ABOUT YOUR HOUSE

GET TO KNOW YOUR SOIL

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Healthy soil is essential to the health and vigour of your garden. This *About Your House* introduces the basic soil properties that influence plant growth; outlines simple field tests to identify your soil condition and provides tips if you need to amend your soil.[1]

Soil has eight basic properties. Knowing your soil type (that is, its texture) and its other properties is important for three reasons:

- It will enable you to pick the most suitable plants for your soil—which is usually more ecologically sound and less costly than trying to redesign your soil for unsuitable plants
- It helps you determine whether your soil needs amendments
- It can help you make informed decisions about other landscape projects, such as water features and rain gardens

Note that, depending on your yard's size, topography and past uses, soil properties may vary in different locations in your yard.

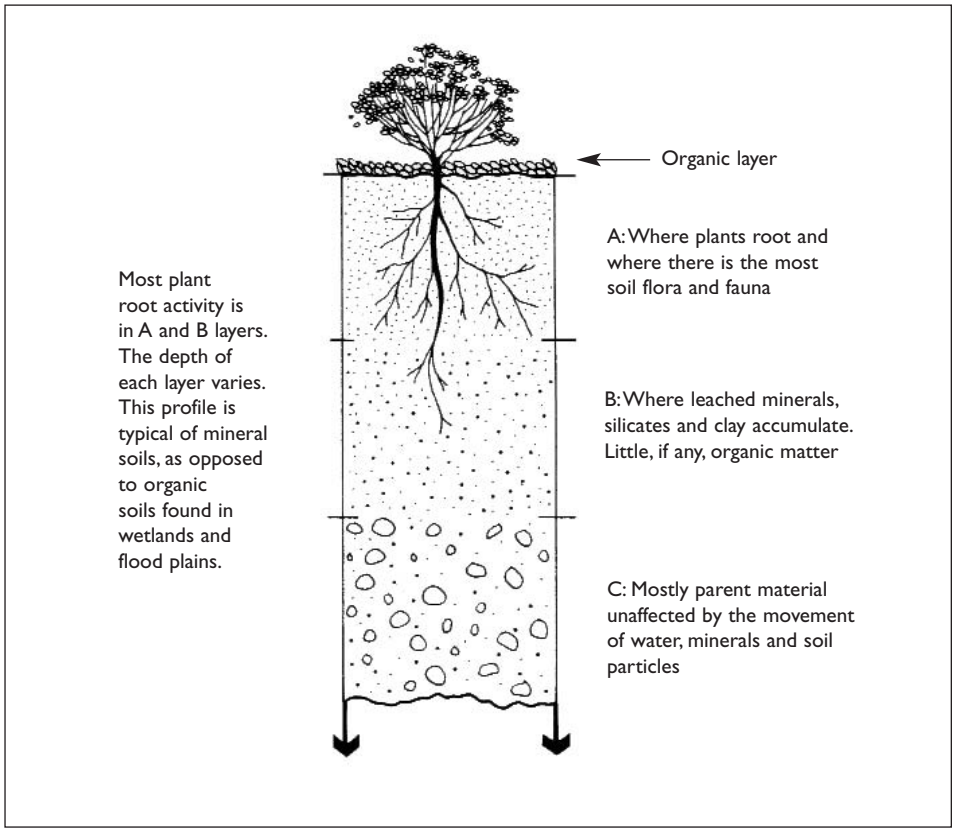

Figure 1: Soil layers

Soil Properties and Field Tests

1) Soil horizons and depth

A relatively undisturbed soil viewed in profile typically reveals, from the surface down, an organic layer, a topsoil layer (the "A" horizon) and two layers or horizons below (Figure 1). Soil profiles vary considerably from one locale or region to the next, depending on geology, hydrology and climate. On sites with a history of construction or agricultural use, mixing, tilling, filling or excavating may have significantly altered some horizons.

If your soils are relatively undisturbed, be careful not to overmix the layers when working the soil. Overmixing can bury organic matter and healthy soil organisms too deeply, which can harm other soil properties.

[1] A soil amendment is any material added to a soil to improve its condition, for example, its fertility, pH or structure, to provide a better environment for your plants.

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Soil depth is the depth of the soil above bedrock. Soils more than 75 cm (30 in.) deep offer better growing conditions than shallower soils and can support a greater variety of plants. Some tree species, such as oaks and hickories, send out long taproots, so they need deep soil. However, many plants are well adapted to shallow soils. If you live in a region with shallow soils, confirm that species are suitable when selecting plants.

Field test:
Soil horizons and depth

1) To examine soil horizons and find out if fill has been placed over the native soil, dig a small trench or pit to a depth of 75–100 cm (30–40 in.). Look for layers in the soil profile.
2) To determine soil depths, check the pit. An option is to use an auger to a depth of up to 100 cm. Rock outcrops generally indicate shallow soils.

2) Organic matter and humus

Humus is produced from the decomposition of raw organic matter, such as leaves, branches and lawn clippings, which accumulates on the soil surface. Decomposition returns vital nutrients to the soil for use by living vegetation. Humus is later carried down to the "A" horizon (topsoil layer) by means that include water, insects and earthworms.

A soil's humus content has a direct bearing on its fertility, structure, porosity, moisture and drainage. In sandy soil, added humus can improve water- and nutrient-holding capacity. In clay soils, it can improve aeration and drainage. Repeated cultivation can deplete your soil's humus content by accelerating decomposition or burying organic matter too deeply to decompose. Humus requirements can vary significantly from one plant species to the next. It is possible to increase humus content by adding organic matter, such as compost, manure or decayed leaves. However, it may make more sense to plant species that are adapted to infertile soils that have lower humus content, if you have those conditions.

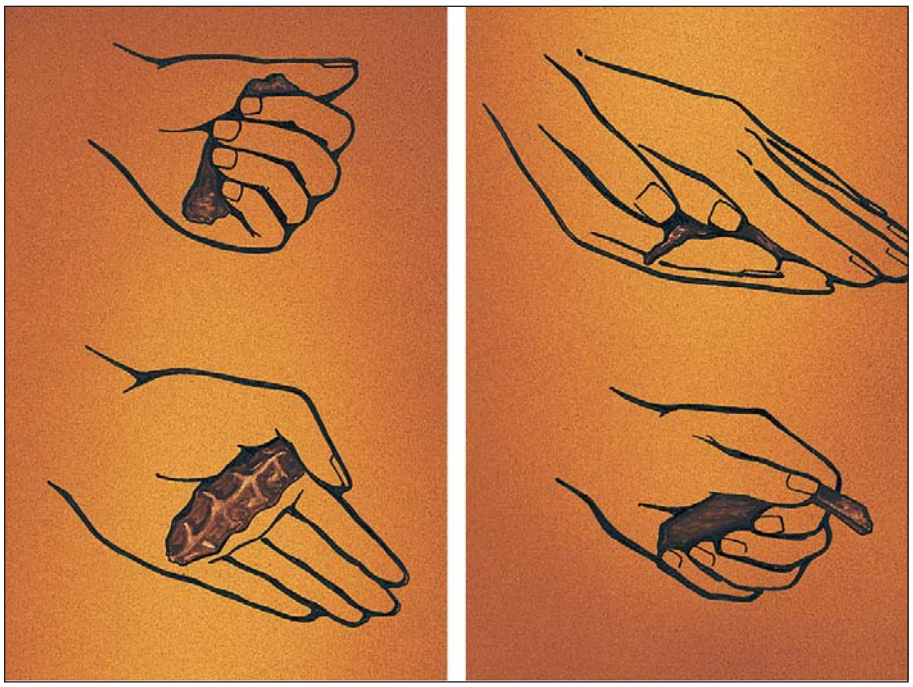
Field test:
Humus and organic matter

Examine the surface and the "A" horizon in the pit you dug for the soil horizon test, or dig a small pit at least 30 cm (1ft) deep. Is there a layer of organic matter and humus at the surface? How deep and how dark is the next layer (the "A" horizon)? The darker the soil, the more humus it contains and the more fertile it is. Hardened, compacted layers of soil generally indicate low humus content and low fertility. Sandy soils are naturally lighter and lower in nutrients than clay or loam.

3) Soil texture

Soil texture is the relative proportion of sand, silt and clay particles that make up a given soil. These particles are graded according to their diameter, with sand particles being the coarsest and clay particles the finest. Soils are typically rated by their texture (Table 1).

A soil's texture directly influences its nutrient content, moisture and drainage capacity. Clay soils tend to be fertile, but are often wet and poorly drained. Sandy soils drain easily but can be drought-prone and infertile. Loams retain moisture and are fertile and friable (crumbly and easy-to-work). Loam soil contains about 40 per cent sand, 40 per cent silt and 20 per cent clay, along with plenty of humus. Many plants tolerate a variety of soil textures, while some have more specific soil requirements.



Source: Regional Municipality of Durham

Figure 2: Testing soil texture: the moist cast test (left) and the ribbon test (right)

Field tests: Soil texture

These three simple tests can help you determine your soil's texture. See also Table 1 and Figure 2. A soil test kit or a testing laboratory can do more accurate testing.

1) Feel test: Thoroughly dry and crush a small amount of the soil by rubbing it with the forefinger in the palm of your other hand. Then rub some of it between your thumb and fingers to measure the percentage of sand. The grainier it feels, the higher the sand content.
2) Moist cast test. * Compress moist soil by squeezing it in your hand. When you open your hand, if the soil holds together (that is, forms a cast), pass it from hand to hand—the more durable the cast, the higher the percentage of clay.
3) Ribbon test. * Roll a handful of moist soil is into a cigarette shape and squeeze it between your thumb and forefinger to form the longest and thinnest ribbon possible. Soil with high silt content will form flakes or peel instead of forming a ribbon. The longer and thinner the ribbon, the higher the percentage of clay.

*For these tests, the soil specimen should be gradually moistened and thoroughly reshaped and kneaded to bring it to its maximum "plasticity" and to remove dry lumps. Do not add too much water, as the sample will lose its cohesion.

Texture	Feel test	Moist cast test	Ribbon test
Sand	Grainy, little floury material	No cast	Can't form a ribbon
Loamy sand	Grainy with slight amount of floury material	Very weak cast, does not allow handling	Can't form a ribbon
Silty sand	Some floury material	Does not allow handling	Can't form a ribbon
Sandy loam	Grainy with a moderate amount of floury material	Weak cast, allows careful handling	Barely forms a ribbon —1.5–2.5 cm (0.6–1 in.)
Loam	Fairly soft and smooth with obvious graininess	Good cast, easily handled	Thick and very short -<2.5 cm (1 in.)
Silt loam	Floury, slight graininess	Weak cast, allows careful handling	Makes flakes rather than a ribbon
Silt	Very floury	Weak cast, allows careful handling	Makes flakes rather than a ribbon
Sandy clay loam	Very substantial graininess	Moderate cast	Short and thick—2.5–5 cm (1–2 in.)
Clay loam	Moderate graininess	Strong cast clearly evident	Fairly thin, breaks easily, barely supports its own weight.
Silty clay loam	Smooth, floury	Strong cast	Fairly thin, breaks easily, barely supports its own weight.
Sandy clay	Substantial graininess	Strong cast	Thin, fairly long, 5–7.5 cm (2–3 in.). Holds its own weight.
Silty clay	Smooth	Very strong cast	Thin and fairly long, 5–7.5 cm (2–3 in.). Holds its own weight.
Clay	Smooth	Very strong cast	Very thin and very long— >7.5 cm (3 in.)

Table adapted from Denholm, K.A. and L.W. Schut, 1993. *Field Manual for Describing Soils in Ontario*. Centre for Soil Resource Evaluation, Guelph, Ont.

Table 1: Field tests for soil texture

4) Soil structure and porosity

Soil structure is the size and arrangement of particles in a soil. This arrangement determines the porosity of the soil, that is, the volume of air between particles.

Healthy soil with good structure may contain up to 25 per cent air. Structure and porosity are functions of several key factors, including soil texture, the burrowing activities of earthworms and insects and the presence of bacteria, fungi and other micro-organisms. Adequate porosity is essential for the gas exchange between the root zone and atmosphere, to contribute to a soil's capability to absorb, drain, and retain water, and to enable roots to easily penetrate the soil to access nutrients.

Compaction eliminates the vital air spaces between soil particles and is the single most significant impact on soil structure and porosity. Although most plants prefer soil that is porous, some species can grow in compacted soils.

Field test: Soil compaction

1) Look for bare patches of soil where there are no plants and areas where water tends to puddle for a long time.
2) Certain plants, such as English daisy, field bindweed, plantains, quack grass and dandelion, may indicate compacted soils.
3) Dig into the soil. Your shovel should penetrate relatively easily in undisturbed soil that has good structure and porosity. Clay soil is denser than sand or loam, but should not be impenetrable. Uncompacted soil should crumble and flake apart easily in your hands.

5) Soil moisture

Soil moisture depends on climate, topography and other soil characteristics, and is typically graded as wet, moist or dry. Some plant species are highly adaptable and can tolerate a range of moisture conditions. Others have very specific moisture requirements. While it is possible to irrigate plants that need more moisture than your soil can provide, it is better to select plants suited to your soil's moisture.

Field test: Moisture levels

1) Examine your property during different seasons to identify where water accumulates or drains rapidly. Depressions, low areas and the base of slopes are generally wetter than slopes or elevated areas. Note areas that are particularly wet or dry, as these will demand appropriate plant selections.
2) Look for existing plant species that might indicate soil moisture levels. For instance, cattail is an indicator of wet soil, while heath aster indicates dry soil.
3) Compare plant vigour in different locations. Thick, lush ground vegetation may indicate moister soils than areas with sparse, thin vegetation.

6) Soil fertility

Soil fertility is the soil's capability of storing and releasing plant nutrients. The main nutrients are nitrogen, phosphorus and potassium (N, P, K), along with a range of trace elements. Fertility depends in part on soil texture. Clay soils are generally more fertile than sandy soils, partly because of the tendency of some nutrients to bond to clay particles. Fertility is also directly proportional to the amount of humus and organic matter in the soil.

Fertility requirements usually vary from one plant species to another. Some, such as certain woodland wildflowers, require deep, rich soils. Others, such as prairie or meadow species, prefer infertile soils and will develop spindly stems and foliage in deep, humus-rich soils at the expense of flowers and fruit.

Field test: Soil fertility

1) Test your soil to determine how much humus and clay is in it, using the tests described earlier. The more humus and clay there is, the more fertile the soil.
2) Look for areas in which even well suited plants do not thrive.
3) Chemical tests are the most accurate tests for specific nutrients in the soil. See the box "Chemical tests" for more information.

7) Soil pH

pH is the measure of a soil's acidity or alkalinity. Most plants do well in soil with a neutral pH of 6.6 to 7.4, or in slightly acid soil with a pH of 6.0 to 6.5. Some plants have very specific needs for soil that is acidic (for example, azaleas, rhododendrons) or alkaline (for example, chrysanthemums, columbine).

Always check soil pH before selecting plants. Although many gardening books give plant pH requirements, you may need some additional research for specific species. While it is possible to change a soil's pH, it generally makes more sense to select plants that are adapted to your soil's pH. The exception is soil that is so alkaline or acidic it cannot support any plants. Concrete surfaces, salt spray, intensive irrigation and other factors can increase soil pH and create conditions that are hostile to many plants.

Field test:
Soil pH

1) The best way to determine your soil's pH is to perform a chemical test. See the box on "Chemical tests."
2) Inspect your property for existing, healthy plants that require extremely acidic or alkaline soils.

8) Life in the soil

A great many life forms—from microscopic fungi, bacteria, algae, protozoa and nematodes, to larger creatures such as springtails, ants, earthworms and moles—live in healthy soils. They contribute directly to the health and vigour of plants. Bacteria, for instance, decompose organic matter and release the nutrients essential for plant growth. Earthworms, ants and other insects, through burrowing, aerate the soil and carry humus from the surface to lower layers. Mycorrhizal fungi form symbiotic (mutually beneficial) relationships with the roots of certain plants, helping them get water and nutrients.

Improper use of pesticides can seriously affect your soil's microbial community, as can repeated cultivation. A soil depleted of its microscopic flora and fauna loses its ability to decompose organic matter and becomes less fertile. It will have poorer structure and porosity, and be less hospitable to plants than a soil rich with life. A diversity of beneficial organisms can also help control organisms that can harm certain plants.

Field test:
Soil life

Look for insects and worms in your soil. Look also for the white, thread-like strands of fungal mycelia, which indicate the presence of beneficial fungi. Soil organisms usually indicate healthy soil. Their absence *may* indicate a soil health problem. If there are no visible soil organisms, look for other signs of poor soil health, such as pH, fertility, moisture and compaction, before assuming you need amendments. Note that some soils, such as sandy soils along shorelines, may contain few visible organisms but many micro-organisms.

Chemical tests

While the field tests described in this *About Your House* can help you gather basic information about your soil, a chemical analysis may be necessary for more accurate information about texture, fertility, and pH, among other properties. Contact a local garden centre, soil testing laboratory or provincial agriculture ministry or department for more information about testing your soil. Home testing kits are also available. For reliability, use a higher cost kit. Laboratory results are generally the most accurate.

Amending your soil

When field tests are completed, you will have a basic understanding of your soil's properties. The next step is to select plants that are suited to your soil and site conditions, such as shade and anticipated rainfall. Local nurseries, conservation agencies, plant catalogues, books and Web sites can help you create a suitable plant list. Refer also to the plant list in CMHC's *Landscape Guide for Canadian Homes*.

Although selecting plants suited to your soil minimizes the need for amendments, there are situations where amendments may be unavoidable. These situations include areas in which soil health has been seriously compromised; food gardens or other specialized plantings that may not be as easily tailored to your soils; and, areas in which even well-suited plants are not thriving. Amendments can also be helpful when establishing new plantings.

Table 2 sets out some common soil problems and non-synthetic solutions. As a renewable and readily available resource, compost is a particularly desirable amendment. The preferred approach is to plant suitable species, but you can work in amendments, or use a combination of the two approaches, depending on site conditions and your goals.

Amend your soil selectively, only where needed, rather than amending soil over the whole yard whether it needs help or not. Work the amendment material into the soil, rather than leaving it on the surface (Figure 3). This helps spread it around, prevents drying, particularly of organic matter and avoids harmful concentrations. It also supports vigorous plants by encouraging roots to spread rather than concentrate only in the amended area.

Soil issue	Problems	Solutions
High clay content	• Compacted, heavy and difficult to handle • Insufficient drainage • Crust formation in dry weather • Difficult for plants to root, establish and grow	• Aerate • Select plants suited to clay soil, and/or • Work in organic matter, such as well-rotted manure, compost, grass clippings and/or leaves • Plant or green manure* • Work in coarse sand
High sand content	• Soil generally low in organic material and less fertile • Good drainage, poor water-retention capability	• Select plants suited to sandy soil (note that plants adapted to sandy soil are also adapted to low nutrient levels), and/or • Work in organic matter
Poor structure	• Difficult to work the soil • Poor drainage • Inability to hold nutrients • Lack of fertility and aeration • Plants experience growth difficulty	• Aerate • Select plants suited to poor soil, and/or • Work the soil to loosen • Work in organic matter • Plant or green manure*
Poor moisture	• Plants experience growth difficulty and wither	• Select plants suited to dry soil, and/or • Work in organic matter
Low fertility	• Low levels of organic material and soil organisms • Poor drainage and structure, hard to work, inability to hold nutrients • Plants experience growth difficulty	• Select plants suited to low fertility, and/or • Work in organic matter • Plant or green manure*
Low nitrogen	• Plant growth problems • Pale green or yellow foliage	• Work in organic matter • Work in blood meal, corn gluten meal or fish emulsion • Plant green manure* or include nitrogen fixers in your plant mix
Low potassium	• Plant growth problems • Poor stem strength • Scorched leaf edges • Less disease resistance and winter hardiness	• Work in ground rock potash (granite dust), wood ash, compost, dried poultry manure, leaves or hay
Low phosphorus	• Plant growth problems • Late maturity • Purple colour on the leaves	• Work in bone meal or rock phosphate
Too alkaline	• Soil nutrients less available • Plants experience growth difficulty	• Select plants suited to alkaline soil, and/or • Work in powdered sulphur or sustainable harvested peat moss • Work in composted coniferous needles, wood chips, and/or sawdust
Too acidic	• Soil nutrients less available • Plants experience growth difficulty	• Select plants suited to acid soil, and/or • Periodically apply lime, wood ash and/or bone meal to raise pH • Make adjustments gradually based on annual testing results

* Green manure typically consists of hardy plants that improve site conditions for subsequent plants.Green manure generally refers to herbaceous plants that are grown on the site temporarily, cut and worked into the top 15 cm (6 in.) of soil before they flower and go to seed. Among other benefits, many species suitable for green manure, such as white clover, fix nitrogen in the soil.

Table 2: Some soil problems and solutions

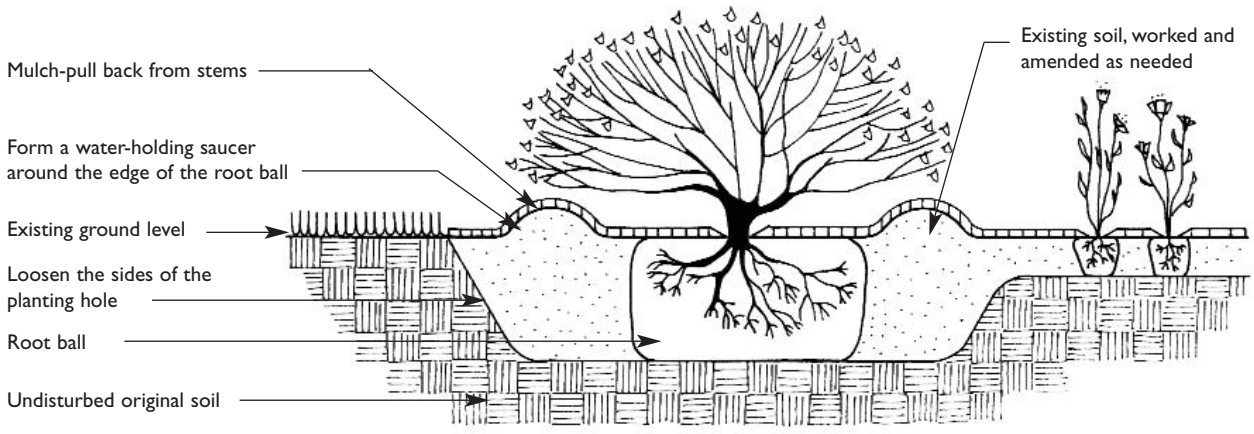


Figure 3: Shrub planting

Some plants suited to clay soil

The following are some plants that are suited to moist, clay soils (common name/Latin name). Most are suitable from southern and central Ontario into eastern Canada and some can be grown in other parts of Canada. Check with your provincial ministry or department of agriculture for plants that are suited to your region, your soil and other site conditions.

Perennials (for full sun or partial shade)	**Shrubs**
Big Bluestem (*Andropogon gerardii*)	Red Osier Dogwood (*Cornus stolinifera*)
Canada Anemone (*Anemone canadensis*)	Shrubby Cinquefoil (*Potentilla fruticosa*)
New England Aster (*Aster novae-angliae*)	Smooth Wild Rose (*Rosa blanda*)
Hairy Aster (*Aster pilosus v. pilosus*)	Common Elder (*Sambucus canadensis*)
Flat-topped Aster (*Aster umbellatus*)	Snowberry (*Symphoricarpos albus*)
Showy Tick-trefoil (*Desmodium canadense*)	Nannyberry (*Viburnum lentago*)
Canada Wild Rye (*Elymus canadensis*)	**Trees**
Fireweed (*Epilobium angustifolium*)	
Bottle Gentian (*Gentiana andrewsii*)	Red Maple (*Acer rubrum*)
Great St. John's Wort (*Hypericum ascyron*)	Silver Maple (*Acer saccharinum*)
Canada Lily (*Lilium canadense*)	Shagbark Hickory (*Carya ovata*)
Bee Balm (*Monarda didyma*)	White Ash* (*Fraxinus americana*)
Wild Bergamot (*Monarda fistulosa*)	Red Ash or Green Ash* (*Fraxinus pennsylvanica*)
Evening Primrose (*Oenothera biennis*)	Tamarack (*Larix laricina*)
Cinnamon Fern (*Osmunda cinnamomea*)	Ironwood (*Ostrya virginiana*)
Smooth Beardtongue (*Penstemon digitalis*)	White Spruce (*Picea glauca*)
Black-eyed Susan (*Rudbeckia hirta*)	Austrian Pine (*Pinus nigra*)
Indian Grass (*Sorghastrum nutans*)	Trembling Aspen (*Populus tremuloides*)
Culver's Root (*Veronicastrum virginicum*)	Choke Cherry (*Prunus virginiana*)
Golden Alexander (*Zizia aurea*)	Bur Oak (*Quercus macrocarpa*)
	Showy Mountain Ash (*Sorbus decora*)
	Basswood (*Tilia americana*)
	Eastern White Cedar (*Thuja occidentalis*)

*Ask your nursery for assurance that purchased Ash trees are not carriers of Emerald ash borer.

Occasionally, the area where you want to plant may consist of such poor quality material that you will have to replace some, or all, of it. An example is the gravel or crushed rock base of an area where you are replacing pavement with plantings. (In this situation, you could also choose plants that grow in gravel.) Another example is a site filled with construction debris. In these cases, you can remove and properly dispose of the material and import suitable soil and/or organic material, such as compost. Note that imported soils may contain weed seeds, so there may be extra weeding for the first few years.

The long-term goal is to reduce and even eliminate the continual need for materials to amend your soil. Your yard and gardens can become healthy, relatively self-sustaining ecosystems in which soils, plants and other living organisms support each other. Understanding your soils is one step towards achieving this goal.

References and resources

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