Site Characteristics
Take note of the land use, the land cover or vegetation, the slope and aspect (direction the slope faces).

Soil Profile
Do you see any **horizons**?
A dark topsoil layer is usually a good indicator for successful plant growth.
Well expressed, naturally formed horizons below this could be a sign of a stable and relatively undisturbed soil.
Multiple layers could also be a result of filling with different types of materials.

Soil colors can tell something of the origin of soil material, and the wetness.
Is the soil uniformly brown? Then it is probably well aerated.
Different colors may also indicate different sources of material.
Is the soil partially gray, or brown with spots of gray? If so, it may be wet, which is undesirable for the growth of certain plants.

Soil texture has important implications for water and nutrient supply.
Very sandy soils may not hold enough water & nutrients for certain plants.
Too many coarse fragments may take up water & nutrient holding space, and even plant rooting space.
Heavy clay soils may have poor drainage. Gray colors may indicate wetness.
Loamy soils (a mixture of sand, silt, and clay) are generally best for most uses.
What is the % (by volume) coarse fragments? What size are they?
Are they natural rocks or artifacts?

Soil Structure reflects soil physical condition.
Well expressed granular structure in the surface is a good sign of biological activity and health.
Platy structure indicates compaction and possible problems with water movement and root growth.
Subangular blocky structure in the subsoil allows for sufficient pore space for movement of water and air.

Soil Consistence also reflects soil physical health.
Firm layers could restrict water or roots.

A **pH test** can give you a quick idea of the soil's chemical status.
The ideal pH for the growth of most plants is between 6.0 and 6.5.
pH values lower than this may need additions of lime (calcium carbonate).
However, most urban soils have high pH values >7.0.

If you're planning a vegetable garden, you should have your soil tested for **contaminants**, such as heavy metals, as well as pH and nutrient content.
The Westchester County Environmental Lab http://www.westchestergov.com/labsresearch/publichealth/environlab/environlab.htm (914-231-1620) and the Microbac Lab http://www.microbac.com/ (724-934-5030) can analyze soil samples for contaminants.

A Field Guide

To Describing Soils in NYC

USDA-NRCS
NYC Soil Survey

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What is soil?

Soil is a mixture of mineral and organic matter,
which forms on the surface of the earth,
and changes, or has changed, in response to climate and organisms.

Soil is composed of:

Solid space	&	Pore space
• mineral material		• air
• organic material		• water

The proportion of each component can vary from one soil to another.
An "ideal" agricultural soil contains:

50% solid space	&	50% pore space
45% mineral material		25% water
5% organic material		25% air

Why should we know our soil?

1) Soils perform important functions in our environment;
2) Soils are variable;
3) Soils can be degraded.

1. Functions of Soil

- Sustain biological activity, diversity, and productivity
- Regulate and partition water and solute flow
- Filter, buffer, degrade, immobilize and detoxify organic & inorganic materials
- Store and cycle nutrients and other elements
- Provide support for socioeconomic structures

2. Variability of Soil

Why are soils different? There are 5 **soil forming factors**:

- *Parent material*: is the raw material or 'geologic substratum' for soil formation
- *Landscape position or topography* influences erosion and deposition, water movement, local climate (e.g., north vs south facing slope)
- *Climate* affects physical, chemical, and biological reactions in soils.
- *Organisms* affect soil through their activity, and in the decomposition of their wastes and residues.
- *Time* changes parent material into soil.

The interaction of these 5 factors result in the **soil forming processes**:

- *Additions* include organic matter accumulation and other surficial inputs.
- *Losses* occur through "leaching" of soluble constituents downward through (and out of) the soil profile by water, and removal of soil material by erosion.
- *Translocations* involve redistribution of constituents within the soil profile (e.g., clay and/or iron).
- *Transformations* are physical and chemical changes (e.g., in minerals or organic compounds)

Soils in NYC

Soils form over time, through a series of processes, from mineral and organic parent materials. In general, soils can be formed directly from the underlying bedrock, or from some type of deposit above the bedrock. Most of New York state is covered with glacial deposits, left behind after the last ice age. Glacial deposits include two main groups: **glacial till**, an unsorted and unstratified mixture of materials left directly by the ice, and **glacial outwash**, the sorted and stratified material left behind by glacial meltwater. In some areas, particularly where the bedrock is more resistant, the ice did more scraping and abrading than depositing. Bedrock outcrops are common here, along with shallow soils.

Because of the high population density and resulting intense land use, soils in highly populated areas are usually disturbed. This disturbance includes:

- mixing of soil horizons or removal of topsoil
- cutting & filling or grading of areas to level land (for buildings, ballfields, etc)
- filling of areas that are wet, or possess undesirable soil characteristics
- adding plant growth media to the soil surface

Material used to 'fill in' an area can be natural soil material (derived locally or not), waste materials (e.g., coal ash, dredged spoils), or a mixture of both. Soils in urban areas can contain cultural artifacts (garbage); construction debris, and various waste products.

Parent materials for soil in New York City include:

- deep glacial till: especially on Staten Island;
- "shallow" glacial till over bedrock: especially in Manhattan and the Bronx;
- glacial outwash;
- alluvial or recent stream deposits;
- tidal marsh deposits;
- organic materials (very wet areas);
- "anthropogenic", or human-deposited materials (fill): found almost anywhere in the urban environment. Fill can be composed of:
    - ❑ Natural soil materials
    - ❑ Construction debris
    - ❑ Dredged materials
    - ❑ Coal ash
    - ❑ Municipal solid waste

Potential problems with urban soils include:

- o Greater variability in horizonation & geographic distribution
- o Little/no organic matter addition
- o Presence of artifacts
- o Modified soil temperatures
- o High probability of compaction & contamination

More soils information is available under the *Teachers and Students* link at http://soils.usda.gov/

Soil Consistence is the ease with which a lump of soil can be crushed by the fingers. It can also describe the difficulty of excavating the soil. Soil consistence, and its description, depends on soil moisture content. Terms commonly used to describe consistence in a moist soil are:

Loose – noncoherent when dry or moist; does not hold together in a mass.
Friable – when moist, crushed easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
Firm – crushed under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Very Firm –needs considerable pressure to crush between thumb and forefinger

Roots
Root content reflects both plant and soil conditions. It can indicate zones in the soil that are physically restrictive to rooting.
Describe quantity:

Few	<2% of total volume
Common	2-20% of total volume
Many	>20% of total volume

and size:

Fine	<2mm
Medium	2 to 5mm
Coarse	>5mm

Soil pH
The most important effect of pH in the soil is on ion solubility, which in turn affects microbial and plant growth. A pH range of 6.0 to 6.8 is ideal for most crops because it coincides with optimum solubility of the most important plant nutrients. Most of the micronutrients for plant growth, and most heavy metals are more soluble at lower pH. Management of pH is important in controlling movement of heavy metals (and potential groundwater contamination) in soil.
In humid areas such as the eastern US, soils become naturally acidic over time as rainwater replaces basic cations (Ca, K, Mg, Na) with hydrogen. Some types of vegetation, particularly conifers, produce organic acids, which can also contribute to lower soil pH values. Addition of certain fertilizers to soil can also produce hydrogen ions. Liming the soil adds calcium, which replaces exchangeable and solution H^+ and raises soil pH.
In general, soils in urban areas have been found to have higher pH values than undisturbed natural soils. These may be due to additions of basic cations from road salts, concrete, plaster and other “anthropogenic” materials.

Horizon Boundary
How thick is the boundary?

Abrupt: <1”	*Clear:* 1 to 2 ½”
Gradual: 2 ½ -5”	*Diffuse*: >5”

What is its shape?

Smooth: nearly straight	*Wavy*: pockets where width>depth
Irregular: pockets where depth>width	*Broken*: discontinuous

Soil formation is all about processes. In time, processes create a soil from a pile of unconsolidated rubble. With more time, the soil will look less like the parent material it came from.

How are soils different?
Soil forming processes influence the **soil physical & chemical properties**:
- horizonation
- soil color
- soil texture
- soil structure
- soil consistence
- pH and nutrient supply

<u>3. Degradation of Soil</u>
It can take up to 500 years to form an inch of soil – is this a renewable resource?
Soil can be degraded rather quickly by:
- Erosion
- Contamination
- Compaction

These abuses of soil can affect its ability to perform one or more functions. This ability or capacity is often called soil quality. Soil quality is affected by soil use. For more information on soil quality (assessment of soil quality) visit the NRCS Soil Quality Institute website:http://soils.usda.gov/sqi

<u>Soil Description</u>
Site Characteristics
- Location: street, etc.
- Land use: athletic field, playground, woods, etc.
- Landform: *natural* - flood plain, river terrace or valley, till slope; *human modified* - leveled land, fill, dump
- Vegetation: types, abundance
- Slope: What is the slant or inclination up or down? Slope can be expressed as change in elevation in feet per 100 feet lateral distance. Pace off 50 or 100 feet and estimate difference in elevation.
- Aspect: Which compass direction does the slope face (down slope)?
- Parent material: natural or fill?

Soil Profile
- ♦ Are there layers or horizons? How thick? Can they be identified?
- ♦ Color or colors for each horizon
- ♦ Texture, including amount, size, and type of coarse fragments
- ♦ Structure
- ♦ Consistence
- ♦ Roots
- ♦ pH
- ♦ Horizon boundary

Soil Horizonation

A soil profile is a sequence of horizons. Soil horizons form naturally as a result of soil forming processes. Horizon nomenclature reflects the dominant process(es). Horizons may also be the result of natural or anthropogenic deposition.

In describing horizonation, you can use these terms if you wish. Separate out horizons when there is any difference in the appearance (color, texture, coarse fragments, structure, roots, or feel (texture, consistence) of a soil layer.

Description of Master Horizons

***O** horizons* are dominantly organic soil material. Organic matter is composed of original and decomposed plant, animal, and microbial components. It is very important in soils as it helps aggregate and loosen soil, provides nutrients, and holds water and nutrients.
Definition: Organic horizon
Process: accumulation of slightly to highly decomposed plant & animal residues
ID: surface material, lighter in weight and darker in color than mineral material,
Comment: not found in all soils
O horizons can be found in wooded areas, or in wet areas, as organic material can accumulate in very wet or waterlogged conditions, where decomposition is slower.

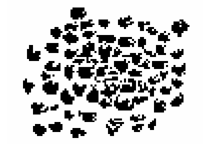
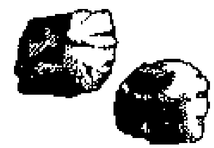
***A** horizons* are mineral layers that formed at the surface or below an O horizon, that show one an accumulation of humified organic matter intimately mixed with the mineral fraction.
Definition: organically enriched mineral horizon (topsoil)
Process: incorporation or mixing of organic material into mineral soil
ID: darker mineral horizon at the soil surface

***E** horizons* are layers in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these, leaving a concentration of sand and silt particles.
Definition: horizon characterized by the loss of some component
Process: eluviation (washing out) of iron or clay
ID: paler color or lighter texture than below, just below A
Comments: not found in all soils

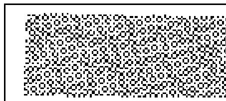
***B** horizons* are layers that formed below an A or E and show one or more of the following:
(1) lighter, brighter, or redder colors than above;
(2) more clay than above;
(3) subangular blocky, prismatic, or columnar structure.
Definition: horizon of accumulation, or development of structure or color
Process: development of structure or color, illuviation (moving in) of iron or clay
ID: noticeable structure, brighter or redder color, more clay or iron than above,

Soil Structure is the combination or arrangement of primary soil particles into secondary units or aggregates. Organic materials and clay are important binding agents, and wetting & drying cycles are important in creating structure. Soil structure influences pore space and water movement in soils.

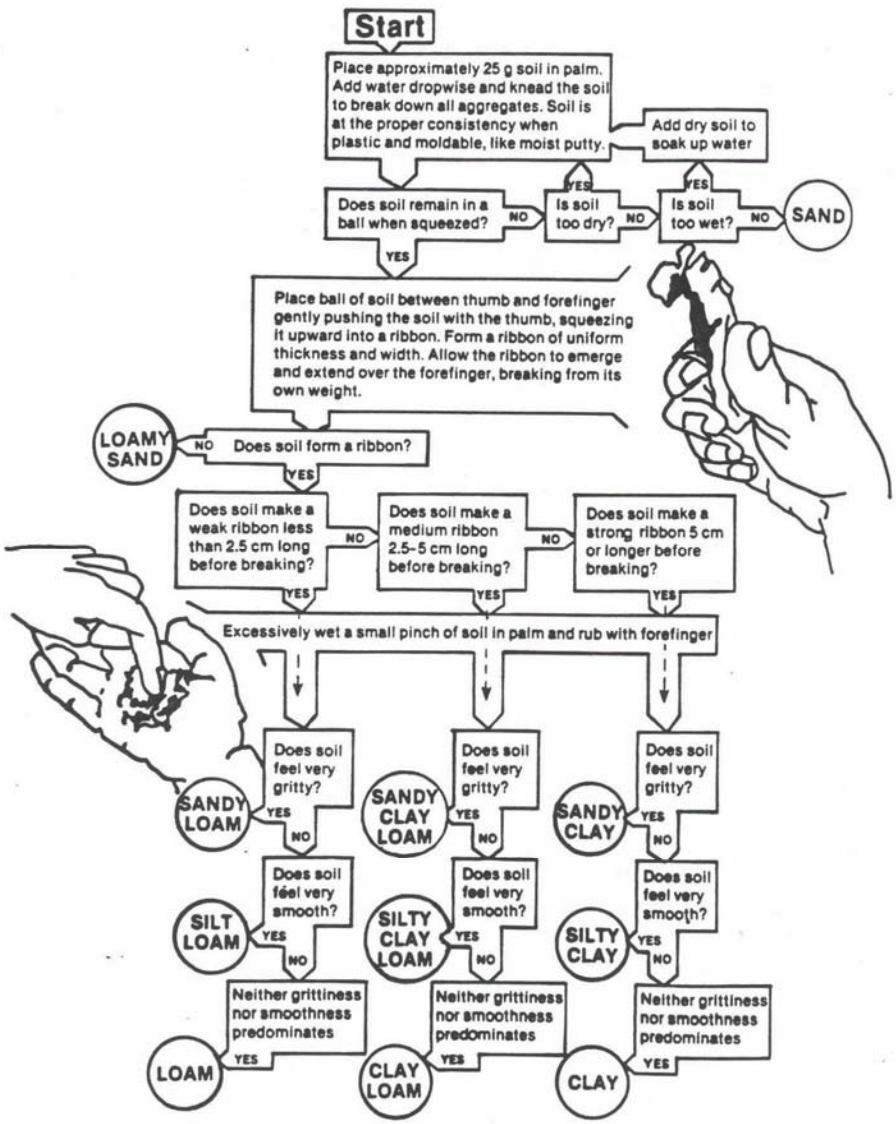
Types of Soil Structure

	**Granular** – roughly spherical, like grape nuts. Usually 1-10 mm in diameter. Most common in A horizons, where plant roots, microorganisms, and sticky products of organic matter decomposition bind soil grains into granular aggregates.
	**Platy** – flat peds that lie horizontally in the soil. Platy structure can be found in A, B and C horizons. It commonly occurs in an A horizon as the result of compaction.
	**Blocky** – roughly cube-shaped, with more or less flat surfaces. If edges and corners remain sharp, we call it *angular blocky*. If they are rounded, we call it *subangular blocky*. Sizes commonly range from 5-50 mm across. Blocky structures are typical of B horizons, especially those with a high clay content. They form by repeated expansion and contraction of clay minerals.
	**Prismatic** – larger, vertically elongated blocks, often with five sides. Sizes are commonly 10-100mm across. Prismatic structures commonly occur in fragipans.

Structureless Soil Types

	**Massive** – compact, coherent soil not separated into peds of any kind. Massive structures in clayey soils usually have very small pores, slow permeability, and poor aeration.
	**Single grain** – in some very sandy soils, every grain acts independently, and there is no binding agent to hold the grains together into peds. Permeability is rapid, but fertility and water holding capacity are low.

ACTIVITY 10 - Figure 5. Flow diagram for estimating soil texture by feel



***C** horizons* are layers which are not bedrock and are little affected by soil forming processes and lack properties of O, A, E or B horizons.
Definition: parent material
Process: no evidence of soil forming processes (can have weathering)
ID: unconsolidated material below B; no structure

***R** horizons* are layers of hard bedrock.
Definition: bedrock
Process: no soil forming processes, little evidence of weathering
ID: hard, consolidated bedrock
Comment: Not found in all soils

Soil Color
Important coloring agents in soil include:
1) *Organic matter* darkens the soil, depending on the content, and the extent of decomposition;
2) *Iron* gives soil a brown, yellow, red, color, even shades of blue or green depending upon its amount, oxidation state, and hydration state. When soil is saturated, iron can become soluble and can be removed, leaving the soil with “mottled” brown and gray colors, or complete gray depending on the extent of the wetness.

Other factors affecting soil color include:
- Parent material
- Soil wetness
- Extent of leaching

Why is soil color important?
- Indicative of source, or parent material
- Color differences in a profile can reflect soil forming processes
- Can be an indicator of soil wetness

Describing soil color
Soil Scientists use a color chart, where color for each horizon is matched to a color chip, but a simple description will work as well.
Some horizons may have more than one color present, in streaks, spots, or mottles, which may be indicative of wet conditions. These are called “**redoximorphic features**.” For these horizons, describe the main color, as well as the color of any streaks or spots. Also describe the abundance, size, and contrast of the streaks or spots as follows:

Abundance	Size	Contrast
Few: <2% of total area	*Fine*: <5mm	*Faint*: Indistinct
Common: 2 to 20%	*Medium*: 5 to 15mm	*Distinct*: Easily seen
Many: >20%	*Coarse*: >15mm	*Prominent*: Striking

Soil Texture

Soil texture refers to the relative amounts of the three particle size separates in mineral soil material. Derived from weathered rocks, these are:

- *sand* - 2 to 0.05 millimeters - gritty feel - can be seen with eye
- *silt* - 0.05 to .002 millimeters - smooth feel- can be seen with microscope
- *clay* - less than .002 millimeters -sticky feel- can be seen with electron microscope

∗ sand and silt (mostly quartz) are relatively inert; they form the 'soil skeleton'

∗ clay particles (layer silicates & oxides) are the active portion of the mineral soil – they have an electrical charge and a high surface area resulting in a high attraction for water, nutrients, other clay particles

∗ varying proportions of each size give the soil a 'texture'

Soil scientists use 12 textural classes (see triangle), which can be estimated with the fingers (see flowchart).

Why is soil texture important?
It affects:

- water movement and storage
- aeration
- nutrient and contaminant adsorptive capacity
- excavation difficulty or ease of tillage

Materials greater than 2mm are considered coarse fragments. Common coarse fragments in the NYC area include:

♦ gneiss, schist, granite (from Manhattan & Bronx)

♦ red sandstone and shale, with associated igneous rocks such as diabase (coarse-grained) and basalt (fine-grained) (from Staten Island & NJ)

♦ serpentinite (green meta-igneous rock from Staten Island)

♦ quartz or chert (coastal plain deposits in Staten Island, Brooklyn, Queens)

♦ human-made "artifacts" are also common in urban areas: glass, brick, wood, concrete, asphalt, etc.

Coarse fragments can also be subdivided by size.

▪ *gravel* - 2 to 75mm (2mm to 3 inches)

▪ *cobbles* – 75 to 250mm (3 to 10 inches)

▪ *stones* – 250 to 600mm (10 to 24 inches)

▪ *boulders* - >600mm (>24 inches)

In describing soil texture, estimate the percent by volume of coarse fragments in the soil. Describe the amount, size, and type of coarse fragments, especially whether they are natural or artifacts. In addition to influencing the physical properties of a soil, coarse fragments can provide information on parent material or origin of soil material.

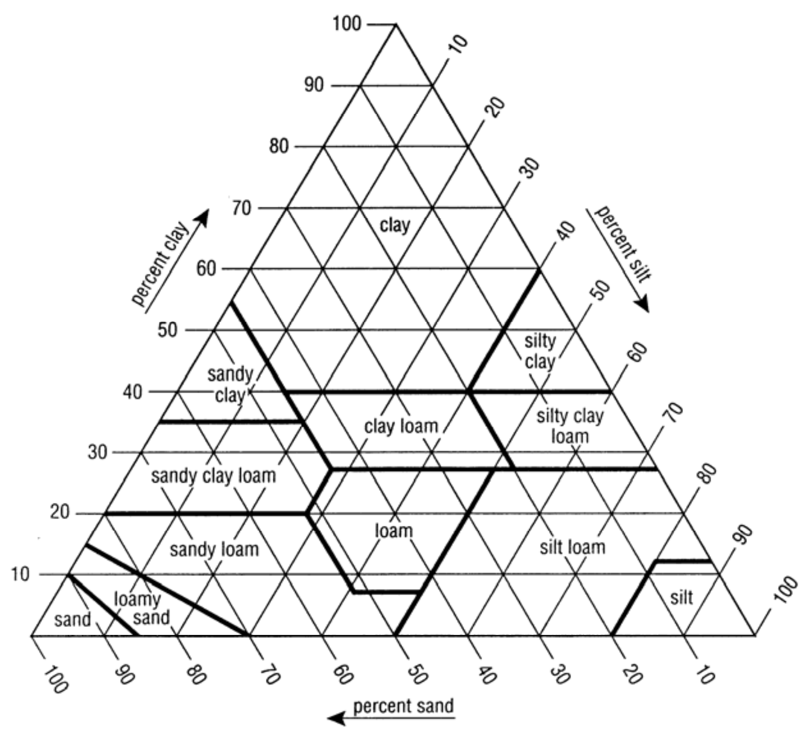


Chart Showing the percentages of clay (below 0.002mm), silt (0.002 to 0.05 mm.), and sand (0.05 to 2.0 mm. In the basic textural classes)