soil material having a non-agricultural, manmade surface layer more than 50 cm (20 inches) thick that has been produced by mixing, filling, or by contamination of land surface moved, graded, and/or or compacted over time, often as a result of construction and demolition activity at the site with addition of non-native soils in urban and suburban areas.

What is the role of the soil in the ecosystem? Six main Soils ecosystem functions:

1. **Nutrients Cycle: Soil is the important part of the ecosystem. It is the natures recycle system. Waste and dead materials are decomposed, and their nutrients are made available for new life.**

2. **Means for plant growth: The plant and roots obtain physical support from the soil to anchor them, air, water, temperature, moderation, protection from toxins and nutrients.**

3. **Regulator of water supply: The soil stores water for the plant for use which affects the water supply or allowing water to seep down into the groundwater. Contaminated water may be also purified as it passed through the soil and removes impurities.**

What is the role of the soil in the ecosystem? Six main Soils ecosystem functions:

4. Atmospheric Modification: Soils breathe. Gases are exchanged between the soil surface and the air. Gases like oxygen and methane are absorbed, while gases like carbon dioxide and nitrous oxide are released. The soil provides a valuable carbon sink. The evaporation of soil moisture also affects air temperature and weather patterns.

5. Habitat for many organisms: Many living things, from small mammals and reptiles to tiny insects and microorganisms, find their homes in the soil.

6. Foundation for construction: Soil provides building material such as bricks and gravel. It also provides the solid foundation for all our roads and buildings.

Soils Ecosystem Services

- Production of food, fuel, and energy
- Clean air and water.
- Helps in the growth of the plant.
- Helps remove the toxic substances.
- Maintains the soil structure
- Helps in the prevention of pests and diseases.
- Transfers the plant for fertilization.

Soils Preserve Natural and Cultural History

- Soils can tell us much about our past.
- They are derived from a variety of parent materials and are transported by wind, water, ice, gravity, or humans.
- What occurs in or under a soil can indicate how old a buried soil layer is and even how it got to its present location.
- Soils can be dated by artifacts within them.
- Layers of garbage or dredge material also can indicate the age of the soils.
- In addition, they help to preserve artifacts of culture and history.

WHY DO WE NEED TO KNOW ABOUT URBAN SOILS?

- Knowing about soil and its potentials and limitations helps urban planners and those living in urban areas to make good decisions about using their soil as a basic and valuable resource.
- Knowledge of Urban Soils provides information important in planning and managing land resources in a manner that helps mitigate problems associated with sedimentation, contamination, runoff, and structural failure.
- Urban soil information will help to estimate the response of urban soils to human-induced and natural stresses in many types of environments.
- The risk levels for unsuitable choices for land use mean higher economic cost in urban areas, necessitating a more specific and risk-sensitive method of comparing soils within a given site.

WHY DO WE NEED TO KNOW ABOUT URBAN SOILS? (CONTINUED)

- Knowing soil responses to specific uses allows engineers and others to design projects that will not require high maintenance costs, will last a long time, will not harm individuals, society, or ecosystems, and will not fail and/or require expensive repair and/or removal costs.

- Knowing Soil is the basic raw material and common link to all projects whether one wants to build a park, a street, a golf course, or a large building, landscape a yard, or just plant a backyard garden. Soil lies beneath each activity!

Factors That May Affect the Productivity of Urban Soil

- Little or no addition of organic matter
- Artifacts that disrupt water movement
- Elevated salt content
- Interrupted nutrient cycling and modified activity of micro-organisms
- High soil temperatures that increase the rate of chemical reactions
- Generally higher pH values resulting from additions of cement, plaster, and road, salts.
- Lateral (sideways) subsurface waterflow resulting from compacted layers

Urban agriculture & It's Importance

Urban agriculture is the cultivation of crops in urban or suburban areas for local consumption or sale.

- Improves the quality of life for people living near the area;
- Provides a catalyst for neighborhood and community development and neighborhood stabilization & stimulates social interaction;
- Produces nutritious food & reduces family food budgets;
- Conserves resources, including those which would otherwise be needed to transport food from remote areas to urban dwellers;
- Creates an opportunity for recreation, exercise, therapy, and education;
- Preserves green space & creates income opportunities and economic development; reduces city heat & reduces impervious urban land area;
- Provides opportunities for intergenerational and cross-cultural connections

Growth Trends in Urban Areas

Figure 1.4: Urban development

Figure 1.2: Playground.

Figure 1.3: City skyline.

Figure 1.1: Urban garden.

Growth Trends in Urban Areas…..

- Urban areas are expanding at a rapid rate within the United States.
- Urbanization is also a worldwide issue. Soils that are best suited to other uses, such as providing food and fiber for the Nation, are commonly the easiest to use as sites for homes and cities.
- Prime farmland is vanishing at alarming rate in certain regions of the United States because of urban expansion and development.
- We must balance the increasing size of urban areas with our need for food and fiber.

Figure 1.5: Land converted to urban development from 1982 through 1997 (NRCS, NRI).

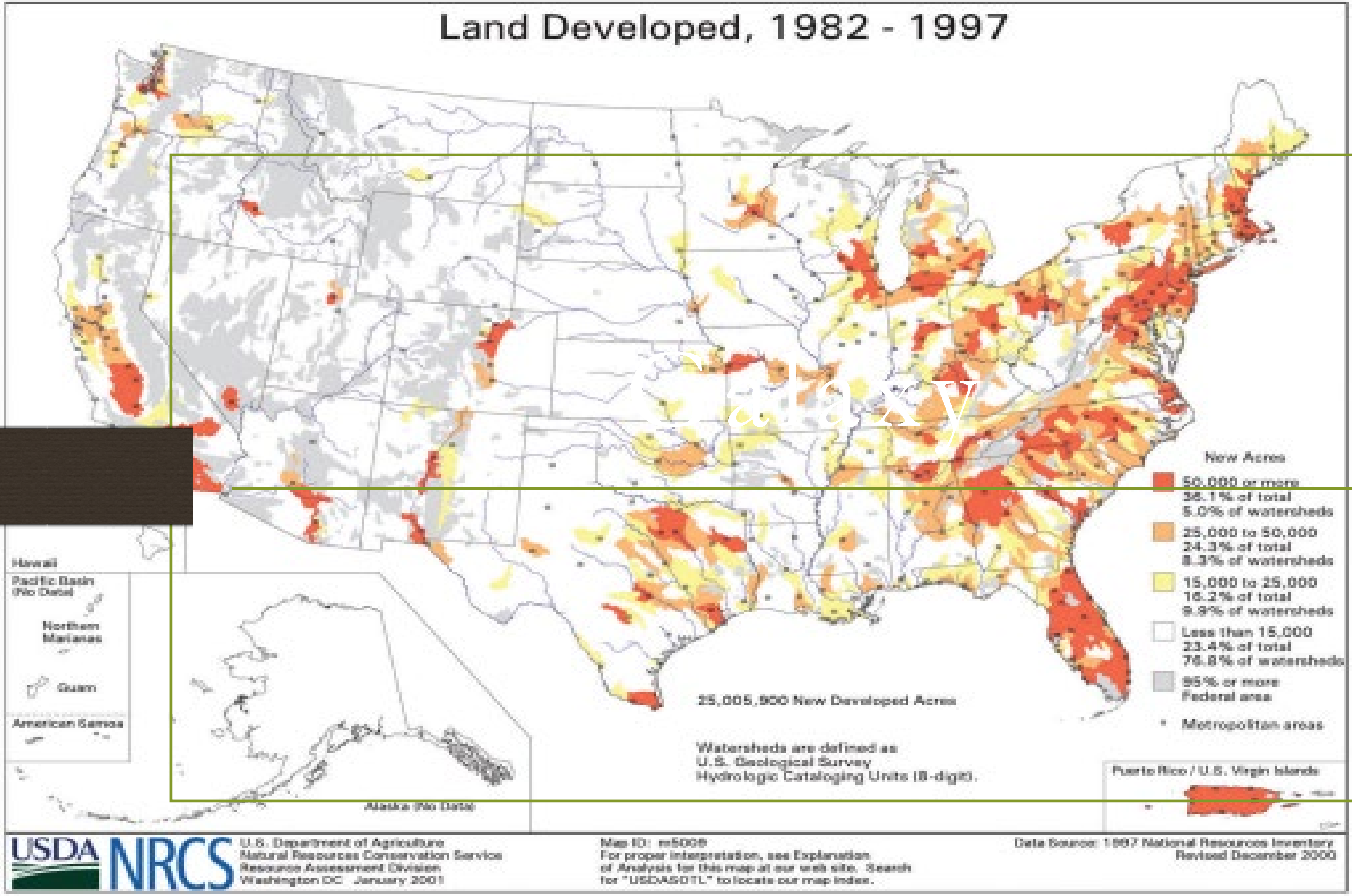
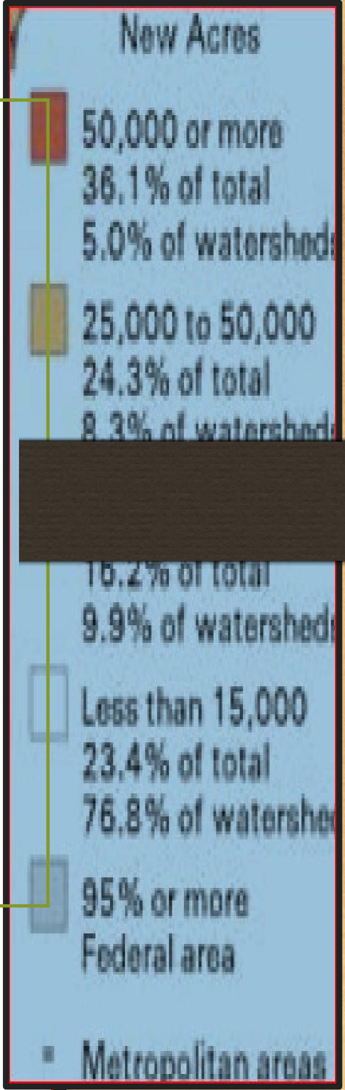
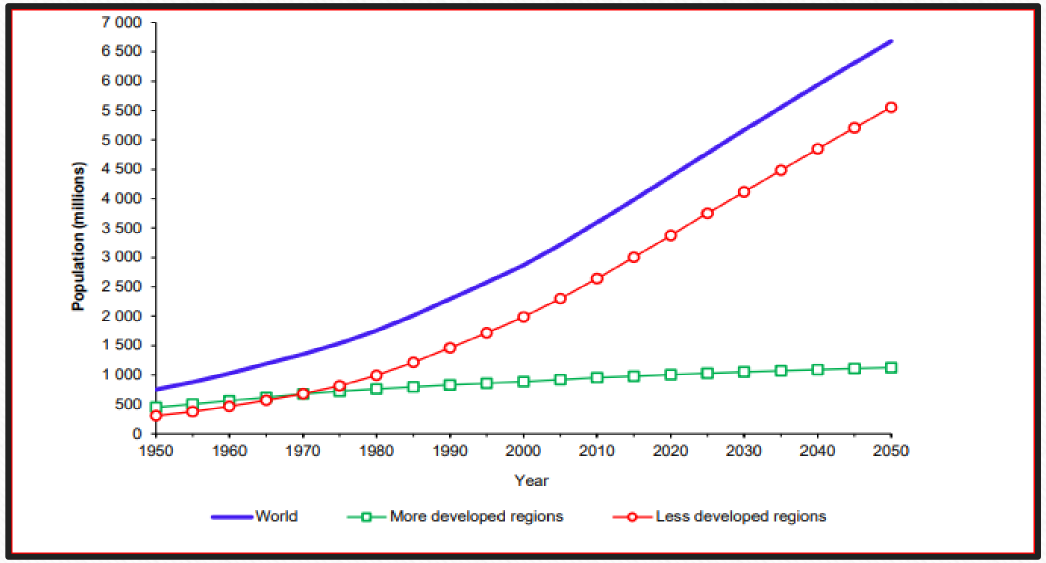


Figure 1.6: Annual rate of urban development from 1982 through 1997 (NRCS, NRI).



Growth Trends in Urban Areas (Continued)…

- The future of the world's population is urban, with more than half of the world's people living in urban areas (55 percent, up from 30 percent in 1950).
- Urbanization determines the spatial distribution of the world's population.
- By mid-century, roughly two-thirds (68 percent) of the world's population will be living in urban areas.
- The global urban population is projected to grow by 2.5 billion urban dwellers between 2018 and 2050.



Estimated and projected urban populations of the world, the more developed regions and the less developed regions, 1950-2050

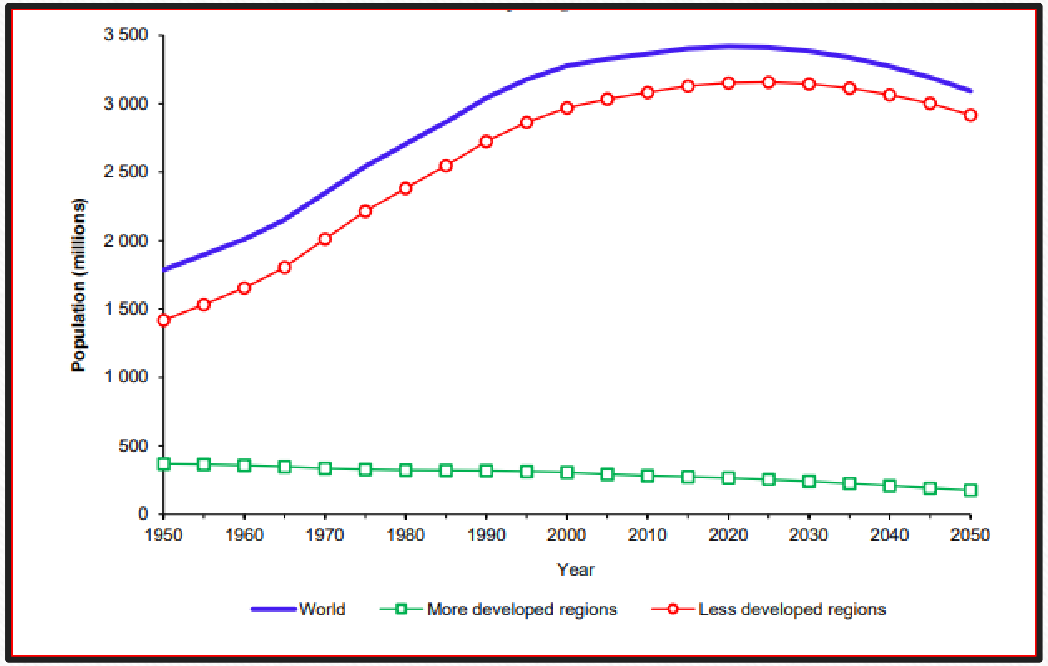


Figure 1: Estimated and projected rural populations of the world, the more developed regions and the less developed regions, 1950-2050

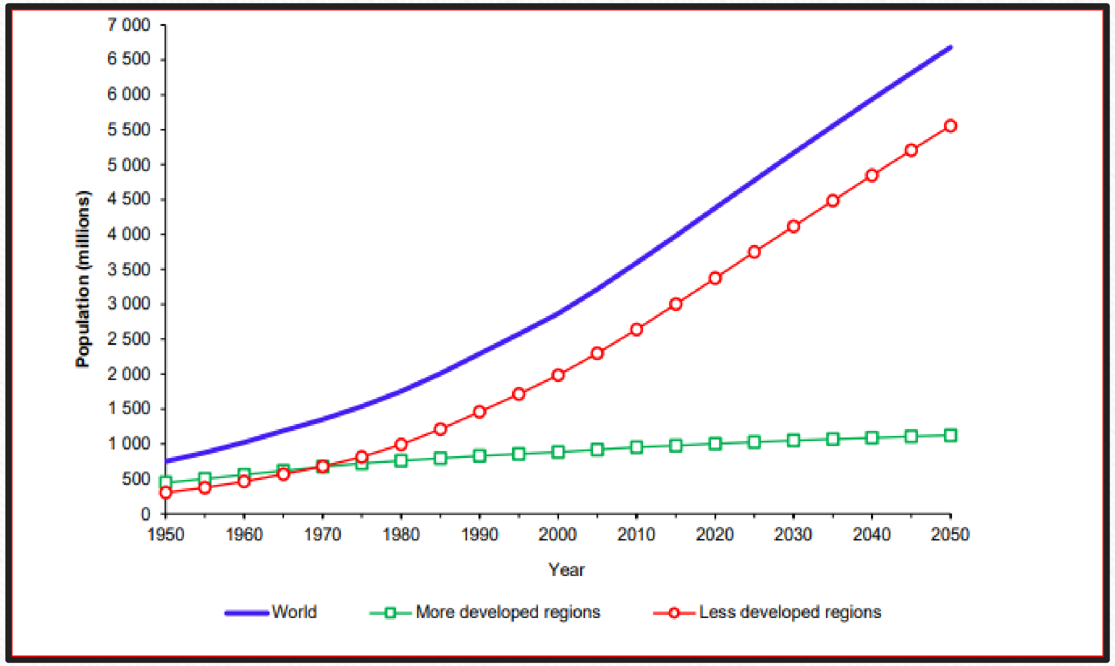


Figure 2: Estimated and projected urban populations of the world, the more developed regions and the less developed regions, 1950-2050

- The United Nations estimates that nearly 6.68 billion people will be living in cities by 2050

- There is such a disconnect between the real challenges of farming and the global macro pressures of an increasing population and urbanization, decreasing access to arable land and fresh water, worker welfare, food safety, food security, and it is necessary to increase awareness of these issues.

- It is fundamentally necessary to develop a greater connection and appreciation for how and where our food is growing, and that will help foster new breakthroughs.

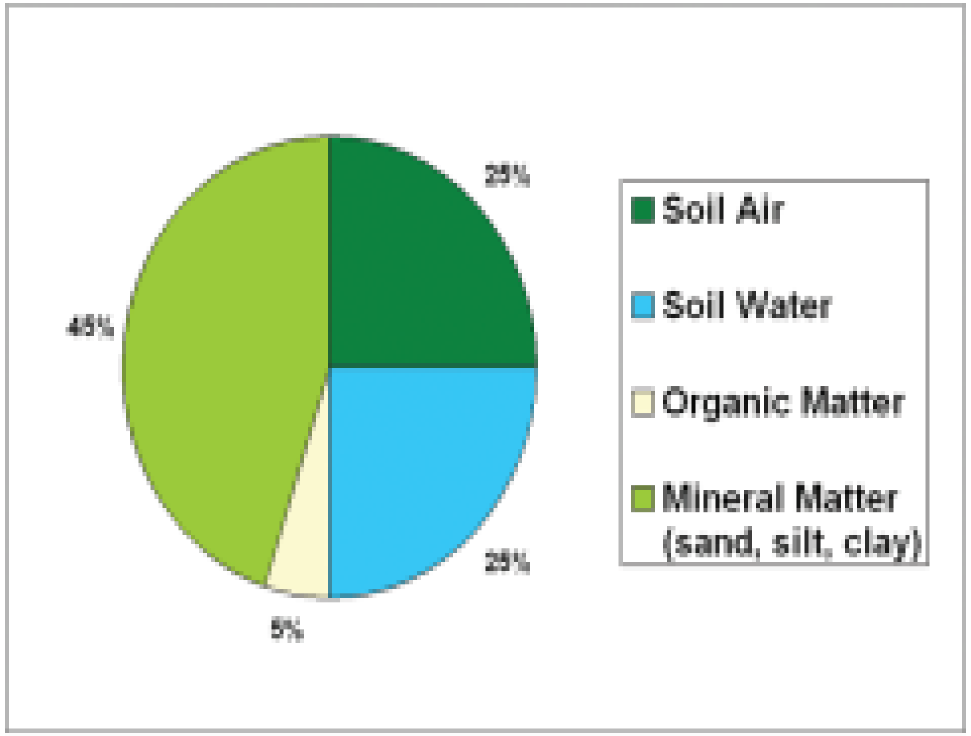
- There is an artificially-depressed cost of food, where the externalities and true costs of farming and negative environmental impacts are not factored in.

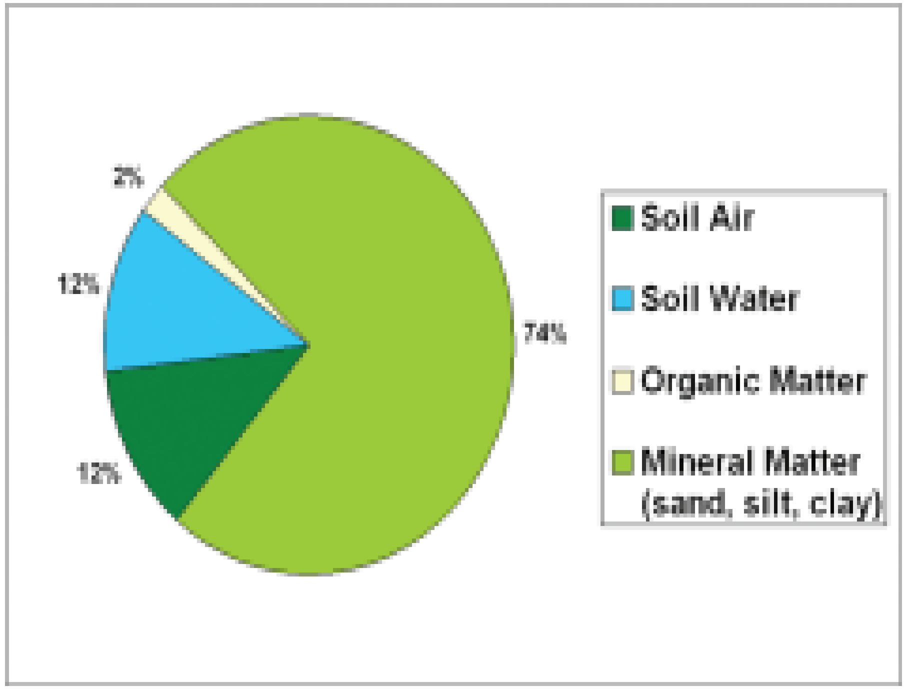
What do we need to know about Urban Soils?

- Soil in an urban area may share some properties with soils in forests, pastures, and crop fields.

- Soil properties, such as soil texture and structure, particle-size distribution, soil reaction, and bulk density, help us to understand and predict how soils react and respond to different uses.

- Construction activities, compaction, and surface sealing dramatically change soil properties and can sometimes result in a reduced ability to perform the critical functions or activities of natural soil





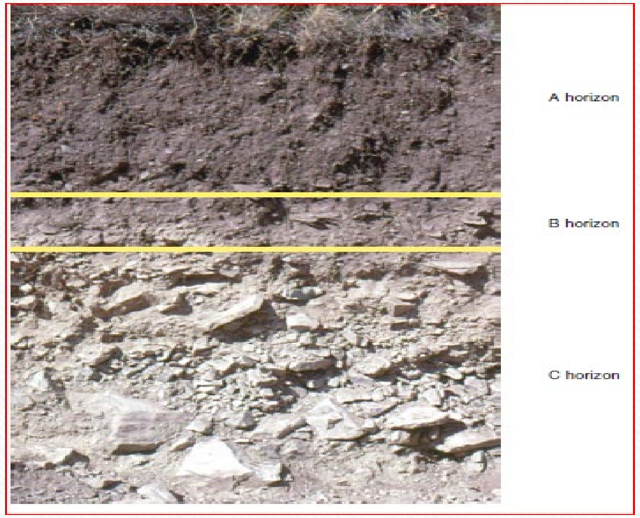
Composition of a natural soil, by weight

Composition of a compacted soil by weight

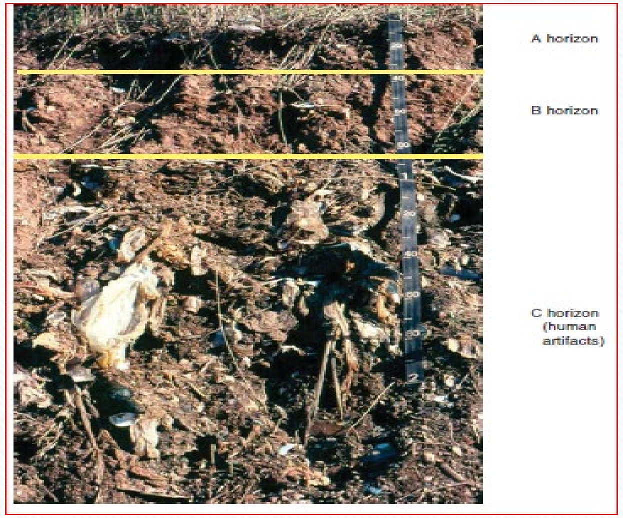
URBAN SOILS FORMATION & CLASSIFICATIONS

Figure 5. The case study location. Left photo shows the site post-demolition. Photo on the right shows an example of construction debris left after demolition.

Photos: William Shuster, EPA and Jennifer Olson, Tetra Tech

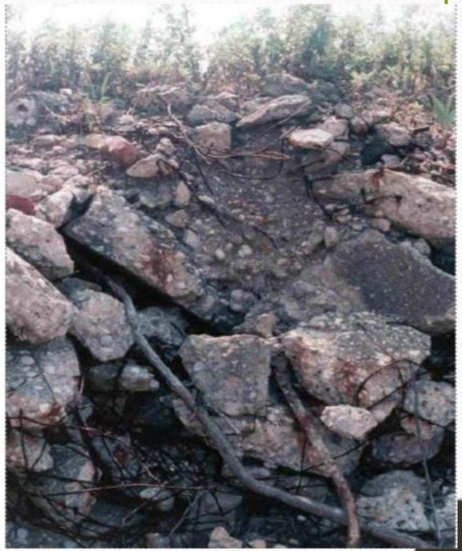


Natural Soil Profile

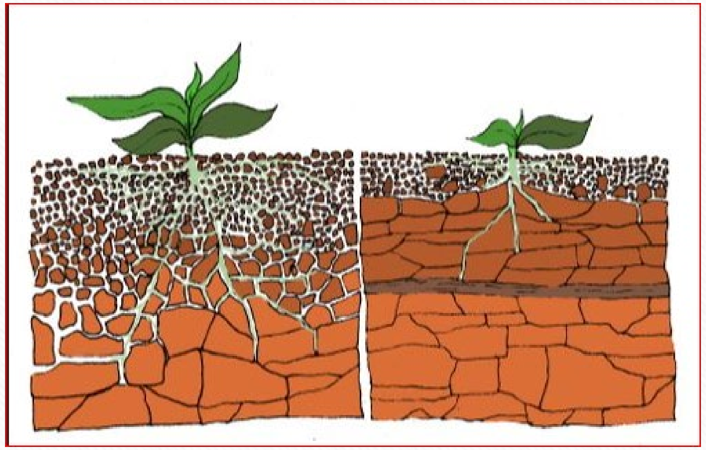


Urban Soil Profile

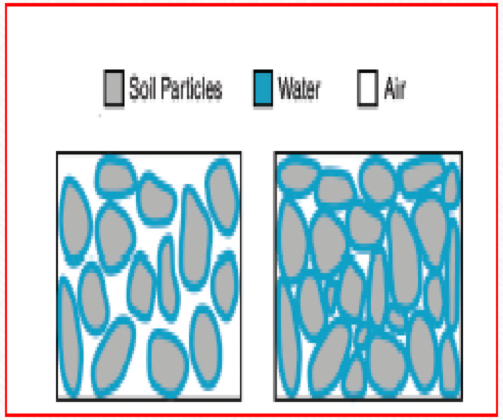
Coal ash



Construction Debris



Natural Soil Urban Soil



Noncompacted Compacted

Soil Temperature

- Higher in Urban Soils
- Due to compaction
- Water supply limited
- Heat stress in plant roots due to dry soils
- Less microbial activities
- More runoff

Urban Soils and City Storm Water

- Construction activities can be major contributors to poor water quality from sedimentation and dust in urban areas.
- Sediment can clog streets and storm drains with mud, and floodwater can carry excess phosphorus, nitrogen, and other contaminants to streams or lakes as well as Urban farms.
- Erosion- and sediment-control plans are used where large land areas are to be disturbed or where activity is expected to last through several rainfall or windstorm events.
- The best and quick remedy is to divert the water away from low spots and to create channels for storm water to flow around the site or in specific streams or ditches across the site.

A flooded parking lot and street

Factors that may affect the Productivity of Urban Soils:

- Little or no addition of organic matter
- Artifacts that disrupt water movement
- Elevated salt content
- Interrupted nutrient cycling and modified activity of micro-organisms
- High soil temperatures that increase the rate of chemical reactions
- Generally higher pH values resulting from additions of cement, plaster, and road salts
- Lateral (sideways) subsurface waterflow resulting from compacted layers

Ways to meet the nutritional needs of urban plants

- **Consider soil moisture and temperature as well as the chemicals and biological organisms needed to convert fertilizers into useful nutrients.**
- **Plant selection may vary according to the grower's nutritional needs, cultural traditions, soil conditions, and the space available.**
- **Attention must be paid to different plant tolerances for metals and to drainage, the growing season, and weed control.**
- **Plant growth and nutrition are closely linked to soil properties.**
- **Managing compost and organic waste is important for plant nutrition and for the biological degradation and conversion of contaminants into inactive forms in the soil.**
- **Organic materials are needed to hold water and nutrients in the soil for plant growth.**

URBAN FARM SITES – IDENTIFICATION

1. Identifying Problem Sites From Historical Records

- Metals in soils come from various sources.
- They may have been present in the geologic rock, or they may occur as atmospheric additions of copper, mercury, lead, and zinc.
- Metals also may have been deposited by past industrial activities, such as battery production, brass and steel manufacturing, mining, and many different processes involving nickel, cadmium, copper, and lead.
- Lead is especially evident near roadways because of automobile emissions before the availability of unleaded gasoline.

2. Identifying Problem Sites by Visual Clues

- Metal contamination on a site may be evidenced by plant growth, animal behavior, or paint flecks containing lead from older buildings.
- Many plants simply cannot grow where the level of certain metals is high.
- Other plants grow well in contaminated soil but fail to set seed or do not grow as well as expected.
- Absence of any plant growth is a warning sign that a site may be severely contaminated.
- Caution is needed in areas of bare ground or leaking water near past industrial sites, dumps, or older homes.

Urban Farm Sites - Assessment

Major Activities:

- Site Investigation
- Urban Soil Sampling and Test (Lab and Field level)
- Planning, Design and evaluate

Team Members Involved:

- Archeologist
- Soil Scientist
- Soil Conservation Planners – NRCS/District staff
- Producers

Role of Archeologist

- ❖ Reviews past history of the site.
- ❖ Identify, evaluate past and present archeological sites artifacts relating to the location for the establishment of the data retrieval system and for the development and management of Urban Agriculture Programs.
- ❖ Collects information through observations, interviews, and documents, recording and managing records of observations taken in the field via GPS/GIS/GPR and other proprietary software.
- ❖ Geophysical surveys and aerial photography

Role of Soil Scientist

- ❖ **Identifies soil type**
- ❖ **Characterizes Soils:**
    - ❖ **Physical**
    - ❖ **Chemical**
    - ❖ **Biological Properties**
- ❖ **Collect Soil Samples**
- ❖ **Interpret Soil Lab results**
- ❖ **Recommend Best Management Practices together with Soil Conservationist**

Joint Roles of Soil Scientist/Soil Conservationist

1. **CPA 116 - Soil Health Management Plan**

Component of a conservation plan that identifies soil health concerns related to the physical, biological, and chemical properties of the soil.

2. **DIA 162 - Soil Health Management**

Develop site specific recommendations and designs for soil health related practices that address the 4 principles of soil health as identified in CPA 116 or a conservation plan.

3. **CEMA 216 - Soil Health Testing**

Quantitative testing for physical, biological, or chemical characteristics of soil and constraints of soil using approved laboratory methods.

4. **CEMA 221 - Soil Organic Carbon Stock Monitoring**

Monitor change in total organic carbon stock to capture the natural variation in soil carbon, which may take several years or longer to occur.

Overall, soil releases about nine times more carbon than human-caused activities, but that's part of a natural cycle when the amount of carbon released into the air is about equal to the carbon taken out by oceans and plants. Fossil fuel emissions knock the atmosphere out of balance by putting more in than comes out.

CEMA 209 - PFAS Testing in Water and Soil

Polyfluoroalkyl substances (PFAS)

Polyfluoroalkyl substances (PFAS): Group of chemicals used to make fluoropolymer coatings used in industry and consumer products that resist heat, oil, strains, grease, and water. They are found in many products in your home, such as clothes, carpeting, upholstery, food packaging also found in many cosmetics. The chemicals travel easily in water and do not easily break down, so they can enter the water supply and soil around these factories or anywhere that the factories dump the chemicals.

<u>**Water and soil testing is required for safety.**</u>

Soil Sampling

Step 1 - Conventional

Soil Sampling Protocols- Field

❖Soil sampling for suitability as a growing medium is strongly recommended for urban agriculture and green infrastructure sites.

❖At a minimum, the soil test should include pH, percent organic matter, macronutrients, micronutrients, such as Lead and Arsenic.

❖Local soil testing information can be obtained from or performed by USDA Cooperative Extension System offices and from many land grant universities and private local laboratories.

Soil Sampling Procedures

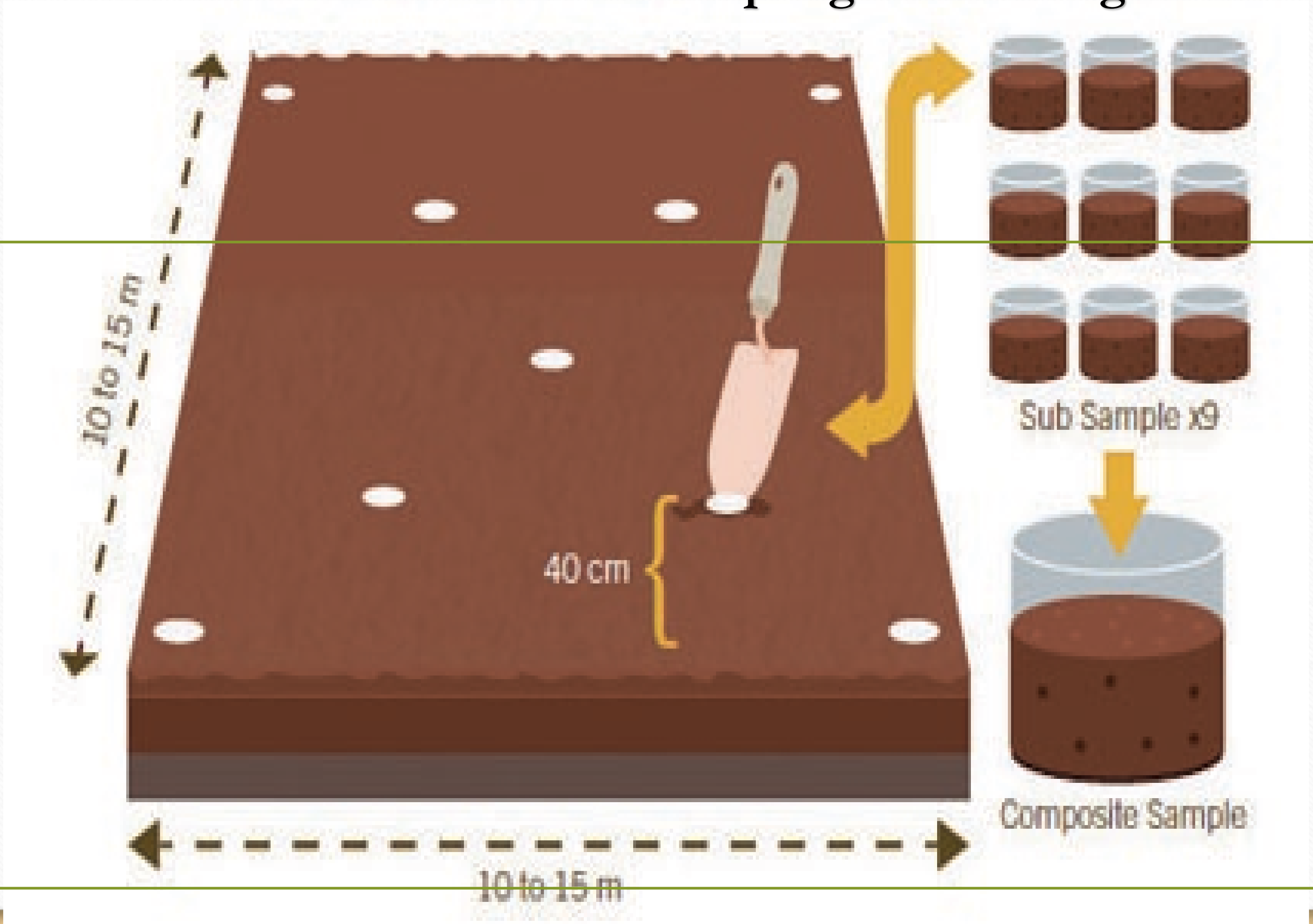
1. Collect a representative soil sample of the site.
2. A composite soil sample is made up of two or more combined sub-samples to represent an area of the garden.
3. Urban Soils Sampling checklist
4. Create a diagram and plan where you are going to take your soil samples:
5. Make note of the name and address of the property
6. Draw a line around your garden using pylons, tape, or rope.
7. The soil sample should be taken from the area that the gardeners use.
8. A typical community garden will need only one or two soil samples.
9. Recommend that a composite soil sample is taken every 10 x 10 to 15 x 15 m area (approximately 50 x 50 ft.)
10. Starting at one corner of the composite soil sampling area, walk diagonally to the far corner and repeat, making an "X" pattern.
11. Mark the location of a sub-sample approximately every 2.5 m (8 ft) using a pylon or some other marker.

- Strip off turf or other vegetation from the sub-sample spot
- Take shovel and dig into soil down to 40 cm (16 in) Place sub-sample soil into Bucket 1.
- Break up and mix the sub-sample soil in Bucket 1.
- Remove stones and visible debris.
- Note the presence and type(s) of debris, smells, and staining in your field notes.
- Transfer a trowel full of the mixed soil from Bucket 1 to Bucket 2.
- Refill the hole with the remainder of the soil in Bucket 1 and replace the turf.

Repeat until nine sub-samples have been collected separately in Bucket 1 and transferred to Bucket 2.

- Create composite soil sample
  - Mix the combined sub-samples in Bucket 2 to make the composite.
- Label sample bag with:
  - name of site
  - sample number
  - sampling date
  - name(s) of person(s) doing the sampling
- Transfer the mixed soil from Bucket 2 to the labeled sample bag
- Seal the sample bag and place it in a cooler with ice packs

Guide for Urban Soil Sampling and Testing



PennState
College of Agricultural Sciences

Home □ Agricultural Analytical Services Lab □ Soil Testing □ Soil Fertility Testing □ Soil Sampling Instructions

Soil Sampling Instructions

Follow steps 1-3 for your particular crop.

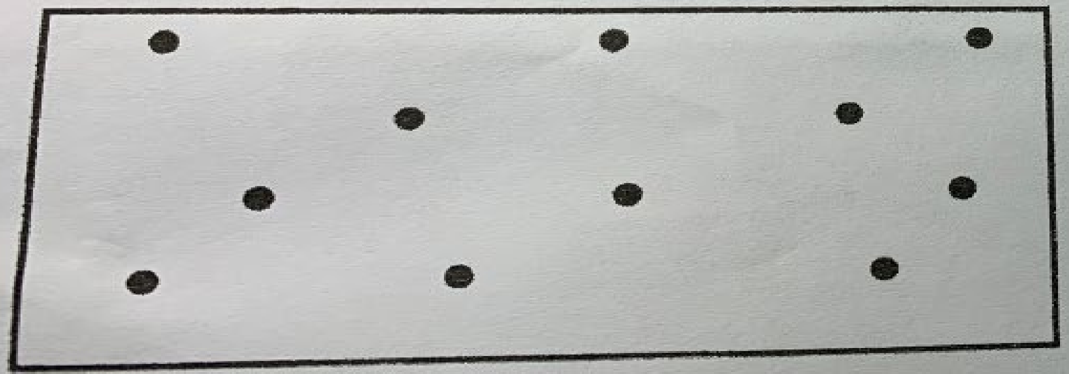
Step 1

A soil test is no better than the soil sample submitted for analysis. Take samples as follows:

Agronomic, Vegetables, Small Fruit, and Home Garden Crops

Using a trowel, shovel, or auger, and a clean pail, obtain thin slices or borings of soil from at least 13 places in a given area. Follow the diagram below to properly locate the samples. For contour strips, take 6 samples 20 feet in from the edge of the entire strip and 6 samples from the opposite side of the strip. Sample to plow depth in cultivated land or to a depth of 6 inches. Sample to a depth of 3 or 4 inches in permanent pastures. If the field varies in soil type, previous fertilizer or lime application, or cropping history, sample each area separately.

Taking a Soil Sample for Agronomic Crops (Video)



Square, Rectangular Field or Garden

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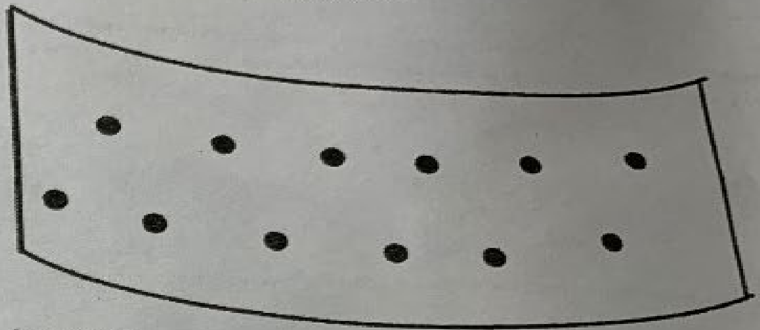


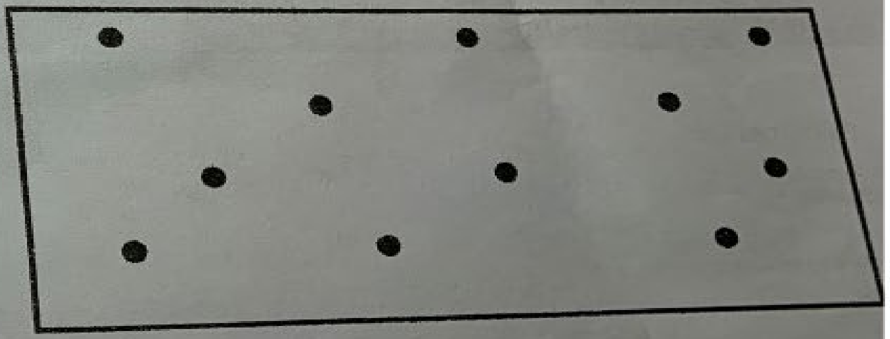
Contour Strips

Turf Soils

Using a soil sampling tube, auger or trowel, and a clean pail, obtain thin slices or borings of soil from 12 or mo
locations. Follow the diagram below to properly locate the samples. Sample to a depth of 2 to 3 inches.

If the area varies in kind of soil, previous fertilizer or lime treatments, use separate mailing kits for each diffe
Discard all grass and accumulated thatch material. Do not contaminate soil with fertilizer or other materials.

If you have a situation where a maintenance recommendation for an existing turf area is desired and also
recommendation for establishing a new turf area is desired, you must use separate soil test kits for each



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Step 2

Mix the soil taken into one composite sample. Spread soil on newspaper in a warm room to air dry overnight. Do not heat.

Step 3

Take 1 cup of representative sample and place in the soil mailing kit bag. Mail soil sample and submission form to The Pennsylvania State University, 111 Ag Analytical Srvcs Lab, University Park, PA 16802-1114.

View Your Soil Fertility Report

Ag Analytical Services Lab

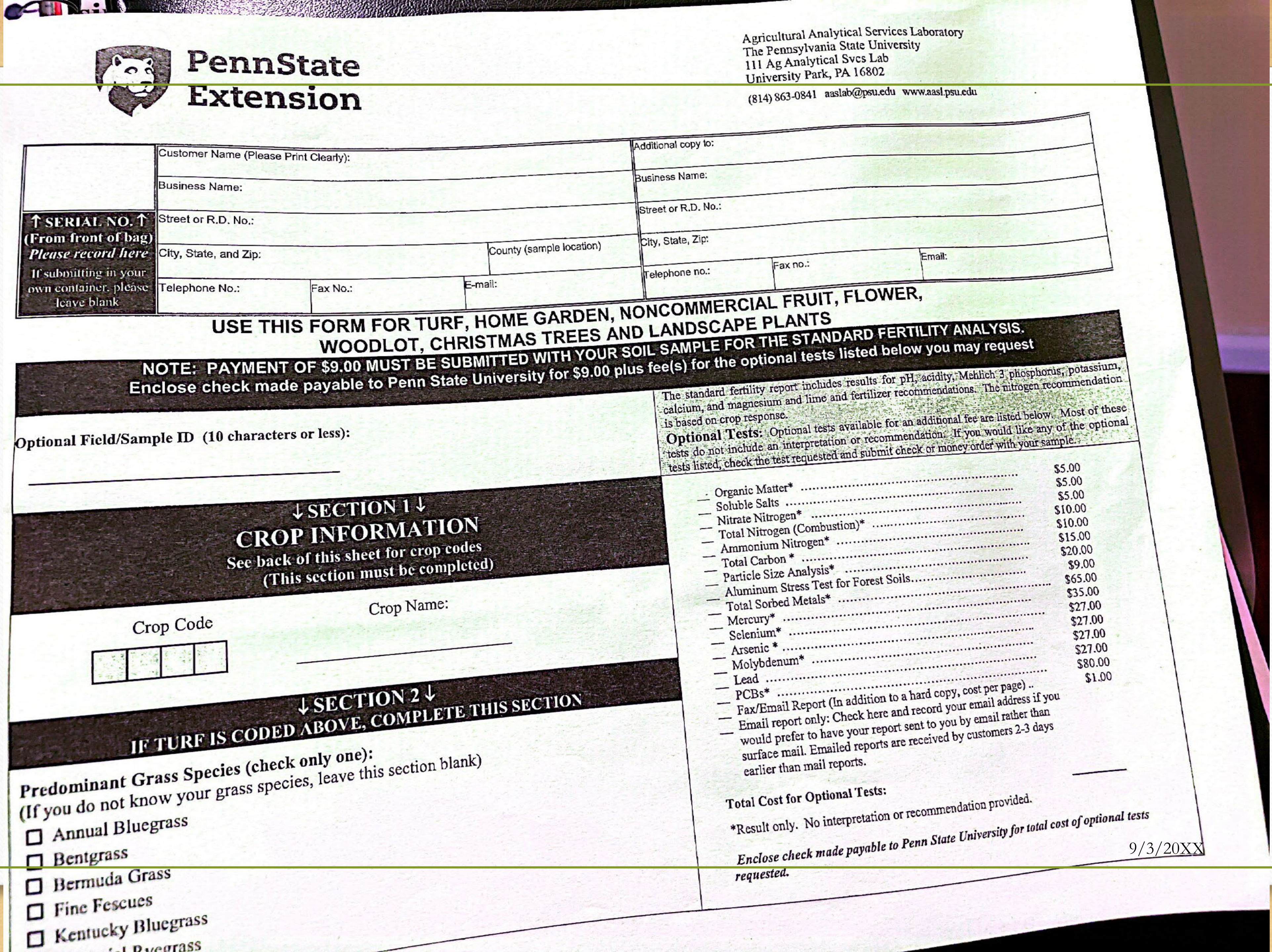
111 Ag Analytical Services Lab
University Park, PA 16802
Directions

Hours: Monday-Friday, 8:00 AM - 4:30 PM

EMAIL aaslab@psu.edu

SOIL LAB TEST

STEP 1



PennState Extension

Agricultural Analytical Services Laboratory
The Pennsylvania State University
111 Ag Analytical Svcs Lab
University Park, PA 16802
(814) 863-0841 aaslab@psu.edu www.aasl.psu.edu

↑ SERIAL NO. ↑
(From front of bag)
Please record here
If submitting in your own container, please leave blank

Customer Name (Please Print Clearly):
Business Name:
Street or R.D. No.:
City, State, and Zip:
County (sample location)
Telephone No.:
Fax No.:
E-mail:

Additional copy to:
Business Name:
Street or R.D. No.:
City, State, Zip:
Telephone no.:
Fax no.:
Email:

USE THIS FORM FOR TURF, HOME GARDEN, NONCOMMERCIAL FRUIT, FLOWER, WOODLOT, CHRISTMAS TREES AND LANDSCAPE PLANTS

NOTE: PAYMENT OF $9.00 MUST BE SUBMITTED WITH YOUR SOIL SAMPLE FOR THE STANDARD FERTILITY ANALYSIS. Enclose check made payable to Penn State University for $9.00 plus fee(s) for the optional tests listed below you may request

Optional Field/Sample ID (10 characters or less):

↓ SECTION 1 ↓
CROP INFORMATION
See back of this sheet for crop codes
(This section must be completed)

Crop Code
Crop Name:

↓ SECTION 2 ↓
IF TURF IS CODED ABOVE, COMPLETE THIS SECTION

Predominant Grass Species (check only one):
(If you do not know your grass species, leave this section blank)

- ☐ Annual Bluegrass
- ☐ Bentgrass
- ☐ Bermuda Grass
- ☐ Fine Fescues
- ☐ Kentucky Bluegrass
- ☐ ...ial Ryegrass

The standard fertility report includes results for pH, acidity, Mehlich 3 phosphorus, potassium, calcium, and magnesium and lime and fertilizer recommendations. The nitrogen recommendation is based on crop response.

Optional Tests: Optional tests available for an additional fee are listed below. Most of these tests do not include an interpretation or recommendation. If you would like any of the optional tests listed, check the test requested and submit check or money order with your sample.

__ Organic Matter*	$5.00
__ Soluble Salts	$5.00
__ Nitrate Nitrogen*	$5.00
__ Total Nitrogen (Combustion)*	$10.00
__ Ammonium Nitrogen*	$10.00
__ Total Carbon *	$15.00
__ Particle Size Analysis*	$20.00
__ Aluminum Stress Test for Forest Soils	$9.00
__ Total Sorbed Metals*	$65.00
__ Mercury*	$35.00
__ Selenium*	$27.00
__ Arsenic *	$27.00
__ Molybdenum*	$27.00
__ Lead	$27.00
__ PCBs*	$80.00
__ Fax/Email Report (In addition to a hard copy, cost per page)	$1.00

__ Email report only: Check here and record your email address if you would prefer to have your report sent to you by email rather than surface mail. Emailed reports are received by customers 2-3 days earlier than mail reports.

Total Cost for Optional Tests:

*Result only. No interpretation or recommendation provided.

Enclose check made payable to Penn State University for total cost of optional tests requested.

Bricks from demolished Wall

Paved lane & yard

EXAMPLE

PennState Extension

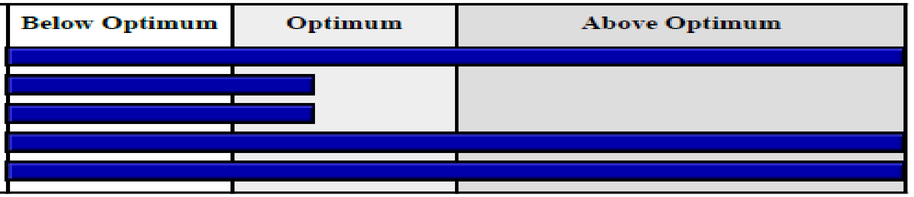
Agricultural Analytical Services Laboratory
The Pennsylvania State University
111 Ag Analytical Svcs Lab
University Park, PA 16802
(814) 863-0841 aaslab@psu.edu www.aasl.psu.edu

SOIL TEST REPORT FOR:	ADDITIONAL COPY TO:
VERONICA ERENBERG BERKS COUNTY CONSERVATION DISTRICT 1238 COUNTY WELFARE RD; SUITE 200 LEESPORT PA 19533	

DATE	LAB #	SERIAL #	COUNTY	ACRES	FIELD ID	SOIL
09/09/2022	S22-38979	40759	Berks			

SOIL NUTRIENT LEVELS

Soil pH	
Phosphate	(P_2O_5)
Potash	(K_2O)
Magnesium	(MgO)
Calcium	(CaO)



RECOMMENDATIONS FOR: ***Landscape, To Plant, pH 5.5***

Limestone, Calcium And Magnesium Recommendations

Apply the following quantities of limestone, epsom salts and/or gypsum to the soil to correct soil pH, calcium and magnesium levels.

Calcitic Limestone: (0-3 % Mg)	NONE
Magnesium:	NONE
Gypsum $(CaSO_4)$:	NONE

Nitrogen, Phosphate And Potash Recommendations

Apply 0.5 lbs per 100 square feet of UREA.

MESSAGES

The above lime and fertilizer recommendations are for this soil sample and this season only. Nitrogen, phosphate and potash recommendations are for fertilizers containing specific ratios of nitrogen (N), phosphate (P2O5) and potash (K2O). As an example 5-10-10 contains 5 % N, 10 % P2O5, and 10 % K2O. If fertilizers with the ratio(s) shown are not available, contact your local garden center or fertilizer supplier for the appropriate substitution.

pH is high. Use sulfur (see Table on back of report) to lower pH to optimum level of 5.5

Field Level Data Collection - In Situ

PXRF -Portable X-Ray Florescence

Portable Tool Kit Test

PXRF Data Collection

PX-ray fluorescence is an analytical technique that returns information about the elemental composition of a sample. The sample is illuminated with an X-ray beam and the atoms which are struck by the beam emit X-rays in response, usually at several different energies. Different elements produce different distributions of emitted X-rays so the spectrum of emitted X-rays can be used to identify which elements are present in a sample.

Portable X-Ray Fluorescence (PXRF)

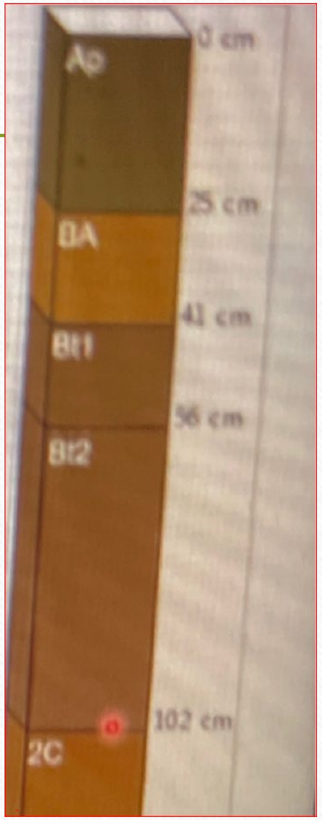
One approach for low cost and rapid assessment of soil Pb bio accessibility is based on portable X-Ray Fluorescence (pXRF) analyzers.

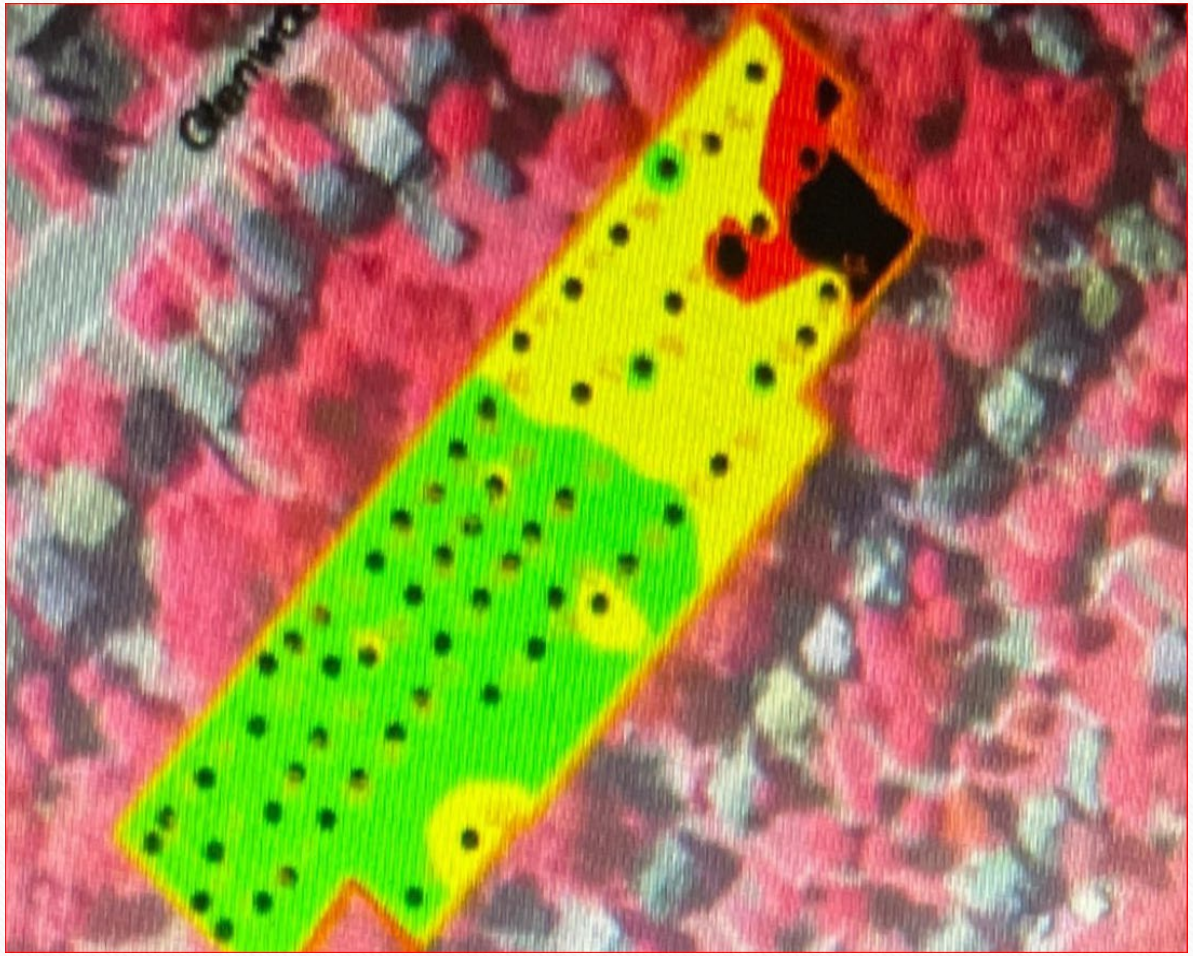
Portable X-Ray Fluorescence (PXRF)

- Working to train and certify staff to operate PXRF
- Required radiation safety training and certification
- Working to deploy PXRF to select staff for technical assistance
- Rapid and accurate total element concentrations
- Soil nutrients and toxic elements
- Reasonably analyze bio accessibility of some elements (e.g., lead)

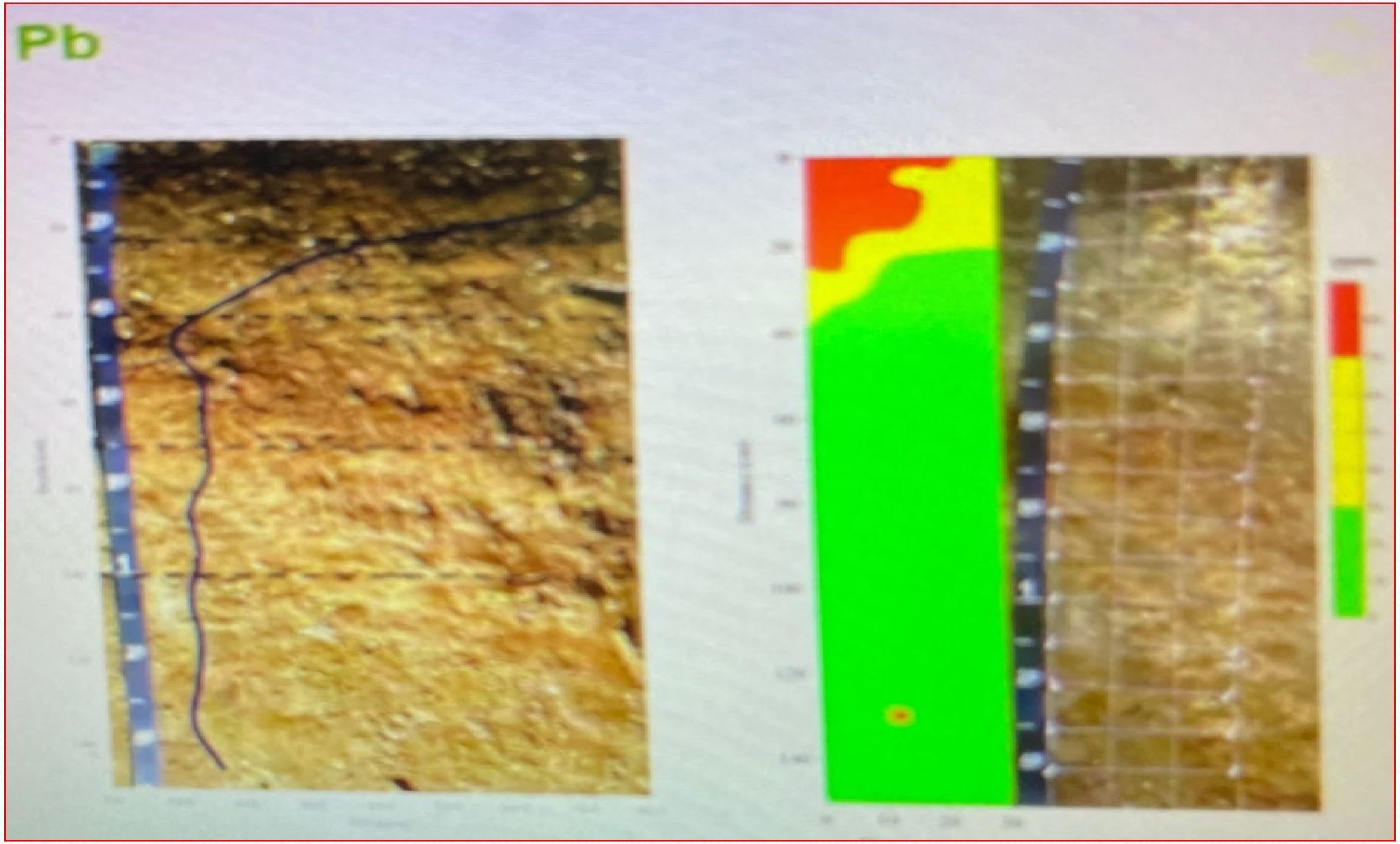
Soils in Sampling Sites

Soil Profile





Sampling sites with different levels of contamination



Total Lead Concentration in soil horizon.

- Prepare the data

te	Time	Reading	Mode	P	S	Cl	K	Ca	Ti
######	8:03:37	2	Soil	<LOD	<LOD	<LOD	3540	7467	
######	8:05:10	3	Soil	<LOD	<LOD	<LOD	7333	20154	
######	8:07:45	4	Soil	<LOD	<LOD	<LOD	4235	8332	
######	8:09:20	5	Soil	<LOD	<LOD	<LOD	4935	9681	
######	8:10:57	6	Soil	<LOD	<LOD	<LOD	3252	10814	
######	8:12:54	7	Soil	<LOD	<LOD	<LOD	3799	7586	
######	8:14:10	8	Soil	<LOD	<LOD	<LOD	6208	21787	
######	8:15:34	9	Soil	<LOD	1072	416	5726	8562	
######	8:17:38	10	Soil	<LOD	<LOD	<LOD	3589	10700	
######	8:19:17	11	Soil	<LOD	<LOD	<LOD	4074	8923	

Climate Smart Best Management Practices of Urban Soils

1. Dust control measures, e.g., mulch on top of contaminated soil and drip irrigation (moist soil), result in minimum resuspension of contaminated soil particles into the air as well as reduced splash or flooding (compared to other watering techniques), decreasing potential recontamination of the soil surface and above-ground plant tissues.

2. The addition of organic matter (e.g., compost) improves soil structure with more stable aggregates that adsorb contaminants and reduce erosion reducing the possibility of fine particle resuspension into the air.

3. Liming increases soil pH, which reduces trace metal bioavailability and improves soil aggregation and structure.

Climate Smart Best Management Practices of Urban Soils

4. Certain crops such as fruiting vegetables, in particular, are much less susceptible to contamination than others. These crops should be prioritized in urban gardens. There should be a clear recommendation that crops that are more susceptible to contamination should be avoided unless thorough testing or ex situ remediation.

5. Installing a garden at least 50 m away from heavy traffic avoids the accumulation of contaminants in the soil over time.

6. Climate change effects, especially temperature and precipitation extremes on soil contamination and metal mobility in soils, requires special attention.

7. In the case of dry seasons, the addition of phosphate fertilizers, composts, and soil amendments may not form stable (and thus less bioavailable) forms of metals due to the lack of water content required for chemical reactions to occur.

Reconditioning and Amending Urban Soils

Reconditioning

- The objective is to increase the soils' ability to support different types of plants and their ability to infiltrate stormwater. Sites intended for urban agriculture might need relatively more work to achieve the specific characteristics needed to grow certain crops.

- Longer term methods for reconditioning soils include amending existing soils with mulch and compost, and/or planting cover crops to provide additional nutrients and erosion control over the winter months.

Reconditioning and Amending Urban Soils

Soil Amendments

Soil amendments and additives introduced into soils to modify specific physical soil characteristics. Any materials brought in to improve a soil's condition should be of known origin and quality to ensure that diseases, unwanted chemicals or seeds, and allergens are not introduced. There are 5 categorizes of soil amendments :

- **Organic:** **Composted plant residues that increase soil organic matter content.**
- **Mineral:** **Natural or processed mineral products that change the texture of the soil.**
- **Physical:** **Manufactured additives designed to amend or replace natural soil structure and improve the soil structure.**
- **Biological:** **Biological used to improve the soil ecosystem by improving the soil food web.**
- **Chemical:** **Added to affect soil chemistry (usually to alter nutrient levels or soil pH).**

Reconditioning and Amending Urban Soils

Organic Amendments

- Organic soil amendments and additives are organic materials added to improve the soil food web, both by introducing organisms and providing the carbon source to support those organisms.

- Organic amendments can also improve the CEC, chemical buffering, and initial aeration of the soils.

- One of the most common organic amendments is compost. Compost added to an urban soil improved the physical properties and the nutrient content of the soil.

- Compost also provides plant-protection benefits and stimulates biological activity. The quality of compost can vary significantly and should be taken into account when selecting a supplier.

Organic Amendments (continued)

- Food scrap items such as vegetable and fruit waste, meal leftovers, coffee grounds, tea bags, stale bread, grains, and general refrigerator spoilage can be effectively composted to be used as organic amendments.

- Food scraps should be adequately secured in a bin while they degrade to avoid attracting rodents and other scavengers and should not be directly tilled or applied into the soil.

- It is important that organic materials be composted properly to avoid introducing noxious, insect eggs, and other undesirable organisms to any site.

- Organic materials hold abundant moisture and require proper aeration.

- Organic amendments are therefore typically not effective for improving drainage in compacted or abused soils where excess water cannot move from the root zone.

- To be effective, organic materials generally must be periodically replenished to maintain benefits.

Reconditioning and Amending Urban Soils

Mineral Amendments

- Mineral amendments are inorganic and are generally permanent and dimensionally stable in the soil and may increase drainage if used in sufficient quantity.
- Perlite, hadite, and pumice are three mineral amendments excellent for soil mixing because they have large internal pore spaces and hold air and water in suitable proportions for plant growth.
  - Perlite is an inert volcanic rock structurally expanded with steam. It comes in different grades and is used for a wide array of applications.
  - Hadite is a clay product baked at high temperatures to form a porous, inert additive.
  - Pumice is a light, foamy volcanic rock.
  - They are all chemically stable and sterile, and they make excellent soil additives.
- Powdered charcoal can be beneficial for soils because it is chemically stable, has high CEC, can absorb a wide array of chemicals, stabilizes pH, and stimulates secondary biological activity.

Reconditioning and Amending Urban Soils

Biological Amendments

Biological amendments are used to improve the soil ecosystem by improving the soil food webcal amendments. Types of biological amendments include:

- Mycorrhizae, a symbiotic fungus that colonizes plant roots and increases water and nutrient absorption;
- The addition of macrofauna or microfauna to break down organic material. In terms of their abundance and their soil forming roles, earthworms, termites and ants are the most important macrofauna components of soils.
- Many of these animals burrow in the soil, aiding soil drainage and aeration; in addition, some organic material passes into the soil through the burrows. Most macrofauna consume decaying plant material and organic debris.

Biological Amendments (continued)

The most effective and readily manipulated soil macrofauna are earthworms. Many earthworm species burrow several feet deep, and all ingest soil. Earthworms leave castings that aggregate soil particles and resist degradation and promote easier air, water, and nutrient penetration into the soil profile. Earthworms alter soil in a variety of ways, including:

- Altering soil chemistry, including pH, CEC, and other major soil parameters
- Efficiently burying seeds and other organic debris
- Detoxifying a wide array of contaminants, including petrochemicals
- Altering heavy metal bioavailability
- Promoting microorganism growth and dissemination
- Providing ideal macropore space for microfauna and root penetration.

Reconditioning and Amending Urban Soils

Chemical Amendments

- Chemical amendments are added to affect soil chemistry (usually to alter nutrient levels or soil pH) but changing the chemical composition of a soil is difficult.
- The application of a chemical amendment, often a fertilizer, is intended to rectify a chemical imbalance in the soil.
- Chemical amendments can have unintended side-effects (e.g., soil salinization) that can be avoided or limited through review of the amendments and existing soils conditions.
- It should also be noted that over-application of fertilizers is common; and every effort should be made to apply the least amount of fertilizer that is necessary to achieve the intended results.
- This is especially true because phosphorus, included in many fertilizers, is often a limiting nutrient and over-fertilization can lead to excessive algae growth in lakes, streams, and ponds.

HEAVY METALS CONTAMINATION AND MITIGATIONS

LEAD CONTAMINATION & PLANT SPECIES

- Crop contamination varies markedly with plant species and types.
- Crop contamination decreased as follows: leafy vegetables > stalk vegetables/root vegetables/solanaceous vegetables > legume vegetables/melon vegetables.
- Another research found as follows: onion > kale > eggplant > cabbage > tomato.
- It was found that most Pb was concentrated in the roots with some translocation into the shoots and that Pb was not concentrated in the edible parts of fruiting vegetable plants.
- Edible leaf crops (Swiss chard, collard greens), herbs (mint, cilantro), and edible roots (carrot, onion, radish) had the highest levels of Pb.
- Certain crops, in particular, fruiting vegetables (e.g., tomato, eggplants, cucumbers), are much less susceptible to contamination than others

Best options to minimize contamination of metals

❖ Crops should be prioritized in urban gardens when growing or prophylactic measures (e.g., construction of raised beds with clean soil) required.

Final Remarks

1. Urban soil testing should be prioritized.
2. Documentation of land-use history should be required and made available.
3. Amendments alone cannot be relied upon as treatment for contaminated soils.
4. Certain crops are much less susceptible to contamination than others.
5. Raised seed beds filled with natural forest soils or upcycled local mineral and organics are preferred to reduce metals contamination.

If we manage our Urban soils properly, we can feed our ever-increasing Urban population in the years to come.

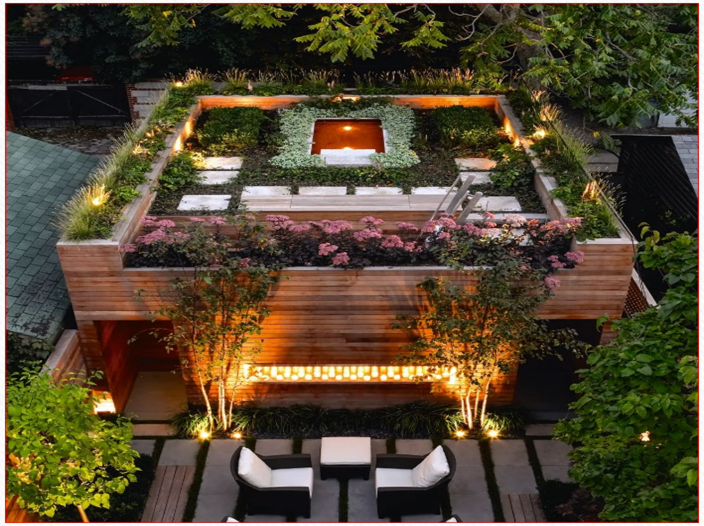
The most common Innovative Urban Agricultures are:

- Meditation gardens
- Rooftop gardens
- Rain gardens
- Butterfly gardens
- Outdoor classrooms
- Vertical Gardens
- Desert gardens
- Kitchen gardens
- Victory gardens
- Green space, open space
- Medicine circles
- Labyrinths

Small Meditation Garden

Crosby Street Rooftop Terrace, NYC

Green Roof + Garden, Toronto



Rain Garden

Kitchen Garden

Kitchen Garden

Desert Botanical Garden

Green Space Garden

Vertical Garden

Victory Garden

Butterfly Garden

Labyrinths

Dr. Kefeni Kejela

NRCS Resource Soil Scientist

kefeni.kejela@usda.gov
717-836-9073