City of Worcester Miyawaki Forest

Miyawaki Forest Short-Term & Long-Term Management Plans

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Monitoring and Maintenance During Establishment (3-5 Years)

The maintenance of the "new forest" is simple and requires only basic instruction. The forest is most vulnerable in its first three years when drought, freeze, invasive species, or browsing animals can severely impair its growth because soil is exposed and not fully occupied. A young forest has not developed deep layers of foliage to shade out competition and cool soil. The Soil has not had time to develop deep layers of roots to dominate nutrients, and host fungi and creature relationships, a population of soil building macroinvertebrates and protective predators. New plants have not had time to develop thick corky bark and complex bitter chemical defenses against browsers. Natural succession forests manage these issues by repeated cycles of seeding over many decades to replace any loss of vegetation. For these reasons, a cultivated urban forest needs early life care, not because it is weak, but because we are forcing rapid succession to gain the benefits of an "old forest" sooner.

Watering

Check and test the automatic water supply at least once a month. Check and rinse irrigation filters. Look at fittings and joints for any needed repairs - this is where blowouts occur often because someone steps on the line. Flag your lines so this can be avoided. Refresh any mulch needed to cover irrigation lines - drip irrigation stays cooler and is less degraded by light when kept lightly mulched.

Repairs: Drip irrigation is easy to repair. Punctures can be secured with vinyl tape while the lines are dry. Flag problem areas for repair when the system is done running. A minor drip after this is not a problem. (See irrigation maintenance guide.)

Borders

During the growing season watch for signs of browsers, deer, and rabbits while plants are green these will not be a significant problem, but depending on your vegetation browser population you may want to add protective wrap or perimeter fence while your trees are small and vulnerable to herbivores. This is particularly important in winter when rabbits, groundhogs, chipmunks, and deer are looking to eat bark and buds. The bark and buds store sugar in their cells to prevent the formation of ice crystals in living plant tissue.

Even if saplings are chewed to the ground, it may not kill them, but it will severely slow them down and can reduce biodiversity. By planting the forest, you have introduced rare gourmet treats to a landscape dominated by common, toxic, or invasive species. Once a majority of your plants have reached maturity, they will have protective chemicals or thick corky bark to protect them and will be setting seedlings of their own which will become the permanent food source we want to provide. Check fence and/or individual tree wrap as these must be adjusted on growing trees so as not to

strangle.

Weeding

Apply the "chop and drop" method of weeding – pull or cut the plant and drop it on the ground. Weed only those species that were not in the original planting plan and are tall enough or robust enough to compete with your woody plants. Do not dispose of the weed, pull/cut it and lay it down to become mulch. When pulling a weed, place roots up where they will dry and die. For all weeds to be pulled or cut, dispose of seeds in a covered pit or designated seed compost, and retain as much biomass in place as possible by letting the weed stems and roots rot in place. Vegetative weed cover is valuable and helps regulate microclimate and soil stability. These will die out as the forest matures and produces shade.

Watch for noxious invasive species. See the visual guide to invasive species, and MIPAG[1] resources. Examine what species are present and compare them to the MIPAG invasive species list.[2]

Replenishing and Replanting

Natural forests receive a regular input of new seed each year. Until the forest begins to produce seed on its own, you may need to replace failed seedlings. You will also need to replenish the duff layer annually as it biodegrades (mulching with clean native leaf litter). Duff can come from fall yard waste bags from known local clean sources, and sample duff from nearby forests. (See foraging guide.)

Access paths may need to be re-dressed in wood chips to prevent soil compaction.

Winterizing

Drain irrigation main lines in the fall. However, delay turning off irrigation as long as possible as desiccation can occur in November and weather volatility and season shift make this increasingly likely. To drain the lines, open valves at the lowest point in the line, and lift one end if elevation is needed for the water to run out of the line. You can also collect and store driplines indoors or underground over winter to protect them.

Pruning

Pruning should mostly be avoided. The exception is when damage occurs that might cause bark to peel down the trunk of a new tree. The other reason is safe access.

Monitoring

This new forest is a nature-based solution, an engineered living space designed for a function based on current research and understanding of what matters and what works in the establishment of an urban forest. The goal of monitoring a new forest is comparable to a doctor observing and

[1] MIPAG: Massachusetts Invasive Plant Advisory Group - https://massnrc.org/mipag/
[2] https://www.mass.gov/service-details/invasive-plants

supporting a living being to better respond to its needs. An observation report ensures later monitors can understand their observations in the context of time by comparing cycles from earlier notes.

Record the following observations to measure plant health:

- Species, including quantity, size, and annual change.
- Soil moisture: (Probe or by hand) Does irrigation need to be adjusted?
- Soil pH: (Probe) Are there areas with unusual acidity? (Our goal is between 5.5 and 6.5.)
- Plant inter-nodal growth (tape measure): Shortening of length between buds indicates a slowing of growth. If that is the case, are there health problems or competition problems?
- Signs of stress or disease (yellowing, flower abortion, foliage loss).
- Dead plantings in need of replacement.
- Documenting trash at the new forest site may give us an indication of the level of effort needed to clean up trash at future sites, or scope and schedule the frequency and size of cleanup events.
- Are there any new seedlings? Use I-Naturalist app to ID them, this will tell you what its qualities are and automatically record the data and share it with other observers and researchers. If the plant is listed as an invasive per the MIPAG list - weed it.
- Observe the presence and type of insects, birds, and mammals. The presence of insect eggs, larva, and chewed foliage are signs of success, except for identifiable invasive pest insects and/or their eggs, which you will report and destroy. Examples include spongey-moth and the spotted lanternfly.
- Monitor drought conditions for your location. If drought or an extended dry period develop, evaluate the need for additional watering.

2. Long-Term Understanding and Management of a Miyawaki Forest

At its initial planting, a Miyawaki forest is an island of diverse species in an otherwise disturbed and depleted urban landscape. Planted in a small area, it contains many types of native plants. A Miyawaki forest grows faster and denser than a normal forest, and it provides a home for many animals and insects. It is important because it adds diversity and beauty to an urban area damaged by human activities. However, as it grows, it cannot remain an island, and it cannot survive by itself. It needs to be cared for and protected. To thrive, it must be nurtured, and its influence must become a part of the community culture – enabling people to learn from it and appreciate its environmental and societal value. Long-term management of the new forest will fall largely to community leaders, champions, and influencers.

Once planted what do you imagine/know will be the steps in your forests' evolution? Are there obstacles you can prevent or prepare for during the forest establishment period? Think of forest life cycles in centuries and millennia, not human years and decades. Try to see the cycles of growth and change over these vast spans of time. We provide some frameworks to predict and manage this change. Long term forest management should look to the following models for guidance.

Fuseki Process Management

'Fuseki' Management Approach: Using this process-focused approach, success comes from a combination of choices based on a reasonably predicted probability for growth. Four principles are applied to a Fuseki Process Management approach: diversity, redundancy, modularity, and consistency. In this system, the possible failure of "Planting group A" increases the probability of success of "Planting group B" (and vice versa). A Fuseki Miyawaki forest does not incorporate two independent Planting A's, because factors causing one Planting A to fail would likewise cause the other Planting A to fail. A Fuseki management example would be a site with two compatibles but contrasting groups of plant species. As the climate and landscape around them change, one will expand for the very reason the other declines, but both are desirable outcomes. Ultimately, this approach can achieve a flexible and balanced vegetation structure that can adapt to various environmental and human conditions.

Joseki Boundary Management

'Joseki' Management Approach: Using this approach, one that focuses on a landscape perspective and intentionally considered boundaries in selecting a site, a designer thinks of it at landscape scale: No landscape exists in a vacuum. Each site affects its surroundings and is affected by them. How will those adjacent lands affect your forest? Is the potential site too isolated to positively influence others? Are there current or future threats to manage? Can they be made into opportunities, per the Fuseki process planning? The Joseki Boundary Management approach identifies a hard boundary to lean on. Typically, hard boundaries are either the built environment or a contrasting land type, such as that found at a wetland vs. upland edge, where species that

could affect one site cannot thrive in the other. Second, if possible, choose a flexible boundary, such as a hedge row, stream bank, or street trees connecting your forest to other forests, to allow influence to be traded between the two landscape types. -- The Joseki boundary management approach is a planting method that creates and maintains optimal boundaries between different land uses.

Intaglio Management Approach

While gardening is largely centered on the installation of plants in a natural landscape, the Intaglio Management approach thoughtfully removes or reduces unwanted plants or elements of the landscape, such as invasive plants, weeds, or debris, to reveal the underlying beauty and diversity of species and create appropriately scaled disturbance for regeneration. This principle is the basis of most indigenous forage and resource production such as food forests or swidden agriculture – a farming method that involves the cutting and burning of plants in a forest or woodland to create a field called a swidden, which can then be re-vegetated. Specifically in the ten- to thirty-year period after planting, it will be essential that early succession trees are thinned. These were essential for creating the biomass and microclimate of the small forest but can reduce long term function or biodiversity if they crowd out other species. Guiding succession for diversity will also mean looking at patterns of climate change, and regional species shifts. Plan for a 5-year cycle of removals and replacements to support biodiversity and overall health.[3]

Manage the Focus for Your Forest

The Worcester Miyawaki forests have three functional pillars. It may be necessary to remove successional plants that were necessary for early establishment to encourage higher value or slower establishing plants. It will also be advantageous to periodically add plants that are valuable to these goals but could not persist in the early exposure or rapid succession phases of growth. ***See ephemeral and groundcover list.***

A Miyawaki forest is a conversation between a site and a community. The features and plant species must be suited to the site per the opportunities and constraints that were reviewed, but it also must suit the human community so its value will be appreciated and cared for. Some examples of the kind of focus your forest can have, and the stories it can tell, are listed below.

Purification Grove: A dense stand of air-scrubbing trees and soil/water cleaning Phyto-remediators between a neighborhood and a pollution source with interpretive features helping the community understand the health and social benefits of urban forests. Many Frederick Law Olmsted, considered the father of the landscape architecture profession in North America, landscapes and parkways were designed with this goal.

Wildlife Refuge: A planting and installation of habitat and resource features housing and feeding

[3] For more on the Intaglio Management Approach method see The Wild Gardener in the Wild Landscape: The Art of Naturalistic Landscaping By Warren G. Kenfield.

pollinators who support plant diversity and agriculture, the birds that support plant migration and pest control, and the soil builders (fungi), and tiny animals that turn vegetation into soil carbon.

Food Forest: A collection of edible or medicinal wild plants and trees with interpretive features helping us understand foraging practice, nutrition, and our stewardship relationship with the wild.

Feature Management

Old Growth Features: These are features that can be added to or amended in your forest as the city transitions from traditional landscape practices to ecological practices and as true old growth forest characteristics begin to occur naturally. On the site, it is helpful to keep snag trees, nurse logs, brushy thickets, soil piles, root wads, stumps, rock piles, compost piles, puddles, and sun stones. These are all valuable habitat features to keep in the landscape. These features can also be stacked, sculpted, or arranged decoratively.

Nest Features: These mimic the function of damaged old growth trees. Add bird boxes, raptor perches, bat boxes, owl boxes, bumblebee nests, ground bee soil boxes, barn swallow shelves, and anti-tick tubes.

Vegetation Management

The 10-20-30 rule (Santamour 1990) is a model for tree population distribution, in which a single species should compose no more than 10% of the tree population, a single genus no more than 20%, and a single family no more than 30%. This proportional orientation helps prevent disease and deforestation by pests. (Note: This does not apply to natural forests which protect themselves by critical mass and resource control.) This rule is for the open landscape where extra sunlight allows for added soft growth and increased bird and pollinator support but can also allow pests or include poorly managed or stressed specimens, a vector of disease. We also recommend including a minimum of 0.5-1% dead standing snag trees for habitat or nest features to compensate for their absence and ecological function. Recent studies find that bird populations drop off as do the varieties of songbird present when native canopy drops below 35% canopy cover or 70% native canopy.

Soil Volume, Connectivity, and Depth

Canopy trees need access to approximately 1,000 cubic feet of soil per foot of trunk diameter - plan and plant accordingly. Twelve (12) inches of friable organic topsoil is a good threshold for most plantings, although turf grass can persist in as little as six (6) inches. Wider soil surface is more valuable than deep soil. As a glacial landscape, New England is prone to thin low nutrient topsoil but not the divisions caused by paving. Connect plantings where possible and provide root paths where soil is isolated. Foot paths can divide soils by compaction, but using stabilized soil material for walking paths which are located over root paths can help prevent this.

Monitor and Manage Invasive and Pest Species

Invasive species of plants and insects can be overwhelming. It is risky to let them establish and

spread and sometimes risky, demoralizing, or wasteful to attempt to suppress or eradicate them once they have become endemic. Following are suggestions for how to employ best practices and where to find support for invasive species management:

Prevention is the best alternative. Avoid, minimize, and mitigate land disturbance. Do not leave soil openings for establishment of invasive species. There is a strong relationship between patterns of land disturbance and increased invasive populations. Undamaged native populations hold territory if we avoid damaging them.

The most effective long-term strategy once an invasive species outbreak occurs is to introduce a host specific predator. As these are developed, tested, and released by professional researchers, they provide a nature-based solution to a specific pest. While waiting for these to become available, it is best to protect the borders of natural populations and ensure rare natives get space to propagate, preserving their population viability until the threat passes. Create control zones at pinch points where you can monitor and control movement along a corridor such as a river or forest pass through town. Crowd out or force invasive species to compete with aggressive natives. Assessing cultural control options such as shade, flood, fire, and timed mowing can be helpful. Remove the invasive species seed and root stock but retain its biomass where possible while reducing effort.

Guides for Landscape Material Selection

It is likely that over the lifespan of an urban forest, it will be called on to include other cultural functions or elements. Select these materials and features in the same spirit the forest was conceived.

Maximizing plant and soil biomass provides many valuable products and functions, including carbon sequestration. The first step to selecting better products is understanding their impacts. The following tools can help assess a landscape project's emissions impact.

- https://climatepositivedesign.com
- Check the sustainability of corporations you buy from at https://www.msci.com/our-solutions.
- To the extent practical, minimize fertilizers, and use them responsibly. Choose organic amendment and natural soil builders. Use these responsibly as well, even natural materials can create nutrient overload in adjacent waters when overused, see https://www.mass.gov/service-details/plant-nutrient-management for more information.
- Relative to soil amendments, avoid loam, which is taken from farmland, and peatmoss, which belongs to valuable ecosystems that store carbon – these are high sequestration and high habitat value landscapes and should be left in place.

Guides for Landscape Construction Material Selection

Landscape construction material selection is a complex and expansive topic. Start by assessing your project individually using criteria developed by the U.S. Green Build Council SITES and LEED

programs. More information can be found through online research. Pick more than one data set and look for non-corporate sponsored sites.

Landscape Building

The following are some notes about the most common categories of landscape materials and how we judge them.

Stone

Locally sourced minimally processed stone is very sustainable and recyclable.

Wood

Until new carbon synthetics and energy sources are available, pressure-treated Southern Yellow Pine remains a responsible selection for landscape. For New England, native, rot resistant Black-Locust, Black Walnut Bamboo, and White Oak are materials that match steel and plastic for service life in most conditions, Black Locust often meets or exceeds the service life of steel fence posts with concrete foundations.

Soil

Soil is often the most valuable, sustainable, and overlooked building material available. Soil is used to make building materials and is used to grow plants used to make building materials. *See Soil Amendment Section for more discussion.*

Herbicide

When properly applied and used for permanent conversion and replanting of infested land, herbicide has relatively low and short-lived health risks for plants and wildlife and minimal environmental effects. In the landscape scale, mechanical removals, plastic smother, and even burning, can be riskier, more damaging, and less effective. The key is to control the treated area and convert it to a stable, native, plant community. Failure to act decisively and failure to modify land after clearing wastes land, time, and resources.

Pesticide

Pesticide should be avoided. The risks to secondary populations and humans are significant and have rarely been a long-term solution in landscape.

Lighting

If lighting is desired, include timers and sensors as effective tools for protecting the habitat and health of the forest, and reduces energy consumption. The height and lens of lighting affects efficiency but may conflict with ecological value and should be selected by site. Mounting high with wide lenses and cool white light increases efficiency. Warm white (under 3600 kelvin color temperature) attracts fewer insects and has less impact on circadian rhythms. Lights lower to the ground do not attract insects from as far and have less effect on migrating birds. Currently, the initial cost of solar site lighting systems is equivalent to (new) line voltage systems where

infrastructure must be added or upgraded for power.

Curious about your local light pollution levels? Visit https://www.lightpollutionmap.info.

Soil Amendment

When amending or expanding forest plantings, soil should be a top consideration. Most of the forest life and biodiversity occurs within the top six inches of soil, not in the airspace above it. Understand the needs of what you are planting and then amend. Here are general recommendations for soil amendments:

- **Compost, duff, and humus:** A key step in restoration is increasing the organic content and biological activity of the soil. Compost amendment can be measured by the relationship between organic by volume versus organic by weight in soil tests. Typical lawn soil loam has 5% soil organic matter (SOM) by weight. It usually takes a 50/50 blend of compost to soil by volume to increase this from 5 to 10% SOM. Most ecological plantings will benefit from being over 5% SOM but assess the function and species of your landscape to make these decisions. As mentioned previously, soil is where forest life occurs most. Be selective about what soil you introduce to the site.

- **Hydrogel:** Hydrogel agriculture technology uses water absorbing crystals to improve the water-holding properties of different soils. Use these, as part of compost tea, for transplants and new plantings. They rapidly absorb water when excess is available and then slowly release it, extending the value of short intense storms and longer droughts that become more volatile with climate change. Hydrogel lasts for 3-5 years in soil and can help new plants become established. It is recommended to saturate the gel before use, due to its capacity to expand.

- **Humates, bacteria, and protozoa:** Micro-organisms that build soil and make nutrients available. These also occupy soil territory that could otherwise be home to pathogens.

- **Fungal inoculation (Mycorrhizae):** The process of introducing fungal spores into soil or plants to improve soil health and plant vigor. The fungi form a symbiotic relationship with the plant's roots, improving access to nutrients and water. They also occupy soil territory sending chemical signals that block parasitic fungi. There are two groups with distinct roles: Endo-mycorrhizae fungi that enter plant roots, most commonly with vegetative plants; and Ecto-mycorrhizae, those that live on roots typically associated with woody plants. Ecto-M.fungi are rarer. A straightforward way to get these is to select and transplant fungal inoculated logs and duff.

- **Mineral supplements:** These include basalt dust, volcanic ash, dolomitic limestone, limestone, greensand, potash, sulfur, and chelated iron. *Note: Limestone has a higher carbon extraction impact than other mineral supplements.*

- **Transplanting duff and woody debris:** The micro-community of a restored site can be enhanced by transplanting in small patches of leaf litter, peat, and woody debris from healthy forest sites.

- **Biochar:** A stable, carbon-rich, charcoal-like substance made by burning organic material from biomass. Biochar is processed and inoculated charcoal which provides homes for microbes,

retains moisture, and mitigates mineral imbalances in soil. Its embedded carbon is effectively a long-term sequestration compared to other organic amendments. (Verify source and content many manufactured biochars have been found to contain pollutants such as PAH)

- **Wood Ash:** Ash from wood fires can be a useful additive to soil, however, be careful when using this as an amendment. While it can provide digestible micronutrients, it can also acidify soil. Research appropriate application rates per your soil test results.

How do I test my soil?

https://ag.umass.edu/services/soil-plant-nutrient-testing-laboratory/ordering-information-forms

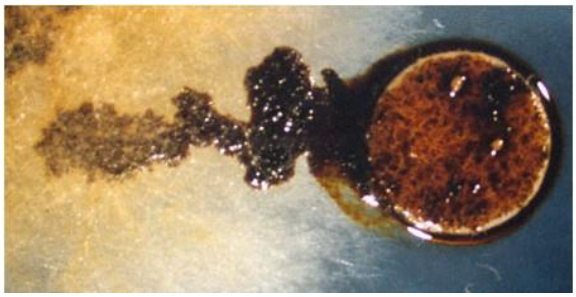
Appendix A: Foraging for Urban Habitat Restoration

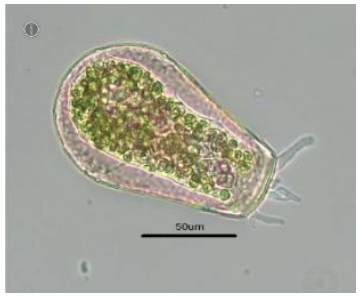
Foraging for Urban Reforestation

Example of post disturbance succession seedlings grasses and duff

The goal of foraging for an urban reforestation project is to collect vital elements to create a forest environment, specifically those that can't be bought, propagated, produced, and are regional to the area.

These include the fungi, protozoa, and macroinvertebrates (tiny soil building animals) that live in the organic leaf litter or Duff of the forest floor. These creatures are vital for building soil structure. They break down stone minerals, fallen leaves, and wood, to form soil. This Duff Layer has more diverse species compared to the airspace above the ground where insects, birds, and other animals live.





Through foraging, we will transplant multiple small samples of these organisms into our newly established urban forest to help it develop and function similarly to a naturally existing forest.

We will collect handful size pockets of duff, leaves, and spongey compost in the first 4" of soil surface. To do this, we will take a double handful from a clean area, bag it, scatter leaves over the spot we disturbed, then collect another sample at a short distance of 5-10 paces. We will also look for fallen trees, as the soil around their stumps has lots of these soil builders.

Stump Soil

Forest Duff

We also want to perform this transplant respectfully and safely. That means taking small, dispersed samples and covering any disturbances we create to prevent depleting an area or exposing the soil to invasive weed seed, erosion, or other stress.

When searching for logs, we will look for ones that have fallen to the ground and show signs of our preferred mushrooms/fungi. We want pieces that are moderately sized, and sturdy enough to be moved. The presence of mushrooms is a sign that the fungi were planning to spread, so by moving these logs we will be expanding their habitat.

We will be selecting saprophytic fungi, which feed on dead wood as opposed to parasites that grow on live wood. Of value are the Trametes family, a group of small woody mushrooms who are better at digesting heavy metals and help clean and stabilize soil in a tough environment like the city. We will provide examples and review of mushroom logs.

Trametes (Turkey tail mushroom)


Aricularia a saprophyte vs Fomitopsis a parasite

We are looking to collect seeds, some species hold their seeds on the stem to keep them out of the soil until spring, others like walnut and hickory nuts often need over winter before they are ready to grow.



We are also looking for clusters of seedlings and small trees up to 1" caliper. Where these have seeded together (within a few inches, not feet apart), only the strongest will survive, while others may serve as food for animals or wither due to competition. While these are still dormant, we can selectively take one or two from each patch without significantly limiting the forest. By replanting these selected seedlings, we add to the species overall diversity and increase the potential of the individual trees reaching maturity.

While dormant these can be gently dug to loosen and pulled out by lifting and shaking the soil off the roots. We will quickly move these into an antiseptic root hormone solution (willowbark and cinnamon tea thickened with hydrogel). It is essential that the roots do not dry during transplant. We will store these in a cool dark place in a straw peat compost. This gives us locally adapted genetic stock to diversify our urban forest for breeding.

Clustered birch seedlings acceptable for harvest

Pine seedlings too close to survive each other. Blueberry, here gets mowed and can't mature.

Learning What to Avoid

While the material we collect is important, education and understanding are even more important. It would be far less engaging to explain what a forest is and how it works while standing over a prepared bed or out in a parking lot.

During our sessions, we will go over sensitive elements of the forest and highlight aspects that we don't want to disturb for their protection. Additionally, we will discuss pests and parasites we don't want to inadvertently transport.

Princess pine rare plant not to be disturbed

Hemlock with adelgid parasite

Appendix B: Habitat Nest Building Guide

HABITAT BUILDING GUIDE

Old Growth Features/Habitat Build Notes

Biomimicry:

"Old growth" forest qualities include many places for birds and insects to make their home, such as pitted soil, leaf and brush litter, rotting logs and standing stumps, and hollow stems. One of the goals in the maintenance of the "new forest" is to mimic healthy old growth forest qualities in the urban environment. Until there is a collection of mature plants, this process is needed to build these "old growth" features in.

Using biomimicry, aspects of a natural old growth forest are transferred into disturbed urban landscapes with new forest to support diverse species while the natural systems "heal" and return to a natural state, providing stability and old growth structures and systems on its own.

1. Nest Building/ Habitat Building:

Here are some online resources to help with nest/habitat building, including for birds, bats, and bees:

A. Nest Build

- **Bird House:** Nests are designed to protect small songbirds against predators and nest-parasitic species, such as the cowbird. More information can be found here: https://www.birds.cornell.edu/k12/educators-guide-to-nest-boxes/
- **Raptor Perch:** Mimicking the tops of large dead trees for easy nesting. For more information: https://efotg.sc.egov.usda.gov/references/public/WY/RaptorPerches.pdf
- **Bat Box:** These structures mimic the crevices naturally available in ancient trees. For more information: https://www.nwf.org/garden-for-wildlife/cover/build-a-bat-house
- **Owl Box/Wood Duck Box:** For more information: https://www.audubon.org/news/how-build-screech-owl-nest-box
- **Bee Box:** Bumblebee nests protected from predators, weather, and wasps. For more information: newsletter@beekeepclub.com
- **Swallow Shelf:** These create a safer home for cliff dwelling swallows. For more information: https://www.rspb.org.uk/birds-and-wildlife/wildlife-guides/bird-a-z/swallow/attracting-swallows-to-nest/

Photo credit: https://www.audubon.org/news/how-build-screech-owl-nest-box

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B. Habitat Build: Ground Level

- **Thicket:** Home for reptiles, rodents, amphibians, and invertebrates. To build, pile straw brush and rocks loosely to create a matrix of homes; add some standing branches to support spider webs.
- **Tick Tube**: Protect small mammals from ticks by providing treated bedding. Treat cotton balls with permethrin and hide them in tubes, in places like brush piles, for rodents to use as bedding. When a tick attaches itself to the rodent the permethrin will ill the tick. Include flags so you can find and refresh next year. For more information: https://svhealthcare.org/news/how-to-make-tick-tubes
- **Snag Holes**: For leafcutter, plasterer, cellophane, and mason bee nests. Drill 3/8”-6” deep holes in dead trees, max 3 per tree or log and spread out, roll brown paper onto a straw, and insert it in the hole for a smooth surface mimicking beetle bore.
- **Nurse Log**: Mushroom inoculant for myco-remediation. Also creates homes for reptiles, rodents, amphibians, and invertebrates. Place these parallel the toe of a slope. That’s where they can do the most protection.
- **Hibernacula Pile**: Piled cobble stones and logs loosely to create voids and cover in soil/ vegetation to mimic the remains of an overturned tree stump.
- **Woodchip Mulch Paths**: These protect soil and avoid informal footpaths.
- **View Clear/Invasive Control:** Make space for native species by removing invasives. Also, creates views for visitors.
- **Vine Cutting**: Helps to prevent bittersweet and other vine invasives from spreading or strangling trees.
- **Collect Thicket & Stake Parts:** Gather brush for habitat thickets and stakes for stabilizations or fences.
- **Cleanup**: Removing harmful litter, such as plastics.

2. Forest Planting for Old Growth Shapes

In urban sites and in freshly turned soils, there is poor soil structure and very little biodiversity. Mimic and speed up succession by planting native pioneer species which will colonize and dominate the landscape and help to minimize invasives while the soil heals.

Projects include:

- **Pit & Mound:** Be sloppy when placing the soil. Old growth surfaces have had time for falling trees to make an uneven natural surface with pits and mounds. This creates microclimates and spaces for plants and creatures to thrive.
- **Expand Hibernacula:** Any cobble stones or branches found while planting can be piled to create habitat cover for small creatures, such as amphibians.

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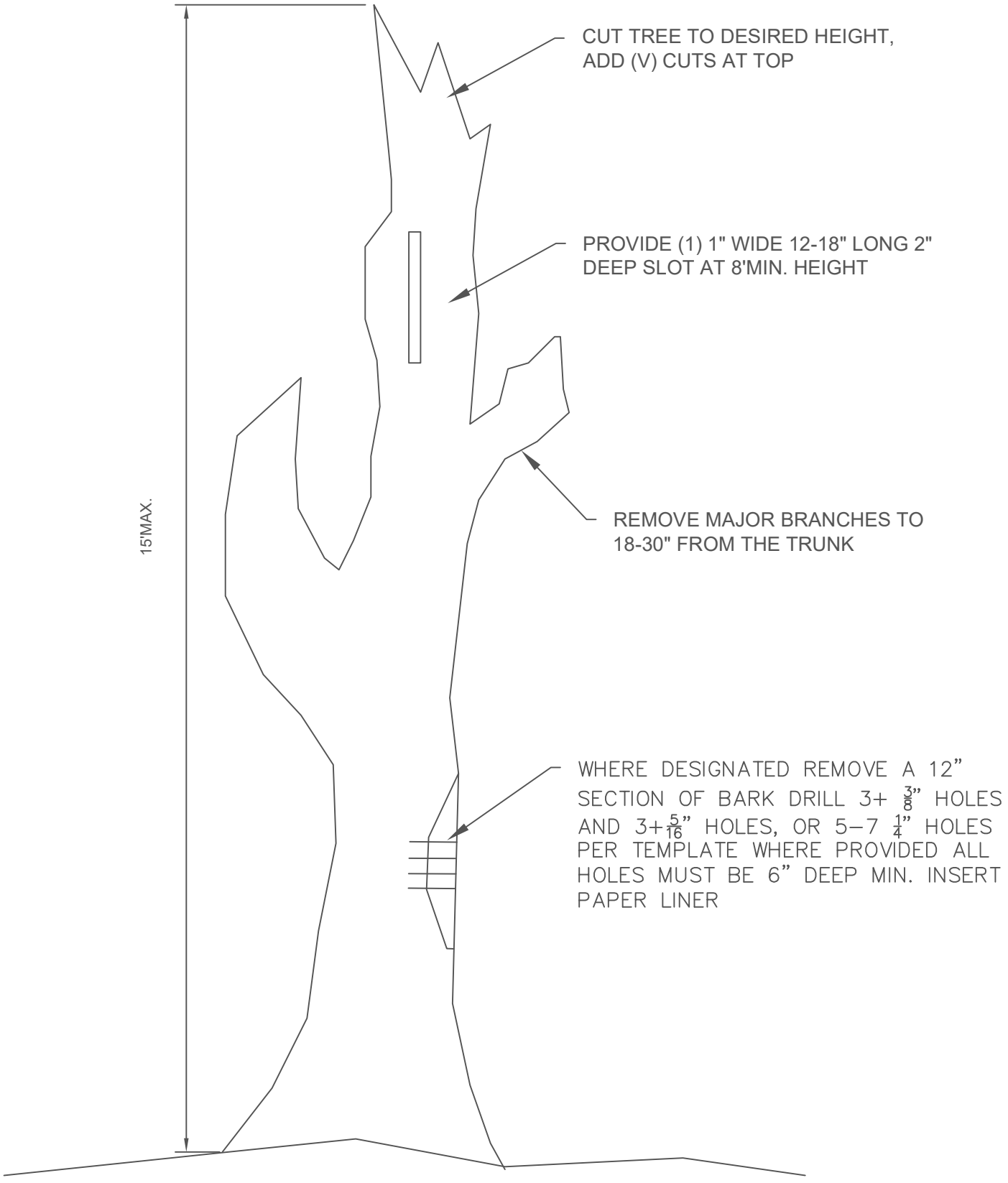
- **Plant Trees:** Plant a diversity of native trees for nectar, foliage, and seed forage. Start with bare root and container seedlings. The roots must be spread over soil, layered in, and pressed tight for good soil contact by the root hairs.
- **Place Hydrogel:** Hydrogel captures moisture from short rains and holds it, slowly releasing it during short droughts. Gel crystals should be pre-mixed with water in trash barrels at a ratio of 5 cups of gel crystals per 30 gallons of water. It should be mixed into soil and not exceed 1 gallon per the gallon size of the plant or one gallon per bare root.
- **Place Compost:** Compost builds beneficial micro-organism colonies, feeds trees, and supports groundcover plantings. Spread 1-2 inches of compost over the ram board and then seed.
- **Plant Groundcover Nurse Seed:** Nurse seeds capture moisture, block invasives, and build soil, giving the forest time to develop in a natural setting. There would be a seed bank—including rapid annual seeds—sleeping in the soil, ready to fill in fast after a flood or fire lets in more light.
- **Wrap & Stake Trees:** A lack of diversity in the forest puts excess pressure on wildlife who in turn must eat anything that is available. To get from where we are now to a future where the forest provides balanced food sources, our trees need to survive to maturity, therefore protecting them while they are young is a necessity.
- **Inoculate and Fertilize:** Degraded urban soils, or those recently cleared of invasives, have some imbalances that can be buffered at the time of planting. Do not introduce synthetic fertilizers that can cause bacterial blooms and affect water quality. Buffer with using nitrogen fixing plants that inoculate the soil with fungi, macro-invertebrates, and protozoa for healthier plants and better carbon sequestration. Apply basalt powder and volcanic ash as these provide the minerals that are hard for new plants to get from damaged soils.
- **Mix Seed, Sand, and Supplements for Spreading:** By pre-mixing seed with sand and supplements, this helps to spread uniformly and get equal coverage. It also helps the seed stick, balances pH, and adds minerals. A sample mix can be 10 scoops of sand, 3 scoops of seed, 1 scoop of wood ash, and 1 scoop of volcanic ash.

Appendix C: Habitat Details

NOTES:
SNAG TREE TO BE SELECTED BY ENVIRONMENTAL SCIENTIST. CONTRACTOR IS RESPONSIBLE FOR INITIAL TRIMMING AND GIRDLING OF SNAG AS SHOWN HERE IN.

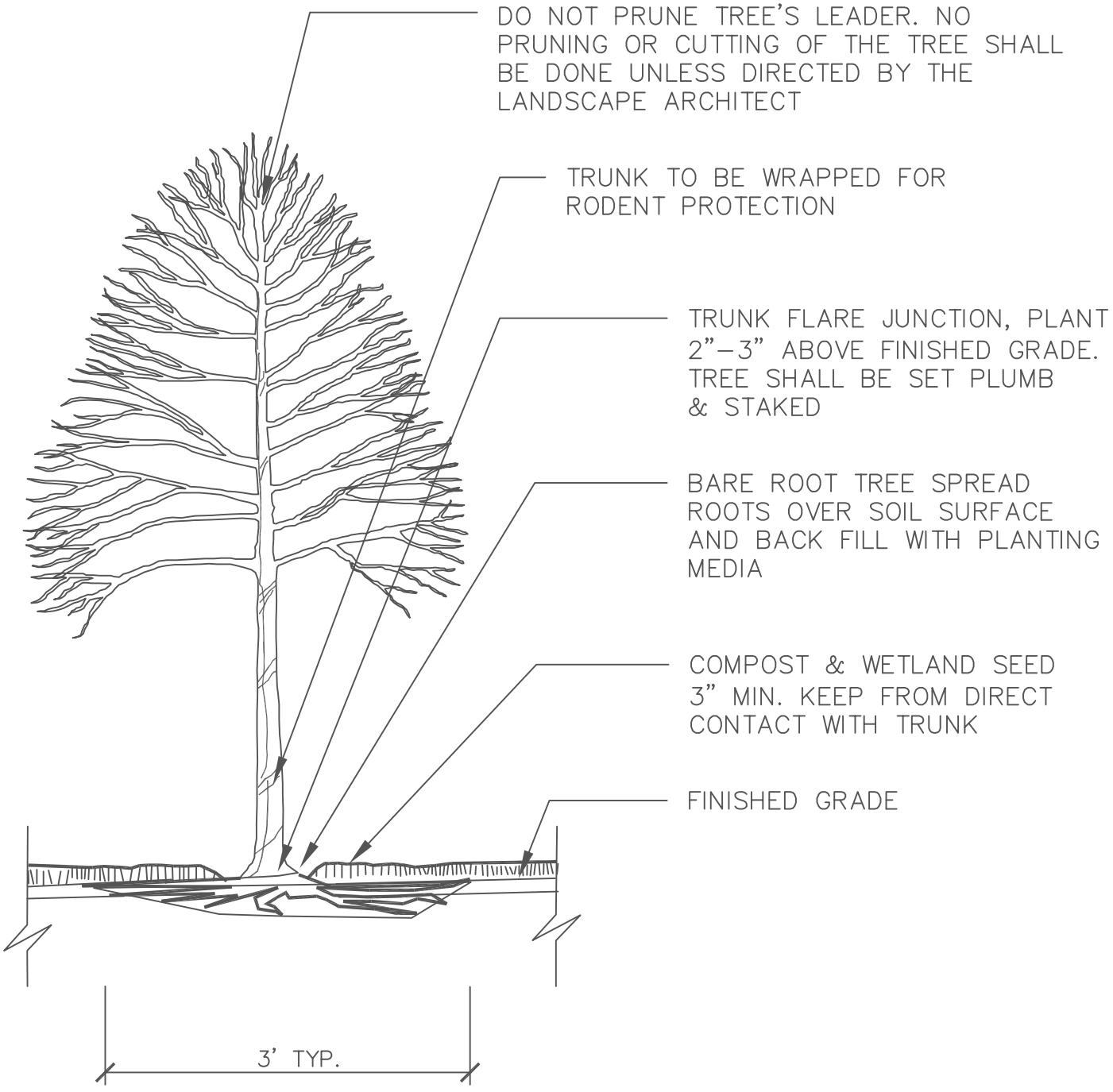


HABITAT SNAG TREE

SCALE: NONE

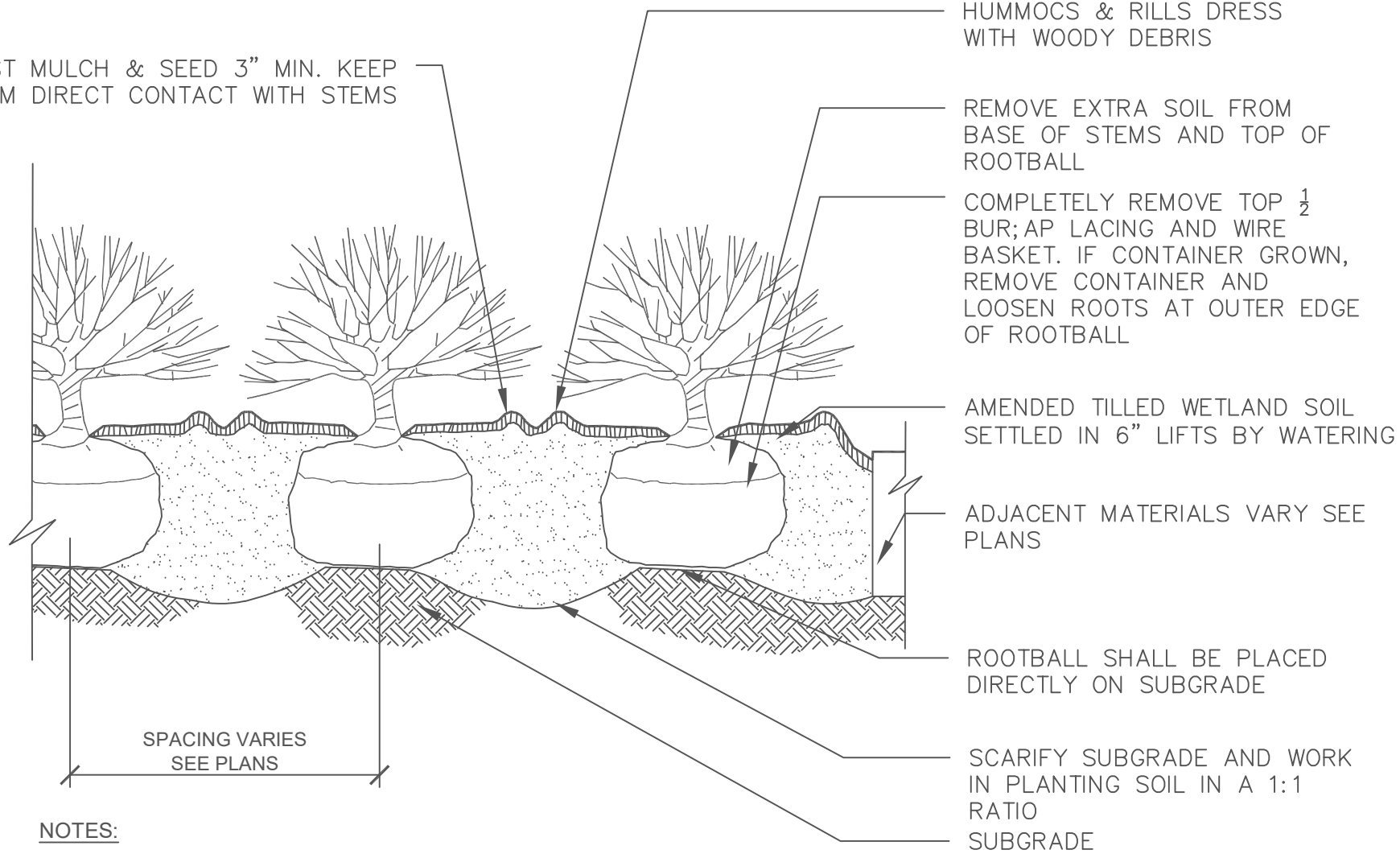
NOTES:

1. SEE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
2. CONTRACTOR RESPONSIBLE FOR MAINTAINING TREES IN A PLUMB CONDITION. UTILIZE BELOW GRADE STAKING METHODS WHEN STAKING TREES.



BAREROOT WETLAND PLANTING

SCALE: NONE



NOTES:

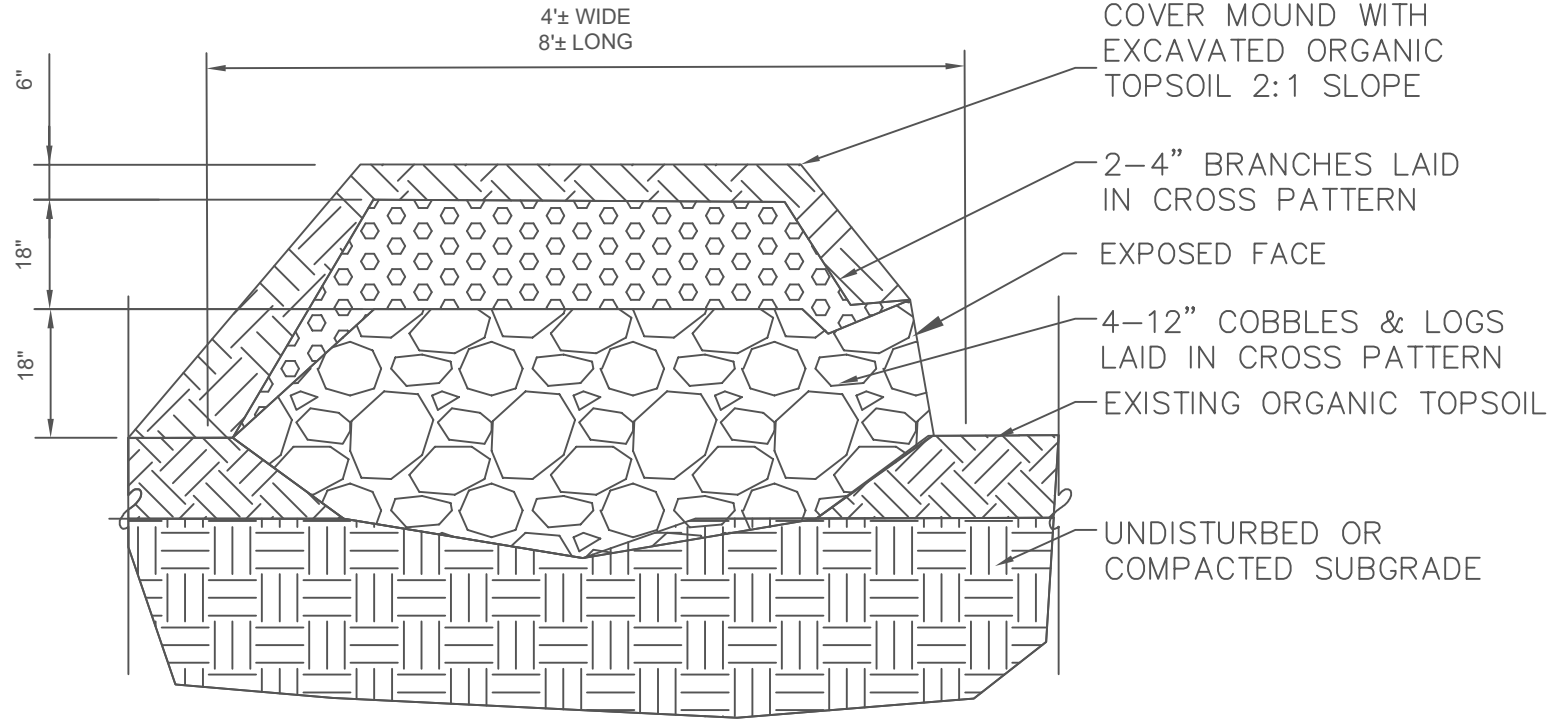
1. SEE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
2. NO PRUNING OR CUTTING UNLESS DIRECTED BY THE LANDSCAPE ARCHITECT.
3. SAUCER SHALL BE FLOODED TWICE DURING THE FIRST 24 HOURS AFTER PLANTING.
4. REMOVE ALL CONTAINERS OR SYNTHETIC WRAPPINGS

SHRUB/ TREE WETLAND REPLICATION PLANTING DETAIL

SCALE: NONE

NOTES:
HIBERNACULA SHALL CONSIST OF STONE & WOODY MATERIAL CLEARED FROM THE SITE CUT TO SIZE AND PLACED AS DIRECTED.

BRUSH MAY NOT INCLUDE INVASIVE WEED SEED. REVIEW MATERIAL TO BE SET ASIDE FOR BRUSH PILE WITH WETLAND SPECIALIST OR LANDSCAPE ARCHITECT.



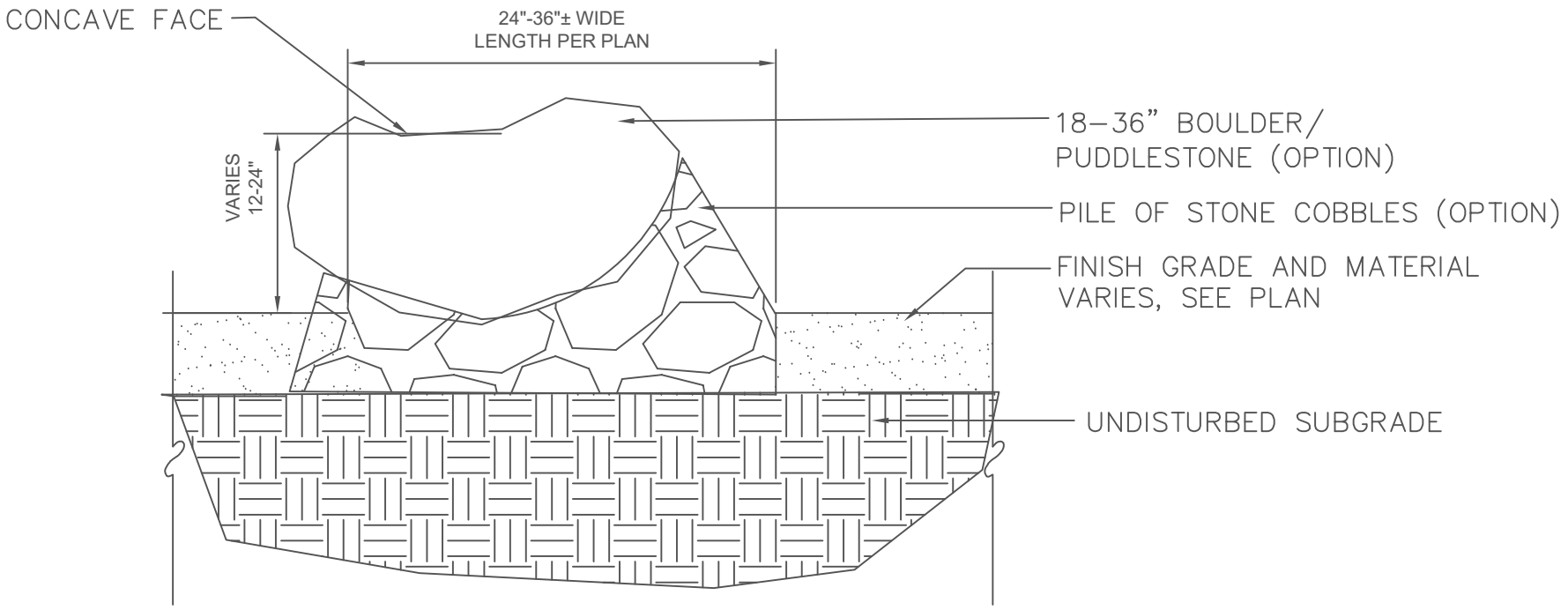
HABITAT: HIBERNACULA – EARTH, STONE, WOOD PILE

SCALE: NONE

NOTES:
COBBLES SHALL BE ROUNDED FIELD STONE 12" MAX. DIA. 3" MIN. DIA.

THE CONTRACTOR MAY UTILIZE STONE REMOVED FROM THE CONSTRUCTION EXCAVATIONS FOR USE IN HABITAT COBBLE PILE.

PLACE COBBLE PILES AS DIRECTED BY THE DOT WETLAND SPECIALIST OR LANDSCAPE ARCHITECT.

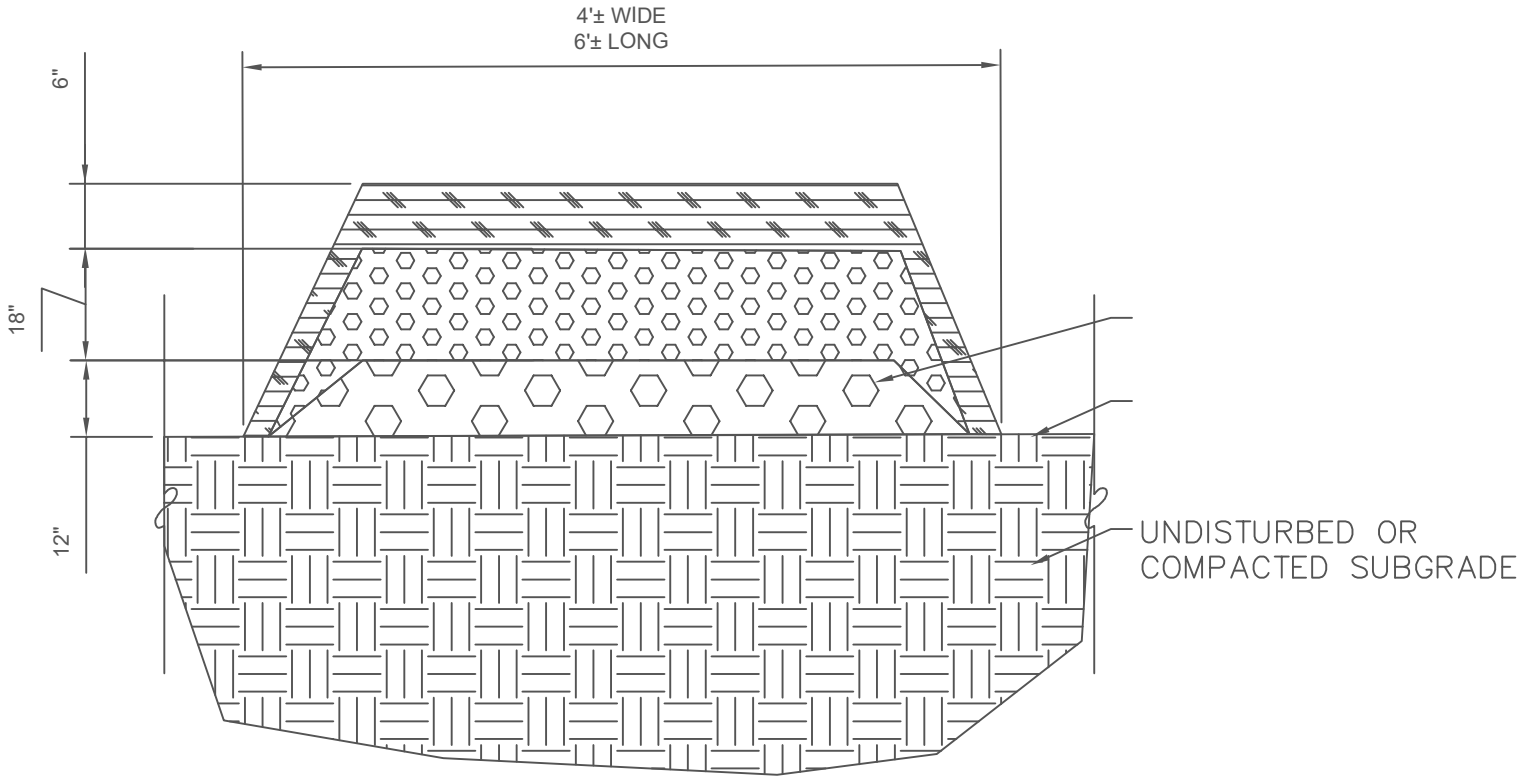


HABITAT COBBLE PILE/ BANK/ PUDDLE STONE

SCALE: NONE

NOTES:
THICKET BRUSH PILE SHALL CONSIST OF WOODY MATERIAL CLEARED FROM THE SITE CUT TO SIZE AND PLACED AS DIRECTED.

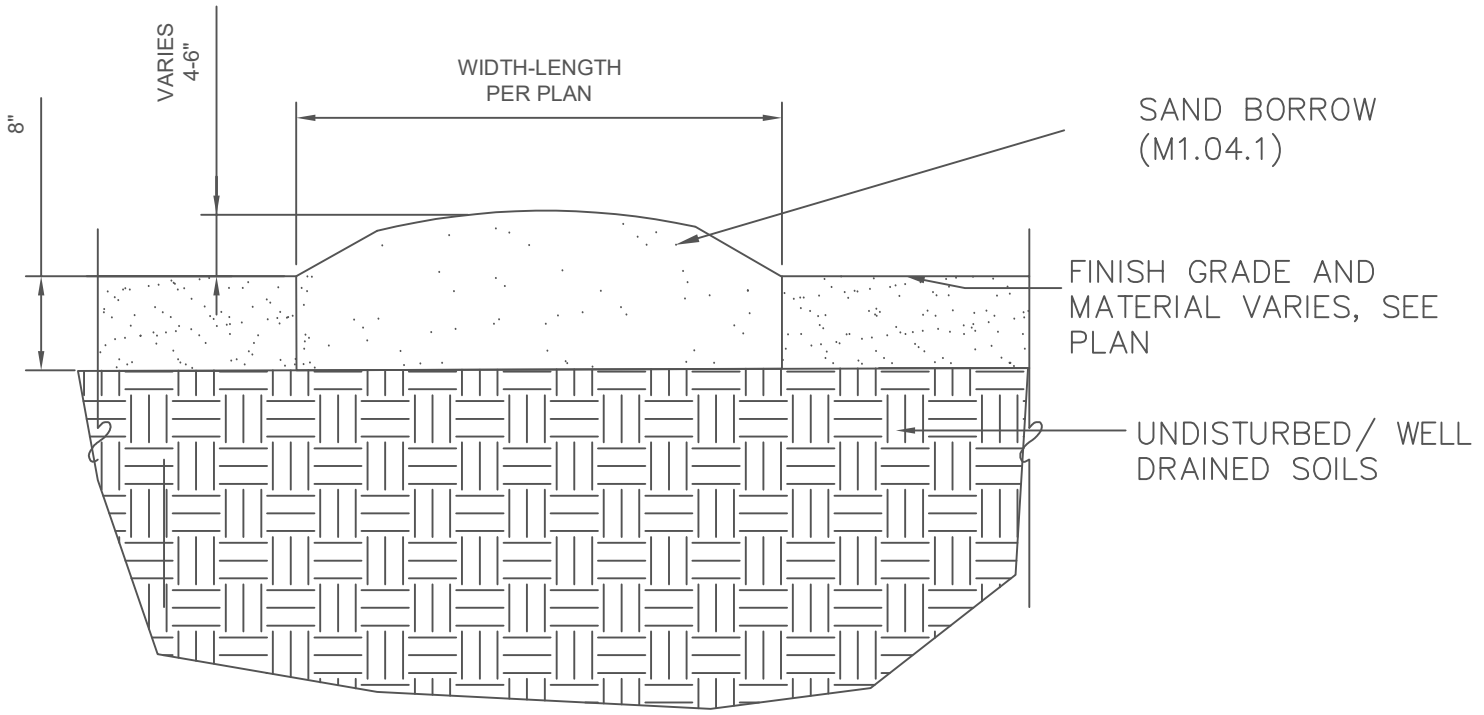
BRUSH MAY NOT INCLUDE INVASIVE WEED SEED. REVIEW MATERIAL TO BE SET ASIDE FOR BRUSH PILE WITH DOT WETLAND SPECIALIST OR LANDSCAPE ARCHITECT.



HABITAT: BRUSHY THICKET – BRUSH PILE

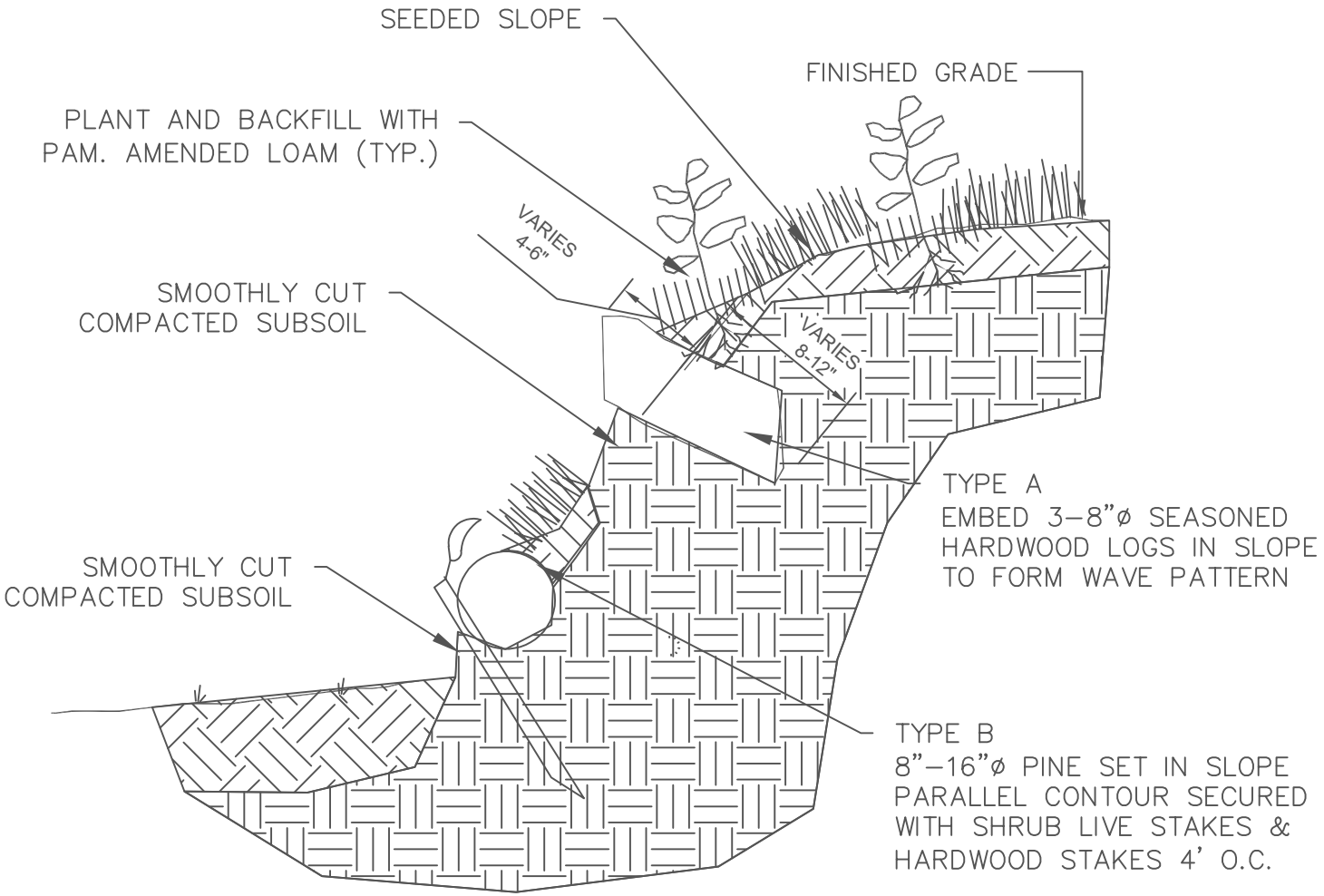
SCALE: NONE

NOTES:
USE COURSE SAND (ASTM– C33).



HABITAT: SAND BANK NESTING

SCALE: NONE



HABITAT EMBANKMENT ROOT BAR – CONTOUR LOG

SCALE: NONE

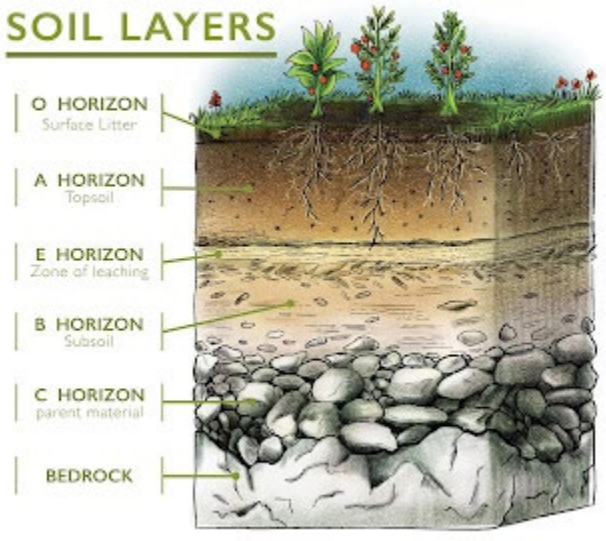
Appendix D: Parts and Materials Guide

PARTS AND MATERIALS GUIDE

Expansion or Restoration of Soil/Ground Preparation:

- Ground preparation should occur close to the time of planting, but not less than a week before. It should include appropriate erosion control. There is a benefit to allowing disturbed soil to settle for two weeks before planting. The rapid oxygen exposure can trigger a bacteria bloom and negatively affect soil biology and nitrogen. Getting the soil in a few weeks before planting lets nutrients, oxygen, and carbon dioxide stabilize.
- The existing ground typically consists of compacted urban fill and thin loam. Till this material to break the surface and allow soil to bond. Maintain irregularities to mimic old growth surface.
- Run a simple perc test.

New forest soil layers should be installed as detailed below:



B-Horizon: Place 12” of sandy loam with 1-2 yd. of woodchip blended in simulating dead root biomass.

A-Horizon: Place 9” of compost-loam. Volunteers to cast in soil amendments as this layer is placed. Soil amendments include: Azomite/Basalt, Greensand, Hydrogel, activated carbon, arbuscular mycorrhizae. The goal for forest conditions is 5-8% organic by weight by loss on ignition (LOI). For example, a 50/50 blend of loam and compost typically comprises 7-10% organic soil, as organic content can make up a lot of volume with little dry weight.

O-Horizon: Place 3” of 50/50 compost/woodchip mulch, or dry leaf litter.

Duff layer: Find a leaf litter pile from a relatively clean source such as a park or cemetery. Alternately, another source is a town waste pile checked for invasive root stock or seed heads. Remove if found.

During Planting: Maintain stockpiles (1-2 yd.) of compost-loam woodchip and sandy loam for use in micro-grading, and to create different soil zones.

Water: Immediately water in new and replacement plantings to allow roots to bond with soil and eliminate excessive air pockets.

Irrigation Parts List:

The following is a list of parts used or included for irrigation adjustments and adaptations to field conditions. Drip Depot[1] is a reliable and comprehensive source for most systems, but many standard fittings are available from local retailers.

Note: If a domestic water line is used, a backflow preventer is required.

Water Source:

1. If the system is on a domestic water main line or hydrant, use Husky Smart Watering Time, powered by Hubspace for Bluetooth water control and simple on box test.
2. If the system is on a fire hydrant, pressure may be an issue if a bell pressure regulator is not included. Add an additional 40psi pressure regulator before the control timer.
3. If the system is from a Rain Barrel or other gravity system, use a zero pressure timer 13919 Irritec Zero Pressure Timer (requires triple A batteries).

Parts:

- 4790 Hendrickson Bros J10 Hose Vacuum Breaker
- 3525 Senninger 3/4" Hose Thread Pressure Regulator - PSI: 15 PSI
    - Include one pressure regulator per zone.
- 1516 Irritec Perma-Loc Tubing x Female Hose Thread Swivel (FHTS) or Adapter – Thread Size: 3/4" FHT - Perma-Loc Size: 3/4"
- 2118 Barb Tubing x FPT Adapter - Barb Size: 3/4" - FPT Size: 3/4"
- 1520 Irritec Perma-Loc Tubing x FHTS Elbow Adapter - Thread Size: 3/4" FHT - Perma-Loc Size: 3/4"
- 1517 Perma-Loc Tubing Male Hose Threads Adapter - Thread Size: 3/4" MHT - Perma-Loc Size: 3/4"
- Distribution lines: 3551 Polyethylene Tubing - Size: 3/4" (.820" ID x .940" OD)
- 1516 Irritec Perma-Loc Tubing x Female Hose Thread Swivel (FHTS)
- 1519 Irritec Perma-Loc Tubing Tee - Thread Size: 3/4" FHT - Perma–Loc Size: 3/4"
- Adapter - Thread Size: 3/4" FHT - Perma-Loc Size: 3/4"
- Pinch clamps 100 psi Polly ¾"

[1] https://www.dripdepot.com/irrigation-supplies

Drip Lines:

- 3542 P1 Ultra 5/8" Drip Tape - Wall Thickness: 8 mil - Emitter Spacing, 12" - Emitter Flow: 0.25 GPH

Drip tape lines can be folded over and taped shut, but cleanout end caps are also an option.

- 1503 Heavy Duty Wire Staple - Length: 8 inches
- 1695 Irritec Perma-Loc Tape x Barb Tubing Adapter
- 1695 Irritec Perma-Loc Tape x Barb Tubing Adapter
- 1785 Barb Tubing Tee - Size: 3/4"
- 3238 1/2" Polyethylene Pressure Compensating Drip Line - Emitter Spacing, 12" - Flow Rate: 0.5 GPH
- A drip zone filter:
    - 1025 3/4" Hose Thread Filter
    - Alternate filter: 1255 Inline Hose Filter by Global

Other Miscellaneous:

- If changing drip line connections to the distribution line:
  1585 Goof Plug - Size: .388" - .440"
- If adding an extra targeted emitter:
  12200 Toro Cleanable Dripper - Flow Rate: 0.5 GPH

Barriers:

If browse damage is observed, it may be necessary to apply tree wrap:

- Light: Industrial Netting OV7822-42x100 Polypropylene Rabbit Pest Exclusion Net, ¼” Mesh
- Heavy: https://www.treepro.com/ tree tubes

Appendix E: Plant Sourcing Guide

MA FOREST PLANT SOURCING GUIDE

List of Sources for Native and Habitat Beneficial Plant Material

This list is provided to support pocket forest development and habitat restoration in Central Massachusetts. This list is not exhaustive. Local retailers not listed may also carry and/or special-order native plants for projects. Inclusion in this list does not endorse the vendor or individual plant materials but provides a starting point for expanding your access to obtaining native plant species.

Nursery Stock (Native Oriented):

- https://www.nativeplanttrust.org/for-your-garden/buy-native-plants/
- https://www.butterflyeffectfarm.com/
- https://www.bluestemnatives.com/
- https://newp.com/
- https://www.prairiemoon.com/
- https://tripplebrookfarm.com/
- https://www.northeastpollinator.com/

Seed:

- https://www.ernstseed.com/
- https://www.americanmeadows.com/
- https://www.prairiemoon.com/
- https://www.ernstseed.com/
- https://newp.com/
- https://wildseedproject.net/

Bare Root and Related Material:

- https://chiefrivernursery.com/
- https://www.nativnurseries.com/
- https://www.arborday.org/
- https://www.ernstseed.com/
- https://newp.com/
- https://midatlanticnatives.com/

Regional Wholesale Nursery Stock (Not Specifically Native Oriented):

From Central MA:

- https://bigelownurseries.com/
- https://www.westonnurseries.com/

Massachusetts-Based:

- https://www.blueviewnurseries.com/
- https://sylvannurseries.com/
- https://www.spillanesnursery.com/

Other Resources:

- https://grownativemass.org/Great-Resources/nurseries-seed#seeds
- LandscapeHub
- Landscape Supply, Irrigation & Agronomic Maintenance: SiteOne

For more information about selecting native plants, visit these sources:

- *The Vascular Plants of Massachusetts: A County Checklist*
- The Native Plant Trust's Go Botany website
- (NRCS) PLANTS Database
- University of Connecticut (UConn) Plant Database of Trees, Shrubs, and Vines,
- Lady Bird Johnson Wildflower Center Plant Database
- Natural Heritage and Endangered Species Program
- http://www.missouribotanicalgarden.org/plantfinder/plantfindersearch.aspx

Appendix F: Soil Monitoring Guide

SAMPLE SOIL TESTS & NUTRIENT MANAGEMENT RECOMMENDATIONS

Part 1:

Before soil preparation and amendment, perform a soil test to establish a baseline condition for future forest development assessment.

This test includes the university ratings of nutrients and organic matter relative to average conditions.

We recommend the Cornell lab test specifically for the inclusion of SOM (Soil Organic Matter).

Part 2:

To aid in understanding what matters in a soil test, BSC has provided examples of two other tests, one for a high performing soil, and another for a poor soil with contamination. These include tags with our comments about what matters most for the new forest.

Appendix G: Irrigation Maintenance Guide

Irrigation Maintenance

Instructions:

Water Supply

1. Forest managers are not qualified or authorized to operate water systems before the hose connection to the irrigation controller.
2. Check for leaks or problems at the water source and report these to the Owners representatives.
3. For issues affecting the water supply contact the City of Worcester Water Dept. or Plumley Village Facilities office, respectively.

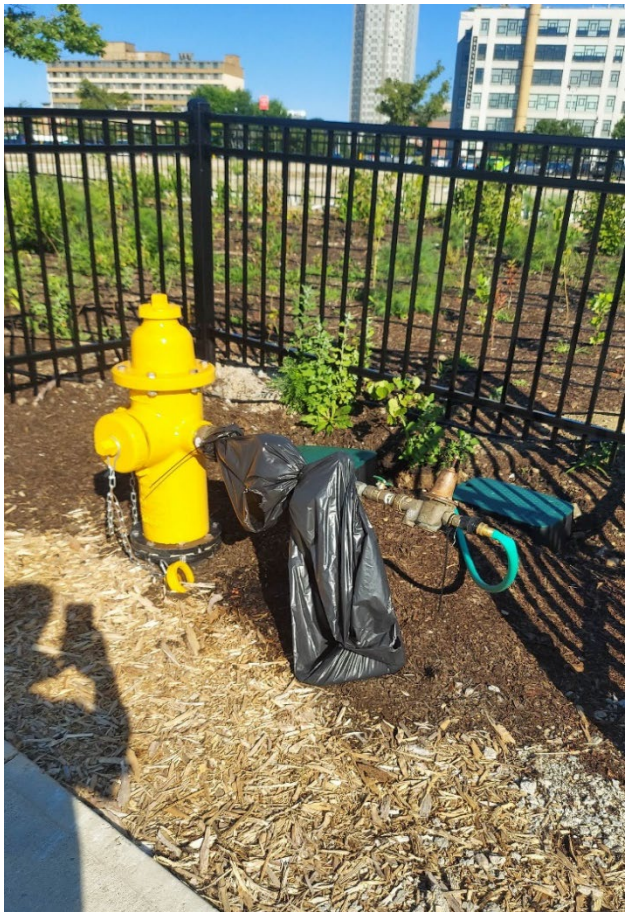


Figure 1: McGrath Hose Connection

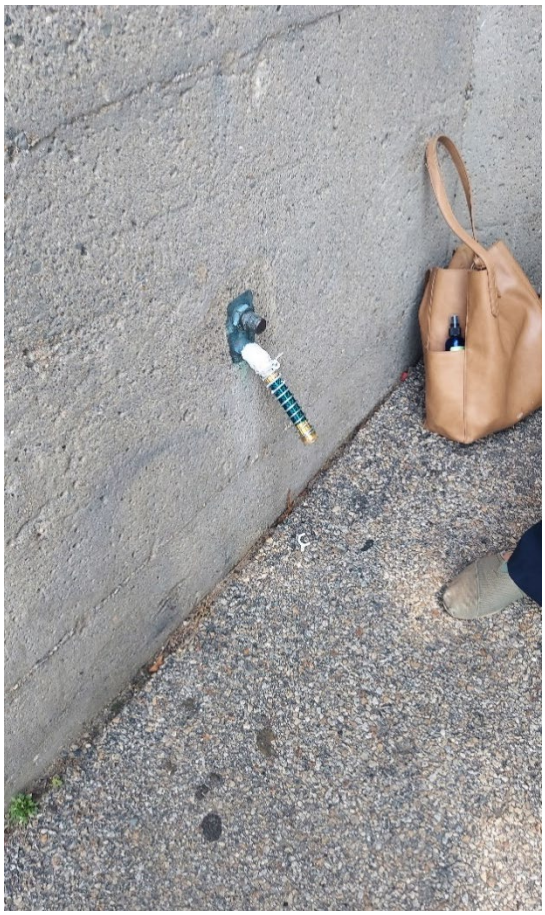


Figure 2: Plumley Hose Connection

(Replace these photos when sites are updated)

Checking the System

1. Are the supply valves open? Do you feel pressure on the hose?
2. Are they leaking? Fittings may need to be adjusted and/or re-tightened or have rubber washers replaced in the hose end. If so, inspect the hose & hose clamps. For pinch clamps use pliers, and for strap clamps use a screwdriver to reset and tighten the fittings. Threads may need to be wrapped with Teflon tape.

The next set of connections in the valve box are the system's timers:

Figure 4: Vault and Controller with Filter

Figure 3: Controller Temperature Start Button

3. Open the green valve box lid, the side with a key hole will lift up.
4. Power: On the timer box, a green light will flash periodically to indicate there is power.
5. To assess the system, press the square button for each zone - do not run both at the same time. You will hear it click, and water will start to run. It can take up to 30 minutes for a zone to fill completely and reveal any issues. Once checked, switch to the second zone and perform other inspections while the zone starts. Then switch back to check the second zone.
6. If conditions appear dry it is acceptable to allow a zone to run fully, they are on a max timer and will run for a full session. This does not affect the automatic overnight schedule. If you forget to turn it off, it will turn off on its own.
7. Filter: The filter does not need to be checked for monitoring but should be opened and rinsed when the system is winterized. To do this unscrew the filter cap, slide out the mesh cylinder inside, and rinse it in clean water. There is also a strainer inside the control valve hose cap, remove and rinse this also. Each zone has a filter.
    a. Next, turn the filter counterclockwise and gently pull out the yellow filter. To clean, give the yellow filter a rinse by shaking it out in a bucket of clean water. Note that it does not have to be perfectly cleaned every time, it must stay clean enough to pass water. Do not scrub the filter with a brush or a rag, as this might loosen the delicate mesh making it inoperable.
    b. Once you clean the filter, seat it back into the housing and thread back onto the line.

8. Batteries: The timer uses 2 AA batteries accessed by a panel on the back of the timer. These should not need to be replaced before winterization. To remove the batteries, you may need to disconnect the main lines.
9. Program: The auto timer is scheduled through the Hubspace app by Bluetooth to the forest manager's phone. Contact Caseylee Bastien at BSC Group, cbastien@bscgroup.com, if you believe the timer needs to be adjusted. To change forest managers and access the timer on a new device download the Hubspace app. There is a QR code to scan on the back of the timer, this will allow you to re-associate the timer with a new phone and reprogram per the instructions they provide.

If for some reason you need to disassemble, replace a part, or re-assemble, remember—there are flow arrows that all need to be put back in the right order.

While most fittings are available at the hardware store, others are easier to order online. See the PARTS & MATERIALS GUIDE for a detailed list of all the parts and where you can get replacements.

Drip irrigation

1. Distribution lines are made of ¾" polyurethane pipe. If these become kinked, they can be worked and massaged back into an open shape but can be punctured by over working. If damage is minor, it can be taped. If it is significant, cut the line and splice it with a connector. Then place stones or sticks to splint and protect this spot as it may be possible to kink again. Check where access paths cross lines.
2. Check the connections. Note that some are threaded connections (push barb fittings with clamps) and some are twist lock. (Twist lock connections are slipped on and then locked on by turning the lock counterclockwise. These rotate opposite of "righty-tight" to cinch down and secure over the hose).

Figure 5: Distribution Line & Drip Connector

3. Drip tape lines are efficient but delicate, avoid stepping on them. While leaks will not prevent the other drippers from functioning, leaks will cause the system to waste water or overwater an area. Drip tape lines must lay flat and parallel the ground.

Figure 6: Drip Tape Line and Emitter

4. Check for kinks in the drip tape lines and ensure they have not shifted out of place. Identify and mark leaks while the water is running. Drip tape lines are hard to patch when wet. Mark the location and let them dry before attempting to patch; or replace the strip in its entirety.

5. Leaks can be patched with vinyl electrical tape. When dry, these are easy to fix with a few wraps of tape. Wrap the tape smoothly and tightly without constricting the shape of the line.

This is easy when the lines are dry and flat but possible while running. If a leak is severe, it is practical to replace one of the drip tape strips.

To replace: The tape is held on with permalock fittings that are pressed into the main line with a barb and screwed back down to secure the tape. Slip the new tape as far over the nipple as possible with the lock fully open, then rotate the lock counterclockwise to cover the tap. Give a tug at the end to ensure it is secure. Next re-set anchor staples on the main line if they were lifted during repair, and fold over and tape the end of the tape.

Figure 7: Drip Tape Connection to Distribution Line

Figure 8: A functioning drip line water pooling at the emitter

Figure 9 Drip tape end with anchor staple

Appendix H: Soil Sample Interpretation

Soil and Plant Nutrient Testing Laboratory
203 Paige Laboratory
161 Holdsworth Way
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Soil Test Report

Prepared For:

The good soil example.

How rich your soil is for the pocket forest: Balanced is good; Rich and Balanced is ok; Rich and Off Balance is risky.

Sample Information:
Sample ID: Middleboro SS

Order Number: 56251
Lab Number: S210628-132
Area Sampled:
Received: 6/28/2021
Reported: 7/28/2021

mcarignan@agresourceinc.com
978-270-9132

In a New England pocket forest, 5.6-6.5 is an acceptable range.

Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	5.8	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	14.2	4-14
Potassium (K)	403	100-160
Calcium (Ca)	1217	1000-1500
Magnesium (Mg)	170	50-120
Sulfur (S)	32.4	>10
Micronutrients *		
Boron (B)	0.4	0.1-0.5
Manganese (Mn)	3.6	1.1-6.3
Zinc (Zn)	2.6	1.0-7.6
Copper (Cu)	0.0	0.3-0.6
Iron (Fe)	25.9	2.7-9.4
Aluminum (Al)	34	<75
Lead (Pb)	1.0	<22

Analysis	*Value Found*	*Optimum Range*
Cation Exch. Capacity, meq/100g	14.0	
Exch. Acidity, meq/100g	5.5	
Base Saturation, %		
Calcium Base Saturation	44	50-80
Magnesium Base Saturation	10	10-30
Potassium Base Saturation	7	2.0-7.0
Scoop Density, g/cc	0.88	
Optional tests		
Soil Organic Matter (LOI), %	6.9	
Soluble Salts (1:2), dS/m	0.47	<0.6
Nitrate-N (NO3-N), ppm	69	

These represent more immediate and consequential effects. It is what's on the menu and how much of each is in a serving. The overall nutrients on the left may be bound in stone or organic compounds. That's what in the pantry.

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation

Nutrient	Very Low	Low	Optimum	Above Optimum
Phosphorus (P):				
Potassium (K):				
Calcium (Ca):				
Magnesium (Mg):				

These get the bar graph because they are the most important.

Soil and Plant Nutrient Testing Laboratory
203 Paige Laboratory
161 Holdsworth Way
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Nitrogen changes quickly when disturbed so it is only practical to measure this for undisturbed soil.

Not currently applicable. To be reevaluated once established.

Recommendations for Established Lawn

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
lbs / 1000 sq ft			
100	2 - 4	0	0

Comments:

-Do not topdress with more than 50 lb limestone per 1000 sq ft at one time. Split the above application between early spring and mid-autumn.
*Your nitrate level is currrently above optimum. Please disregard nitrogen recommendation. No additional nitrogen is needed at this time.
-Soil test phosphorus is above optimum. No additional P2O5 is required.
-For instructions on converting nutrient recommendations to fertilizer applications in lawns, see Reference "Step-by-Step Fertilizer Guide for Lawns" (listed below).
-Avoid over-fertilization. In addition to threatening water quality, excessive nutrient applications can compromise plant health and contribute to insect and disease problems. For details, see Reference "Corrective Measures and Management of Over-Fertilized Soils" (listed below).
-For best results, split the N, P2O5, and K2O recommendations above into three to four applications over the course of the growing season at six to eight week intervals, beginning in mid- to late-April.
-Many fertilizer sources and rates may be combined to provide acceptable turfgrass fertilty.
-The lead level in this soil is less than 22 ppm, which falls below the listed optimum level. However, many variables affect this result, and safety thresholds vary by location and soil use. There is still a potential risk of lead exposure for soils used for growing food or as play areas for children. Our Total Sorbed Metals test provides an accurate measurement of soil lead. For more information about lead levels in soil, see the fact sheet entitled "Soil Lead: Testing, Interpretation, & Recommendations," listed under General References at the end of this report. ATTN: The Total Sorbed Metals Test is currently unavailable. We apologize for any inconvenience.

References:

Home Lawn and Garden Information	http://ag.umass.edu/resources/home-lawn-garden
Corrective Measures and Management of Over-Fertilized Soils	https://ag.umass.edu/SPNTL-13
Step-by-Step Fertilizer Guide for Lawns	http://ag.umass.edu/soil-plant-nutrient-testing-laboratory/fact-sheets/fertilizer-guide-for-lawns

Just because lead is listed does not mean the soil is toxic. There are natural baseline quantities that don't require action. (This is not a TSM test.) If this initial test goes over the 22 ppm and you plan to grow root or foliage crops then it is best to get a TSM test performed.

PennState Extension

Good compost

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

Analysis Report For:	Copy To:

A soil test can be acquired for compost. This is important because compost is complex and has significant effects on chemistry. Generally it is best to get local compost.
Compost comes in different varieties. This is a leaf mold compost. It is lower in nutrients than other composts like "Bio-solid compost made from human waste and typically used in sport soils, or food waste compost typical for vegetable and flower gardens.

LAB ID:	SAMPLE ID:	REPORT DATE:	SAMPLE TYPE:	FEEDSTOCKS	COMPOSTING METHOD	COUNTY
C13460	Ipswich Leaf	07/02/2021				

All acceptable ranges per specifications

COMPOST ANALYSIS REPORT

Compost Test 1C

Typically compost will have low pH under 7. This may have high Calcium Carbonate.

Analyte	Results (As is basis) (Weight basis)		(Volume Basis)*			
pH	8.0		—		—	
Soluble Salts (1:5 w:w)	3.19	mmhos/cm	—		—	
Bulk Density[1]	—		750	lb/yd^3		
Solids	54.7	%	410	lb/yd^3		
Moisture	45.3	%	340	lb/yd^3		
Organic Matter	30.8	%	231	lb/yd^3		
Total Nitrogen (N)	1.0	%	7.8	lb/yd^3		
Organic Nitrogen[2]	1.0	%	7.4	lb/yd^3		
Ammonium N (NH_4-N)	417.5	mg/kg	0.313	lb/yd^3		
	or 0.0417	%			or 0.0763	%
Carbon (C)	16.0	%	120	lb/yd^3	29.2	%
Carbon:Nitrogen (C:N) Ratio	15.40		—		15.40	
Phosphorus (as P_2O_5)[3]	0.70	%	5.25	lb/yd^3	1.28	%
Potassium (as K_2O)[3]	0.32	%	2.41			
Calcium (Ca)	3.94	%	29.54			
Magnesium (Mg)	0.18	%	1.37			
Sulfur (S)	0.17	%	1.25			
Sodium (Na)	522	mg/kg	0.39			
Aluminum (Al)	2628	mg/kg	1.97	lb/yd^3	4804	mg/kg
Iron (Fe)	3717	mg/kg	2.79	lb/yd^3	6794	mg/kg
Manganese (Mn)	180	mg/kg	0.14	lb/yd^3	329	mg/kg
Copper (Cu)	21.1	mg/kg	0.02	lb/yd^3	38.6	mg/kg
Zinc	70.6	mg/kg	0.05	lb/yd^3	129.1	mg/kg

Organic carbon is not measured by volume but by weight after ignition. A 100% organic compost is about 30% SOM. It takes a significant volume of compost to alter SOM by weight.

Be aware of how compost will affect trace metals when combined with your soil. Broad variability can be acceptable but spikes or deficiencies in one metal can affect soil health.

[1]*Volume results are calculated on the basis of laboratory-determined compost bulk density

[2]See comments on back of report .

[3]To convert phosphorus as P_2O_5 into elemental phosphorus (P), divide by 2.29. To convert potassium (as K_2O) into elemental potassium (K), divide by 1.20.

INTERPRETATION

pH

pH is a measure of active acidity in the feedstock or compost. The pH scale is 0 (acidic) to 14 (basic) with 7 being neutral. Most finished composts will have pH values in the range of 5.0 to 8.5. Ideal pH depends on compost use. A lower pH is preferred for certain ornamental plants while a neutral pH is suitable for most other applications. pH is not a measure of the total acidity or alkalinity and cannot be used to predict the effect of compost on soil pH.

Soluble Salts

Soluble salts are determined by measuring electrical conductivity (EC) in a 1:5 (compost:water, weight ratio) slurry. EC is related to the total soluble salts dissolved in the slurry and is measured in units of millimhos/cm (mmhos/cm). Compost soluble salt levels typically range from 1 to 10 mmhos/cm. High salinity may be toxic to plants. Ideal soluble salt levels will depend on the end use of the compost. Final compost blends with soil or container media/potting mixes should be tested for soluble salts.

% Solids, % Moisture

The ideal moisture content for composting will depend on the water holding capacity of the materials being composted. In general, high organic matter materials have a higher water holding capacity and a higher ideal moisture content. A typical starting compost mix will have an ideal % solids content of 35-55 % (65-45 % moisture. Finished compost should have a % solids content of 50-60 % (50-40 % moisture).

% Organic Matter

There is no ideal organic matter level for feedstocks or finished compost. Organic matter content will decrease during composting. The organic matter content (dry weight basis) of typical feedstocks and starting mixes will be greater than 60 % while that of finished compost will be in the range of 30-70 %. An organic matter content (dry weight basis) of 50-60 % is desirable for most compost uses.

Nitrogen : Total, Organic, Ammonium, and Nitrate

Total nitrogen (N) includes all forms of nitrogen: organic N, ammonium N (NH_4-N), and nitrate N (NO_3-N). Total N will normally range from less than 1 % to around 5 % (dry weight basis) in most feedstocks and from 0.5 to 2.5 % (dry weight basis) in finished composts. NO_3-N (an optional test) is generally present in only low concentrations in immature composts, although it may increase as the compost matures. NH_4-N levels may be high during initial stages of the composting process, but decrease as maturity increases. Organic N is determined by subtracting the inorganic N forms, NH_4-N and NO_3-N, from total N. However, because NO_3-N levels are generally very low, total nitrogen minus NH_4-N provides a good estimate of organic N in most composts and is the value shown on the front of this report. In stable, finished composts, most of the N should be in the organic form. While NH_4-N and NO_3-N are immediately available to plants, organic N is only slowly available, approximately 10 to 20 % per year. However, mineralization or break-down of organic N into available inorganic forms depends on the C: N ratio (see below) as well as factors such as soil moisture and temperature.

Total Carbon

Total carbon (C) is a direct measurement of all organic and inorganic carbon in the compost sample. Unless the sample has a high pH (> 8.3) or is known to contain carbonates, essentially all carbon will be in the organic form. Compost organic matter typically contains around 54 % organic carbon by weight. The carbon content of individual feedstocks may vary from this ratio.

Carbon: Nitrogen Ratio

This is the ratio of total carbon (C) to total nitrogen (N) in the compost sample provided. C:N ratio may be used as an indicator of compost stability and N availability. Compost C:N ratio typically decreases during composting if the starting C:N ratio is > 25, but may increase if the starting C:N ratio is low (< 15) and N is lost during the composting process. Composts with high C:N ratios (> 30) will likely immobilize or tie-up N if applied to soil, while those with low C:N ratios (< 20) will mineralize or break-down organic N to inorganic (plant-available) N.

Phosphorus, Potassium

Phosphorus (P) and potassium (K) are plant macronutrients. Values reported are for total amounts given in the oxide forms (P_2O_5 and K_2O). These results provide an indication of the nutrient value of the compost sample. However, plant availability of total phosphorus and potassium in compost has not yet been established.

Nitrogen, Phosphorus, Potassium Balance

When compost is applied on the basis of nitrogen (N), most composts will have an excess of phosphorus (P) and potassium (K) relative to crop demand. These mineral elements and salts can accumulate to above optimum levels with repeated application. Growers using compost should regularly soil test to monitor P, K and salt accumulation and should consider using other nutrient sources or nitrogen fixing legumes in their crop rotation especially when P and K levels are above optimum.

Peat moss is often recommended by contractors and makes the basis of potting soils because it is clean and can add water holding capacity. But peat moss should be avoided for a couple of reasons. This type of soil is one of the best forms of sequestered carbon and should not be harvested. It also has low and off balance nutrients and a very low pH.

Test	Peat Moss Grade						
	Extra Fine	**Fine**	**Medium**	**Coarse**	**Extra Coarse**	**Extra Coarse + Chunks**	**Chunks**
Root content (%)	Less than 0.1	Less than 1	Less than 1.5	Less than 3	Less than 3.5	Less than 5	Less than 8
Screening (%) **	C: 5-12 F+D: 37-58	C: 15-30 F+D: 35-50	C + M: 49-63 D: less than 6	C + M: 50-70 D: less than 7	C + M: 55-75 D: less than 7	C + M: 65-80 D: less than 7	C + M: 80-90 D: less than 7
Water Holding capacity (%)	70-72	70-72	68-72	60-68	58-66	50-65	50-60
Water Holding capacity (x dry weight)	10-14 times						
Air Space (%)	18-22	20-25	20-26	20-28	22-30	22-32	25-35
Dry Bulk density (g/l)	70-75	67-70	62-70	60-68	55-67	55-65	40-55
Moisture (%)	45 -55						
pH	3.5 - 3.8						
Electrical conductivity (µS/cm)	70 -120						
Organic matter content (%)	98 - 99						
Cation Exchange Capacity (CEC) (meq/100 g)	100 - 150						
Carbon / Nitrogen ratio	48-54						
Ash Content (%)	0.8 - 2						
Nitrogen %	0.8-1.0						
Phosphorus %	0.01-0.03						
Potassium %	0.01-0.2						
Magnesium %	0.1-0.2						
Calcium %	0.1-0.25						

Typical - acidic and may push your soil balance too far too fast. Soil likes slow changes.

** C - (Coarse): Particle size > 2.38 mm
M - (Medium): Particle size between 2.38 mm and 0.849 mm
F - (Fine): Particle size between 0.849 and 0.149 mm
D - (Dust) = Particle size less than 0.149 mm

Revised: June 2013

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Soil and Plant Nutrient Testing Laboratory
203 Paige Laboratory
161 Holdsworth Way
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Particle Size Analysis - Comprehensive with 2mm Passing

Sample Information:

Texture
This is less of an issue for the pocket forest but may be important if loam topsoil is imported. Varying texture and drainage will affect what you choose to plant. One thing to note is that course texture soils will have a lower CEC. If you need to calm a soil down, sand may help. Soil sieve test is a separate order form.

USDA Size Fraction

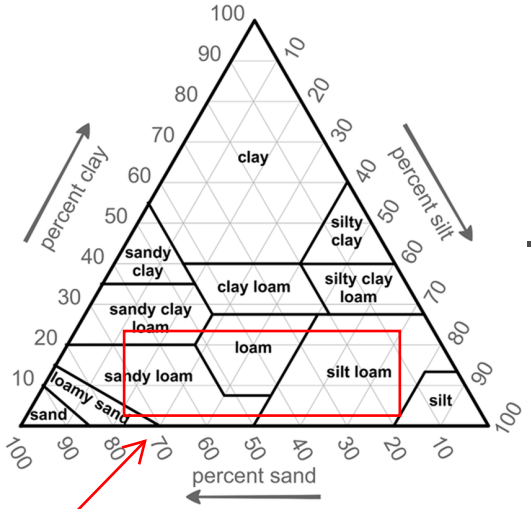
Main Fractions	Size (mm)	Percent
Sand	0.05-2.0	81.0
Silt	0.002-0.05	12.5
Clay	<0.002	6.5

Sand Fractions	Size (mm)	Percent
Very Coarse	1.0-2.0	6.5
Coarse	0.5-1.0	21.1
Medium	0.25-0.5	28.9
Fine	0.10-0.25	18.9
Very Fine	0.05-0.10	5.6

Silt Fractions	Size (mm)	Percent
Coarse	0.02-0.05	8.0
Medium	0.005-0.02	3.6
Fine	0.002-0.005	0.9

Percent of Whole Sample Passing

Size (mm)	Sieve #	Whole Sample % of Sample Passing	Finer Than 2mm % of Sample Passing
2.00	#10	87.1	100.0
1.00	#18	81.4	93.5
0.50	#35	63.0	72.4
0.25	#60	37.9	43.5
0.10	#140	21.4	24.5
0.053	#270	16.5	19.0
0.02	20 um	9.5	11.0
0.005	5 um	6.4	7.4
0.002	2 um	5.7	6.5



USDA Textural Class: sandy loam

Gravel Content: (%) 12.9

Acceptable textural class an gradation.

Over 15% is usually too much unless you need to create more drainage.

In most cases, aim for the average loam. The exception would be a wetland pocket forest where more silt is desired.

Lab Number X210727-108

Soil and Plant Nutrient Testing Laboratory
203 Paige Laboratory
161 Holdsworth Way
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Soil Test Report

Prepared For:

The Bad
Here is an example of a soil test with some problems. It is an urban fill by a river so both high organics and high but minimally accessible nutrients.

Sample Information:
Sample ID: S5

Order Number: 59020
Lab Number: S220321-329
Area Sampled: 1000 sq ft
Received: 3/22/2022
Reported: 3/28/2022

Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	6.3	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	3.0	4-14
Potassium (K)	107	100-160
Calcium (Ca)	2026	1000-1500
Magnesium (Mg)	202	50-120
Sulfur (S)	22.6	>10
Micronutrients *		
Boron (B)	0.2	0.1-0.5
Manganese (Mn)	9.7	1.1-6.3
Zinc (Zn)	44.4	1.0-7.6
Copper (Cu)	2.3	0.3-0.6
Iron (Fe)	41.7	2.7-9.4
Aluminum (Al)	58	<75
Lead (Pb)	24.5	<22

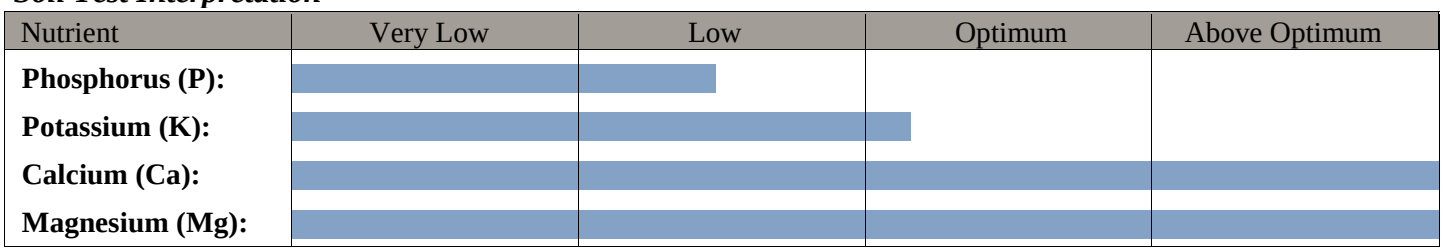
Analysis	*Value Found*	*Optimum Range*
Cation Exch. Capacity, meq/100g	17.5	
Exch. Acidity, meq/100g	5.5	
Base Saturation, %		
Calcium Base Saturation	58	50-80
Magnesium Base Saturation	9	10-30
Potassium Base Saturation	2	2.0-7.0
Scoop Density, g/cc	0.59	
Optional tests		
Soil Organic Matter (LOI), %	14.3	
Soluble Salts (1:2), dS/m	0.11	<0.6

Many of these metals are high enough to stunt different types plant growth, specifically the zinc, but this is mitigated by the high calcium and iron levels.

This might not be a true red flag. If lead comes back high, take a second sample to test or get a TSM test. See the next test of this soil by SoilRx.

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Rang found in soils and are for reference only.*

Soil Test Interpretation



Poorly balanced

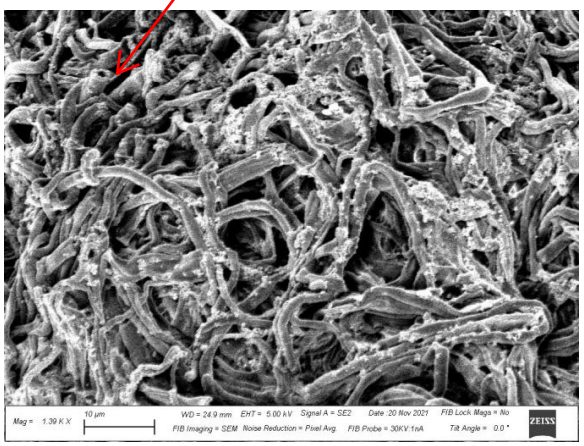
YOUR HEAVY METALS RCRA SOIL ANALYSIS

In most cases, aim for the average loam. The exception would be a wetland pocket forest where more silt is desired. This is a test of problematic urban fill soil. In the end, we chose to minimize soil disturbance and amended backfill of individual plants with hydrogel, bone meal, azomite, wood ash, compost, and an arbuscular endo- & ecto-mycorrhizae, with inoculated logs of trametes fungi to stabilize metals.
(See photo)

Below you will find the results of your heavy metals soil analysis. For each metal tested, you will find a part-per-million (ppm) count that the laboratory was able to identify in the tested portion of your soil sample. All samples are analyzed for metals using a testing method referred to as EPA 3050B, unless your are also testing for mercury, which is handled by a testing method referred to as EPA 7471B.

Alongside the ppm count for each element, we provide a graph that shows how your count compares to known benchmarks for metals in US soils, gathered from government resources at the EPA, CDC, and others. Please reference these sources and others to assist in making your own determination regarding the safety of your soil.

Fungal hyphae bonding spots of lead



Arsenic
(As)
20 ppm

Range in Nature*
1 - 40

For New England, this arsenic level is pretty good.

I II III

NEED HELP

20 ppm - Your Soil Sample

Soil and Plant Nutrient Testing Laboratory
203 Paige Laboratory
161 Holdsworth Way
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Compost

Bonemeal

Ash

Recommendations for Deciduous Trees, Shrubs & Vines-Maintenance

Limestone (Target pH of 6.0)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
lbs / 100 sq ft			
0	.1 - .2	0.25	0.1

Comments:

-The lead level in this soil is elevated. It is recommended that soils with elevated levels of extractable lead (greater than 22 ppm) be tested for Total Sorbed Lead. The UMass Soil Lab offers a Total Sorbed Metals test that measures total lead and other heavy metals. Ordering information can be found on our website here: https://soiltest.umass.edu/ordering-information. For more information about lead levels in soil, see the fact sheet entitled "Soil Lead: Testing, Interpretation, & Recommendations," listed under General References at the end of this report. ATTN: The Total Sorbed Metals Test is currently unavailable. Please visit our website for more information. We apologize for any inconvenience.
*To supply Nitrogen, apply EITHER 1 - 1.5 lbs. Dried Blood (12-0-0) OR 0.2 - 0.4 lbs. Urea (45-0-0) per 100 square feet. Application should be split between early spring and mid-June.
*To supply Phosphorus, apply EITHER 2.1 lbs. Bone Meal (4-12-0) OR 0.6 lb. Triple Phosphate (0-45-0) per 100 square feet.
*To supply Potassium, apply 0.2 lbs. Potash (0-0-60) per 100 square feet.
-For instructions on converting nutrient recommendations to fertilizer applications in home gardens and landscapes, see Reference "Step-by-Step Fertilizer Guide for Home Grounds and Gardening" (listed below).

References:

Home Lawn and Garden Information	http://ag.umass.edu/resources/home-lawn-garden
Step-by-Step Fertilizer Guide for Home Grounds and Gardening	https://ag.umass.edu/SPNTL-4

General References:

Interpreting Your Soil Test Results	http://soiltest.umass.edu/fact-sheets/interpreting-your-soil-test-results
Soil Lead: Testing, Interpretation & Recommendations	http://ag.umass.edu/soil-plant-nutrient-testing-laboratory/fact-sheets/soil-lead-fact-sheet
For current information and order forms, please visit	http://soiltest.umass.edu/
UMass Extension Nutrient Management	http://ag.umass.edu/agriculture-resources/nutrient-management

I) 5 ppm - Lowest detectable amount from laboratory method.
II) 5 ppm - Average range of natural arsenic found in soils.
III) 40 ppm - Upper range of natural arsenic found in soils.

Resources:
ATSDR Arsenic Report
CDC Arsenic Factsheet

Barium
(Ba)
120 ppm

Range in Nature*
20 - 3000

No Problem

I II III

120 ppm - Your Soil Sample

I) 2.5 ppm - Lowest detectable amount from laboratory method.
II) 500 ppm - Average range of natural barium found in soils.
III) 3000 ppm - Upper range of natural barium found in soils.

Resources:
ATSDR Barium Report

Cadmium
(Cd)
< 0.8 ppm

Range in Nature*
0.01 - 1

Not great

I II

NEED HELP

Your soil sample is less than 0.8 ppm, our Reporting Minimum

I) 0.80 ppm - Lowest detectable amount from laboratory method.
II) 1.00 ppm - Average range of natural cadmium found in soils.

Resources:
NIH Review on Cadmium in Soils
CDC Cadmium Factsheet

Chromium (Cr) 79 ppm

Range in Nature*
14 - 70

Not good

I II III

79 ppm - Your Soil Sample

I) 1.3 ppm - Lowest detectable amount from laboratory method.
II) 37 ppm - Average range of natural chromium found in soils.
III) 70 ppm - Upper range of natural chromium found in soils.

Resources:
ATSDR Chromium Report
CDC Chromium Health Statement

Lead (Pb) 98 ppm

Range in Nature*
10 - 50

Not great

NEED HELP

I II III IV


98 ppm - Your Soil Sample

I) 100 ppm - Maximum level the EPA generally regards as safe for food crops and gardening with children.
II) 400 ppm - Maximum level the EPA generally regards as safe for non-root crops. Low-growing leafy greens and root crops not recommended above 100 ppm.
III) 400 ppm - EPA definition of hazardous levels of lead for child play areas in residential soils.
IV) 1200 ppm - EPA definition of hazardous levels of lead for general non-play area residential soils.

Resources:
EPA - Lead Information Site
EPA - Lead in Soils Overview
PennState Extension - Lead in Residential Soils

Mercury (Hg)
0.37 ppm

Range in Nature*
0.020 - 0.625

Not good

I II III


0.37 ppm - Your Soil Sample

I) 0.025 ppm - Lowest detectable amount from laboratory method.
II) 0.060 ppm - Average range of mercury found in soils.
III) 0.625 ppm - Upper range of mercury found in soils.

Resources:
ATSDR Mercury Report
CDC Mercury Factsheet

NEED HELP

Selenium (Se) < 5 ppm

Range in Nature*
0.10 - 8.00

Not bad

I II III

Your soil sample is less than 5 ppm, our Reporting Minimum

I) 2.0 ppm - Upper average of natural selenium found in most soils.
II) 4.5 ppm - Upper average of natural selenium found in soils in the Western US.
III) 5 ppm - Lowest detectable amount from laboratory method.

Resources:
NCBI Overview of Selenium in Soils

Silver (Ag) < 1.3 ppm

Range in Nature*
0.10 - 1.00

Not bad

I II

Your soil sample is less than 1.3 ppm, our Reporting Minimum

I) 1.00 ppm - Upper range of silver found in most soils.
II) 1.30 ppm - Lowest detectable amount from laboratory method.

Resources:
Boise State University Silver Toxicity Study
ort

NEED HELP

---

*Range in Nature is intended to describe the levels that are naturally occuring in soils across the United States, based on the references found above. Your regional or state averages will differ. Residential and industrial history can affect your specific levels.

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Need to Contact Us?
info@rxsoil.com
844-797-6454

Version: 2.0.0-alpha-48

NEED HELP

Subject: Rx Soil - Heavy Metals Results Completed

Good afternoon,

The heavy metals test panel for your soil has been completed. Please use the following link to review your report:

https://app.rxsoil.com/kit/rx-002952

In summary:

- **Regarding Cadmium, Selenium, and Silver** - there was so little metal present in your soil sample, if any, that the lab was unable to detect a reportable level. Please see the report for details on the reporting limit, and know that your sample fell below this reporting limit for these metals.
- **Regarding Arsenic, Barium, Chromium, Mercury, and Lead** - there was enough metal present in your soil sample for the lab to report a specific part-per-million level. Please see the report for your precise levels.
- **Regarding Lead Specifically** - your detectable Lead level in your sample **tested at 98 parts-per-million**. Above 100 PPM, the EPA begins to recommend changes in the use of your soil. Please reference these resources for additional information.

If you have any additional questions after reviewing your soil report, please reach out to us.

Thanks,
- The RxSoil Team

Appendix I: Visual Invasives Guide

WEEDING GUIDE

Plumley Village and McGrath Lot Forest Sites

Weeds
Apply the **"chop and drop"** method of weeding: pull or cut the plant, shake the soil from its roots, and lay it on the ground to dry. Focus on weeding only those species that were not in the original planting plan and are tall or robust enough to compete with the woody plants.

Do not dispose of the weeds; instead, pull or cut them and lay them down to become mulch. When pulling a weed, place the roots facing up so they can dry out and die.

Seeds
Dispose of seeds in a designated seed compost pile and retain as much leafy biomass as possible by allowing weed stems and roots to decompose in place.

Note: Vegetative weed cover is valuable as it helps regulate microclimate and soil stability. Ground cover and low weeds should be left as living mulch to stabilize and shade the soil. These will naturally die out as the forest matures and produces shade.

Note: Late in the fall, some weeds may be taller than our slower-growing trees. Please walk carefully and look closely for these small trees and uncover them.

At Plumley Village Forest Site, weed seeds can be stored along the rear chain-link fence in the shaded area.

At the McGrath Lot Forest Site, weed seeds can be stored in buckets under the mature tree and later added to a dense pile.

GREEN WORCESTER
MIYAWAKI FOREST

Visual Guide (Weeds)

Annual Winter Rye
Remove seed heads and flip roots

Amaranth (Amaranthus Spp.)
Remove seed heads

Smart Weed (Persicaria lapathifolia)
Remove seed heads

Green Dock; Yellow Dock; Curly Dock (Rumex crispus)
Remove seed heads and pull deep tap roots

Shepherd's Puse (Capsella bursa pastoris)
Remove seed heads

Horse weed (Erigeron canadensis)
Remove seed heads

GREEN WORCESTER
MIYAWAKI FOREST

Goose foot (Chenopodium album)
Remove seed heads

Burdock (Arctium lappa)
Remove seed heads and pull deep taproot

GREEN WORCESTER
MIYAWAKI FOREST

Visual Guide (Noxious Plants)

Black Swallow-wort (Cynanchum louiseae)
Hand pull

Black Swallow-wort
Remove seed pods

Tree of Heaven (Ailanthus altisima)
Remove entire plant

Knottweed (Polygonum cuspidatum)
Remove root

GREEN WORCESTER
MIYAWAKI FOREST

Common Reed (Phragmities australlis)
Cut all stems and pull roots

Wormwood (Ambrosia artemisiifolia)
Pull roots, drop stems and foliage, and dispose of seeds.

Mugwart - (Artemesia vulgaris)
Pull roots, drop stems and foliage, and dispose of seeds.

Oriental bittersweet vine (Celatrus orbiculatus)
Dispose of seeds

Oriental bittersweet vine (Celatrus orbiculatus)
Pull orange roots

GREEN WORCESTER
MIYAWAKI FOREST

Appendix J: Installed Plant List

Common Name, Scientific Name	Common Name Scientific Name
Early Succession Canopy trees	**Persistent Canopy trees**
Silver Maple, Acer saccharinum	Paper birch, Betula papyrifera
River Birch, Betula Nigra	Shagbark Hickory, Carya ovata
Grey Birch, Betual deltoides	Smooth Hickory, Carya glabra
Black Willow, Salix nigra	Mockernut Hickory Carya tomentosa
Tulip Poplar, Liriodendron tulipifera	Shellbark Hickory, Carya laciniosa
Eastern Cottonwood, Populus deltoides	Black Cherry, Prunus serotina
American Sycamore, Platanus occidentallis	Sugar Maple, Acer saccharum
Winged Head, Catalpa Speciosa	Red Oak, Quercus rubra
Elm, Ulmus Americana	Basswood, Tillia americana
Black Locust, Robinia pseudoacasia	Hackberry, Celtis occidentallis
Early Sucession Canopy trees	White Oak, Quercus Alba
Silver Maple, Acer saccharinum	Chinkapin Oak, Quercus muehlenbergii
River Birch, Betula Nigra	Butternut, Juglans cinerea
Grey Birch, Betual deltoides	Black Walnut, Juglans, nigra
Black Willow, Salix nigra	
Eastern Cottonwood, Populus deltoides	**Conifers**
American Sycamore, Platanus occidentallis	White Pine, Pinus strobus
Winged Head, Catalpa Speciosa	Red Cedar, Juniperus virginiana
	Tamarack tree, Larix laricina
Understory trees	
June Berry, Amelanchier lamarckii	**Facultative shrubs**
Shad Bush, Amelanchier canadensis	Lindera, Benzoin
Allegheny Serviceberry, Amelanchier laevis	Winterberry, Ilex verticillata
Speckled Alder, Alnus rugosa	Sweet Pepper Shrub, Clethra alnifolia
American Plum, Prunus americana	Buttonbush, Cephalanthus occidentalis
Eastern Redbud, Cercis canadensis	Elderberry, Sambucus canadensis
Pagoda Dogwood, Swida alternifolia	Redtwig Dogwood, Swida sericea
Groundsel tree, Baccharis Halimifolia	
Sweet Bay Magnolia, Magnolia virginiana	**Groundcover**
	Virginia Creeper, Parthenocisus virginiana
Upland Shrubs	Sweet fern, Comptonia peregrina
Ninebark, Physocarpus opulifolius	Low bush blueberry, Vaccinium angustifolia
Hazelnut, Corylus americana	Strawberry, Fragaria virginiana
Bayberry, Myrica Pensylvanica	
	(Other Native and introduced weeds included in compost or local wind borne sources)
Mesic Shrubs	
Red Chokeberry, Aronia arbutifolia	
Black Chokeberry, Aronia melanocarpa	3,700 Installed plants
Nannyberry, Viburnum lentago	1,600 at McGrath
	2,100 at Plumley

Appendix K: Future Goals for Understory, Plant List

Recommended Understory and Groundcover Infill Plants for Maturing Miyawaki Forest

Understory Trees, Shrubs, Vines, and Groundcover	
Understory trees	**Vegetative cover**
Acer pensylvanicum	Aegopodium podagraria
Acer spicatum	Ageratina altissima
Hamamelis virginiana	Amphicarpaea bracteata
Ostrya virginiana	Arisaema triphyllum
Aralia nudicaulis	Gaultheria procumbens
Carpinus caroliniana	Chaenorhinum minus
Crataegus phaenopyrum	Collinsonia canadensis
Amelanchier sanguinea	Eurybia divaricata
	Erigeron pulchellus
Shrubs	Fragaria virginiana
Corylus cornuta	Galium sp.
Ribes americanum	Geum canadense
Rubus sp.	Hieracium aurantiacum
Spirea alba	Hypericum perfoliatum
Viburnum dentatum	Iris versicolor
Viburnum lantanoides	Impatiens capensis
Viburnum acerifolium	Lapsana communis
Sambucus racemosa	Lysimachia borealis
	Maianthemum canadense
Vines	Oenothera sp.
Vitis sp.	Potentilla sp.
Clematis virginiana	Prunella vulgaris
Diervilla lonicera	Pyrola elliptica
Apios americana	Polygonatum pubescens
Campsis radicans	Solanum dulcamara
	Solidago sp.
Grasses	Tiarella cordifolia
Carex swanii	Thalictrum pubescens
Carex vulpinoidea	Urtica dioica
Cirsium arvense	Veronica americana
Carex radiata	Viola cucullata
Sisyrinchium angustifolium	Zizia aurea
Carex arctata	
Carex debilis	**Ferns**
Carex flava	Adiantum raddianum
Carex intumescens	Dennstaedtia punctilobula
Carex pallescens	Matteuccia struthiopteris
Luzula multiflora	*Osmunda cinnamomea*

Rare Plant List

Common Name	Scientific Name	Taxonomic Group	MESA Status
American Twinflower	Linnaea borealis	Vascular Plant	Special Concern
Arborvitae	Thuja occidentalis	Vascular Plant	Endangered
Big-leaved Holly	Ilex montana	Vascular Plant	Endangered
Bristly Black Currant	Ribes lacustre	Vascular Plant	Special Concern
Climbing Fumitory	Adlumia fungosa	Vascular Plant	Special Concern
Culver's-root	Veronicastrum virginicum	Vascular Plant	Threatened
Downy Arrow-wood	Viburnum rafinesqueanum	Vascular Plant	Endangered
Fogg's Goosefoot	Chenopodium foggii	Vascular Plant	Endangered
Houghton's Flatsedge	Cyperus houghtonii	Vascular Plant	Endangered
Large-bracted Tick-trefoil	Desmodium cuspidatum	Vascular Plant	Threatened
Lyre-leaved Rock-cress	Arabidopsis lyrata	Vascular Plant	Endangered
Michaux's Sandwort	Minuartia michauxii	Vascular Plant	Threatened
Nodding Chickweed	Cerastium nutans	Vascular Plant	Endangered
Pale Green Orchid	Platanthera flava var. herbiola	Vascular Plant	Threatened
Purple Clematis	Clematis occidentalis	Vascular Plant	Special Concern
Rand's Goldenrod	Solidago randii	Vascular Plant	Endangered
Small-flowered Buttercup	Ranunculus micranthus	Vascular Plant	Endangered
Smooth Rock-cress	Boechera laevigata	Vascular Plant	Special Concern