

Green Stormwater Infrastructure **Landscape Design Guidebook**

Version 4.0 April 2020

PHILADELPHIA WATER DEPARTMENT


THE CITY OF PHILADELPHIA . SEAL
PHILADELPHIA
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DEPARTMENT

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What's New?

Effective Date: April 2020 **July 2024** - Addendum Developed

Revisions History: Listed below are the major changes that occurred between the 2018 version of the GSI Landscape Design Guidebook and this most recent 2020 version.

GENERAL

- Substantial formatting changes throughout.
- Content revisions (word choice, narrative, and explanatory sentences) made throughout the document with the aim of clarifying intent and guidance.
- New images added.

CHAPTER 2

- Combined *Site Assessment* and *Landscape Design Guidelines* sections.
- Added guidance about edge treatment.
- *Figure 2.2.6: Micro-climate Over Time* diagram updated.
- Enhanced and expanded *Table 2.4.1: Local List of Plant Nurseries within the Region*.
- Expanded guidance and new diagrams in *Light Requirements* section.
- Enhanced sample plant palette table on seasonal interest - now sub-chapter *2.4 Summarizing Landscape Design*.

CHAPTER 3

- Revised plant list. Now includes cultivars commonly utilized by PWD.
- Reformatted plant tag format, including plant size, form, hydrology capacity, light preference, and seasonality.
- Redefined selection criteria and planting restrictions.
- Removed lists of plant categories by canopy shape and bloom period.

CHAPTER 4

- Relabeled *Case Studies* chapter to *Landscape Design Approaches*.
- Content updated on the first page of each SMP type.
- New case study locations added.

CHAPTER 5

- *Table 5.1.1: Plant Sizes and Spacing* has been revised.
- Revised titles for *Figure 5.1.1: Example Tree Pit Design with 36" Depth of Soil* and *5.1.2: Example Tree Pit Design with Greater than 36" Depth of Soil*.
- The *Existing Trees & Vegetation* section was retitled *Construction Tree Protection*. Content in this section has been revised.
- PWD Street Tree Standards have been created. Standard tree pit sizes added.
- Location information has been removed due to redundancy with *Figure 5.1.8: Street Tree Planting Diagram*. Now, users are encouraged to use this figure to derive all Streets Department offset requirements.
- *Figure 5.1.8: Street Tree Planting Diagram* has been modified to remove the Philadelphia Streets Department tree pit size preferences. PWD street systems should rely on PWD Street Tree Standards for pit sizes and spacing.

CHAPTER 6

- Revised references.



NEBINGER SCHOOL RAIN GARDEN

Introduction



chapter 1



PARKSIDE EDGE RAIN GARDENS



1.1 Introduction

The Philadelphia Water Department (PWD)'s *Green City, Clean Waters* program is recognized at an international scale for its ambitious goals and innovative strategies to treat and manage stormwater in Philadelphia. The program is redefining the way people think about their infrastructure and helping to improve the urban landscape of the City. A once highly impervious environment is being transformed through the implementation of green stormwater infrastructure (GSI). This technology takes advantage of urban fabric to incorporate vegetated, "green" landscapes to slow, filter, and manage rainfall to prevent polluted runoff from entering our sewers and waterways. GSI can be implemented into Philadelphia's streets, sidewalks, schools, parks, parking lots and more.

Vegetation is a key component of green stormwater infrastructure. Plants can improve the performance and lifespan of the stormwater management practice (SMP) by reducing stormwater runoff volumes and sediment load. In addition, vegetated SMPs can provide significant environmental, social, and economic benefits. Vegetation in urban environments can mitigate the urban heat island and reduce energy demands, improve air quality, provide habitat, improve human health, and increase land values.

A successful landscape must begin with an understanding of the site. Urban environments present numerous challenges for plant survival such as increased heat, extreme weather events, pollutants, and vandalism. Additionally, SMPs bring their own set of challenges including space constraints, engineered soils, and stormwater flow. Other site considerations include site uses, preferences of partners and community groups, and maintenance schedules. Each site will have unique challenges and require unique solutions to ensure that the project is beautiful and functional.

PWD has demonstrated various SMPs throughout the City of Philadelphia and has evaluated the success of a number of landscape designs. As part of an extensive maintenance program, PWD inspects plant survival and performance for every GSI project. PWD has also reviewed numerous research documents and municipal guides and applied this knowledge to the specific nature of green stormwater infrastructure in Philadelphia. Finally, PWD works closely with partners and community groups to listen to their preferences. The GSI Landscape Design Guidebook is a synthesis of knowledge to serve as a guide for government employees, design professionals, private developers, community groups, and others involved in the planning and design of GSI in Philadelphia. All private development projects should reference the *Stormwater Plan Review Guidance Manual*.

1.2 An Evolving Resource

This resource provides landscape guidance for the most common types of publicly-owned GSI in Philadelphia. PWD recognizes that technologies and designs may be added or enhanced over time as new projects are implemented. The enclosed guidelines are based on current knowledge, especially plant survival data and up-to-date nursery information, that may be adjusted per future findings.

1.3 How to Use this Resource

This resource provides guidance and requirements for design professionals to complete successful landscape designs for public GSI projects for the Philadelphia Water Department. Knowledgeable landscape designers and nursery suppliers may provide additional information regarding plant selection. Because individual plants often have unique growing requirements, which are difficult to convey in a generalized manner, it will be necessary to research specific information on the plant species, cultivars, and varieties that are proposed in order to ensure successful plant establishment.

This document is divided into six chapters:

1. **Introduction:** This section explains how to use this resource in conjunction with other resources during the design process.

2. **Site Assessment and Landscape Design Guidelines:** This section includes key criteria for developing a successful landscape plan for GSI projects in Philadelphia, from site assessment to design.

3. **Plant Selection:** This section outlines key factors that should be considered with selecting a plant palette for SMPs, followed by a list of all recommended plant species (in both textual and pictorial form) that may be used within the different SMP types. All green infrastructure projects should reference this list for species selection. Species outside of this list may be discussed on a per project basis.

4. **Landscape Design Approaches:** This section provides design recommendations per each GSI typology through example scenarios of project sites, the site's specific challenges, and landscape plans used to address these challenges.

5. **Landscape Design Requirements:** This section includes requirements that must be followed when producing landscape design plans for the Department.

6. **References:** Pertinent references are cited.



INGERSOLL COMMONS RAIN GARDEN



RESOURCES



SITE EVALUATION





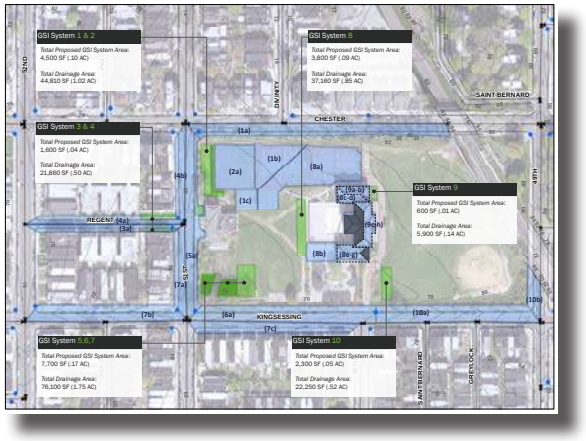
PLANT SELECTION











SMP EVALUATION



1.4 Design Strategies for SMP Design

When approaching the design of GSI in Philadelphia,PWD recommends following some general design strategies. This is to ensure that thoughtful projects are being designed for the space, which reflect and incorporate the site's surrounding context.

Resources

Prior to design, it is recommended that multiple resources are referenced, so that GSI and plant selection can be thoughtfully incorporated into a site. Refer to Chapter 6: References to view some recommended resources.

Site Evaluation

It is also important to evaluate the site where the GSI will be designed. Evaluate the site context, how people use the space, existing conditions such as vegetation and site typography, low points, etc. Involvement with the community and partners is crucial at this stage to get the necessary input that will result in a successful design. Refer to Chapter 2: Site Assessment and Landscape Guidelines for more detail on other considerations during the site evaluation stage.

SMP Evaluation

At the beginning stages of design, it is important for the type of SMP be evaluated. Since some systems may work better than others for the overall design of a site, it is important to evaluate all options and consider community and partner input, available space, existing conditions, footprint sizing, and overall design intent. Evaluating SMP opportunities and considering input from others at this stage will significantly help with the overall site design. Refer to Chapter 4: Case Studies for more information pertaining to SMP evaluation and selection.

Plant Selection

After the SMPs have been designed, use this manual to select the appropriate vegetation. Consulting with knowledgeable landscape designers and nursery suppliers is highly recommended. This manual serves as a guide and is not an all-inclusive manual.

Site Assessment and Landscape Design Guidelines



chapter 2

ROOSEVELT PLAYGROUND TREE TRENCH

2.1 Site Assessment

Site assessment is critical to designing and implementing successful green stormwater infrastructure projects (GSI). Whether part of a retrofit or a development project, stormwater management must fit into the larger goals for a given site. All projects should consider two scales relevant to the design of GSI landscapes: site context and site conditions.

Site Context

Look to the surrounding block and neighborhood to understand environmental and cultural context of the site.

Consider how the new SMP will fit in as part of the existing landscape. Identify existing vegetation and how the new landscape may compliment, both aesthetically and ecologically. Preserve healthy vegetation whenever possible. If construction requires the removal of vegetation, evaluate the benefit the vegetation is currently providing and seek opportunities to relocate or replace this vegetation on site to provide the same benefit. If unhealthy, hazardous, or invasive species are present on the site, even outside of the limits of disturbance, consider species removal in the scope of the project.

Understand the desires of partners and community members. Have a general understanding of the area history and cultural importance of the site. Consider current and desired views, along with safety concerns to determine sight lines that will need to be preserved (see Green Streets Design Manual (GSDM) for more detail on tree placement in the right-of-way, as well as the *"Species Diversity & Sight Lines"* section of this document). Take note of circulation systems (either formal or informal) and consider how they might intersect with the SMP. Note site uses and where and how human interactions are likely to occur with the SMP (i.e. dog walking, recreational activities, etc).

Figure 2.2.1 : Site Context - Park



Green Stormwater Infrastructure (GSI) project potential at a park location in West Philadelphia. Knowing the park's context within the associated urban watershed, political councilmanic district, and cultural neighborhood geography are important to the initiation of a GSI project.

Site Conditions

Planting strategies will need to respond to the specific conditions of the site where vegetation will be planted. Locate any structures that might impede or compete with plant growth. Choose mature heights and widths in a corresponding fashion.

Identify the various ecological niches that may exist within the SMP and how this will affect the plant selection. Complete a study of sun and shade distribution. Evaluate environmental factors such as soils, moisture/water issues and distribution on the property, stormwater flow paths, slopes, and expected pollutant load to the SMP including sediment and road salts. See also the *"Hydrology"* section of this document.

Site Assessment Checklist

SITE NAME: _____

ADDRESS: _____

DATE: _____

TIME: _____

SITE CONTEXT

- LANDSCAPE CHARACTER
  - ☐ formal garden
  - ☐ natural area
  - ☐ historic landscape
  - ☐ disturbed
- EXISTING VEGETATION
  - ☐ health of vegetation
  - ☐ species
    - native
    - non-native
    - invasive
  - ☐ benefits of vegetation
- SOCIAL FACTORS
  - ☐ site uses near SMP
  - ☐ user desires
  - ☐ local history and culture
- VIEWS/SIGHT LINES
  - ☐ on site
  - ☐ off site
  - ☐ safety concerns
- CIRCULATION
  - ☐ pedestrian
  - ☐ bicycle
  - ☐ automobiles
  - ☐ service vehicles

SITE CONDITIONS

- STRUCTURES
  - ☐ buildings
  - ☐ overhead wires
  - ☐ utility poles
  - ☐ existing vegetation
  - ☐ walls
- ECOLOGICAL NICHES
  - ☐ sun/shade distribution
  - ☐ wind patterns
  - ☐ stormwater flow paths
  - ☐ slopes
  - ☐ expected pollutant load
  - ☐ sediment
  - ☐ road salt
  - ☐ other
- TOPOGRAPHY
  - ☐ existing grade changes
  - ☐ steep slopes
  - ☐ low and high points



Existing Vegetation

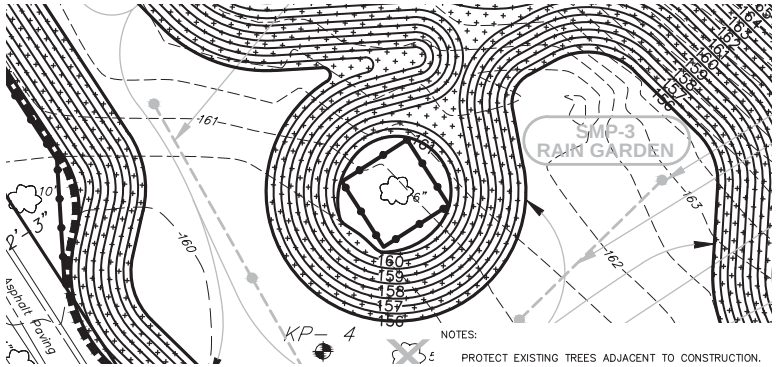
This yellowwood tree was preserved on site and was incorporated into the design of this rain garden.

Size and Spacing

It is important to use size and spacing guidelines in order to specify the appropriate amount of species needed. Some species that spread more readily may be able to use looser spacing while species that are slow to establish may need tighter spacing.

KEMBLE PARK RAIN GARDEN

Figure 2.2.2: Plant Spacing Example



Kemble Park - Example of the existing yellowwood tree being protected as part of the project. The SMP was designed with a sufficient offset to preserve the tree's root structure.

Table 2.2.1: Plant Spacing Table & Diagram

CONTAINER SIZE	SPACING (S)	PLANT ROW (R)	PLANTS/SF.
PLUG	6"	5.2"	4.6
	8"	6.9"	2.6
	9"	7.8"	2.0
	12"	10.4"	1.15
#1 , #2	15"	13.0"	0.75
	18"	15.6"	0.51
	24"	21.0"	0.29
#3 , #5 , #7	30"	26.0"	0.18
	36"	31.0"	0.13
	48"	41.5"	0.072

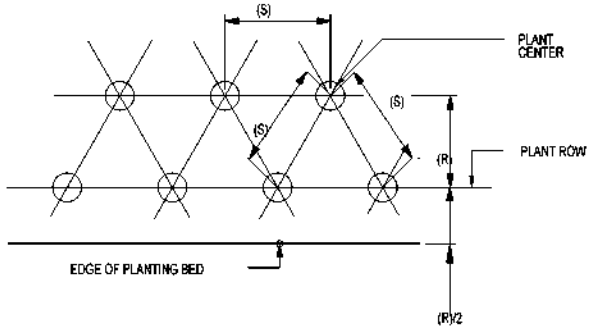


Diagram of spacing and table of multipliers used to calculate the amount of plants needed for a given area based on the square footage.

2.2 Landscape Design Guidelines

Site assessment should lead to the planting strategy for a site. Design is often an iterative process, beginning at the planning stage, adjusted during design development, and reevaluated during construction given field conditions. The landscape strategy will need to be revisited throughout the process.

Existing & Proposed Vegetation

Be conscious of offset spacing needed to protect existing vegetation and proposed spacing needed for optimum performance of new vegetation.

Existing Vegetation

Survey existing vegetation including canopy extents. Develop tree and vegetation protection plans with recommended spacing offsets. Refer to the *"Construction Tree Protection"* section of this document for specific guidance. Where removal is necessary, ensure the property owner is informed. Develop a plan for transplantation for healthy, desirable plants when possible. Create a plan for the removal of invasive or hazardous species both in and around the project area.

Plant Sizes and Spacing

Plant spacing is dependent on a number of variables. Plants will perform best if planted when relatively small and can adapt as they grow. It is also more economical to plant smaller sizes. However, the designer must also balance community expectations and the need for durable plant sizes. Plugs will require a tighter spacing than container plants and smaller container plants will require a tighter spacing than larger. (See *"Table 2.2.1: Plant Spacing Table & Diagram"* for spacing recommendations). Spacing recommendations can also vary per the mature size of each particular species. Plants with a larger mature size may required greater spacing than plants with a smaller mature size. Online plant spacing calculators may be helpful tools.

SEEDING

Seed mixes may be applicable on certain projects or on certain portions of a project. They may create a more naturalized look that can be mowed, rather than a formal aesthetic which requires higher maintenance. Therefore, seed mixes should be composed only of non-woody plant species. The green master specifications includes direction on stabilization seed mixes for erosion control. It is recommended that designers work closely with seed suppliers to determine appropriate mixes and density of seed per acre.

Massings & Habitat

Landscape design which relies on strategic clustering and structuring can maximize system benefits towards easier maintenance (increased longevity), higher aesthetics (community adoption), and enhanced habitat (healthier environment).

Plant in Massings

When planting formal areas of grasses, perennials, and shrubs, plant in massings or groups, with each group consisting of individuals of the same species. This will both create a strong visual impact and support maintenance efforts. When selecting species for seed mixes and/or plugs, consider visual impact of the planted zone. While exceptions may apply, PWD typically recommends clustering plants with similar heights together. Number of individuals in each grouping will vary depending on the project and overall design intent.

Appropriate Number of Species

The number of species will be determined by the desired design impact and range of environmental conditions within the SMP. While supporting these goals, the number of species should be limited by the reality of maintenance crews and budgets. SMPs with a large number of species may be more challenging to maintain. Refer to *"Chapter 4: Landscape Design Approaches"* for more specific depictions on how to select an appropriate number of species. For specific guidance on selecting diversity in trees, refer to the *"Tree Selection Criteria"* section in this document.

Enhancing Habitat

If possible, consider utilizing native plants and plants with wildlife value. Projects located within or nearby naturalized areas such as large parks provide opportunities to enhance habitat. Depending on the property owner, this may be an important priority. For example, Philadelphia Parks & Recreation may request that only native species be used in some large parks. Multi-tiered plant communities with upper, middle, and lower story vegetation can support a diversity of habitats. Selecting plants that have known value to wildlife can assist these efforts, such as edible fruits or seeds and a structure that provides cover and nesting habitat for birds and other animals. Note that some sites will allow for a greater density of vegetation than others. Habitat goals should be secondary to stormwater function and public safety including preserving lines of sight.



PHILADELPHIA ZOO RAIN GARDEN

Habitat



Massings

Creating massings help to form more aesthetic groupings that are more recognizable to people who may pass by the system. It will also make maintenance of the system easier.

Adjacent Uses

Having a shrub border on the parking lot edge creates a more durable edge where cars will be present. A flowering perennial edge along the sidewalk creates visual interest for people that may be walking by.

Zoo Parking

Woody, Durable Edge

Flowering Edge may be more susceptible to trampling with adjacent sidewalk.

Sidewalk

Define the Edge

GSI systems rely on clearly delineated edges to visually signal a change in terrain for users of the site, to deter pedestrian and vehicular entry into the system, and to demarcate the extents of PWD maintenance for the long-term stewardship of the project.

Edging Techniques

Consider how the SMP will be distinguished from the surrounding landscape such that it is easily identified by pedestrians and vehicles. A clearly marked edge treatment is preferred for consideration of long-term maintenance responsibilities between PWD and other stewardship partners. Some SMPs will have a defined edge made from physical barriers such as fences, boulders, or paving. Other SMPs will use a soft edge created by planting structural vegetation around the perimeter. This is important for areas that abut lawn, areas adjacent to considerable activity such as a schoolyard or active recreational area, and areas with steep changes in grade (for example, 3:1 slope or steeper with more than 3' of elevation change).

DESIGN FOR THE USERS

Be mindful of the various user groups at a site. Each site will have somewhat unique requirements. Community meetings can help gauge a preferred aesthetic or vegetation type in relation to defining the edge..

Figure 2.2.3: Defining the Edge



Temporary stake and rope fencing *defines the edge while GSI plantings are establishing*



Chain link fencing *behind a recreation court protects the rain garden from basketballs entering the system*



Boulders *protect the system from vehicles parking on the edge*



Ornamental fencing *prevents trampling of plants and pets from using the space*



Split rail fencing *deters users cutting through the system and protect against cyclists*



Cobble edging *defines the edge of the rain garden for PWD maintenance crews and PPR mowing crews*

Examples of various edge treatments where more robust protective measures were desired to ensure the longevity of the system.

Plant Border

This structural border of shrubs on the back side of the bumpout adjacent to the curb provides a natural edge treatment to provide structure and a sense of safety for pedestrians.





Diversity

Different species in the system create diversity and build resilience against potential pests and disease.

Sight Lines Maintained



COBBS CREEK & SPRINGFIELD RAIN GARDEN

Species Diversity & Sight Lines

Selecting a diverse palette of plant species in a single GSI system can rendering higher aesthetic interest and greater system resiliency against pests, disease, and plant death. Context sensitivities should still be abided by, like maintaining sight lines and public safety, while selecting a diverse range of species.

Consider Site Context When Selecting Species

There may be several environmental conditions within a site, created by variations in light availability, graded slope, hydrology, and stormwater flow. This will break the site up into niches; appropriate species must be selected for each niche

BE CONSCIOUS OF SPECIES GROWTH AND SPREADING HABITS

Plants with high growth rates can be an asset to an SMP, where the environment is challenging and it may be difficult to find plants that can readily establish and prevent erosion. At the same time, be wary of plants that have the potential to become aggressive at a given site. Understand how the plants spread (e.g. by rhizomes, re-seeding, or other methods) and evaluate the potential of the plants to spread to other areas where they may not be desirable. For example, an aggressive plant that spreads by rhizomes will have minimal potential of becoming invasive if it is in a traffic island contained by concrete and asphalt, but the same plant could become a nuisance if it is planted within a large park adjacent to a naturalized area.

AVOID COMBINATIONS OF PLANTS THAT WILL HARM ONE ANOTHER

Avoid planting a species that may host a fungus that attacks another selected species. For example, cedar-apple rust can harm hawthorns and crabapples when planted next to junipers or cedars.

DO NOT SELECT PLANT SPECIES FOR HUMAN CONSUMPTION

The stormwater runoff that is being captured by these SMPs frequently contain harmful pollutants. Due to this and the potential uptake by the vegetation, species that are typically consumed by humans are not recommended in the design.

Sight Lines

It may be necessary to keep vegetation low and trees limbed up in areas, keeping the area visible through the SMP and maintaining sight lines. A general guideline for a clear zone is between 4' and 7'. This is especially critical at street intersections, where dense vegetation should be no greater than 4' above top of curb. Sight lines may also be important in areas where perception of crime is high or child supervision is a priority.

Visual Interest

Visual interest can be a difficult concept to interpret, but is crucial to the public acceptance and stakeholder adoption of a GSI system. Ushering different textures, providing year-round intrigue, and creating plant hierarchy are good ways to heighten the visual appeal of a system.

Hierarchy

Consider the mature height and width of species as well as the relationship of container sizes specified. Creating levels of vegetation between trees, shrubs, herbaceous, and grasses/groundcovers can help create visual interest. Consider this specifically for the edges of systems depending on their adjacent uses as well as their location if the system has side slopes.

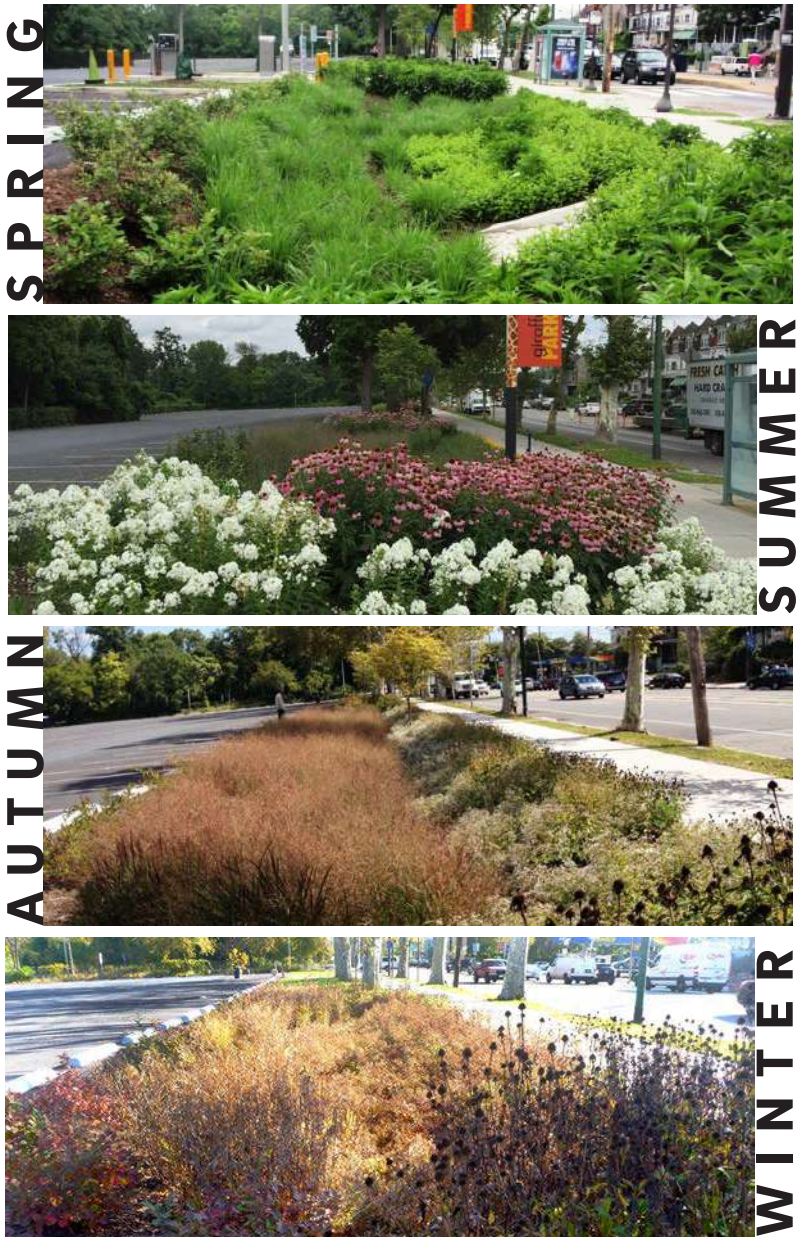
Seasonality

Consider using some woody plants (e.g. shrubs and trees) or grass-like species that will provide structure year-round. Using structural plants in a system prevents that system from becoming ephemeral throughout the seasons. Some characteristics to keep in mind are evergreen needles, fall foliage, seasonal fruits and flowers, bark color, and texture. Use flowering perennials as accents that will bloom throughout the growing season and have interesting winter structure. Keep in mind the time of year when the site will be most active to determine which season to emphasize the most.

Textures

Consider the combination of textures used in the plant palette. Choose plants with different shaped leaves, stems, flowers, and fruits that will create various textures whether they be fine, soft, or rough. Keeping these characteristics in mind when placing plants can help to create an aesthetically pleasing combination of massings.

Figure 2.2.4: Seasonal Interest of SMP



Philadelphia Zoo - Plantings selected provide interest during all seasons along a busy corridor.



Hierarchy

Creating levels of vegetation can promote visual interest and help create canopy levels within the system as the landscape matures

Textures

Choosing plants with different textures may provide visual interest through contrast.

STENTON & WASHINGTON BUMPOUT

Micro-climate

Existing vegetation and structures that are adjacent to the site will create site specific climate conditions that are ideal for some plants and not for others. It is important to also consider how the functioning system will change the climate of the site once online and receiving stormwater, and to select plants accordingly.



A Changing Landscape

Over time, plants may spread, become more dense, or grow taller. It is important to plan for these changes.

WOMRATH PARK RAIN GARDEN

Micro-Climate and Succession

Consider how the landscape will change over time. Design with the mature heights and widths of the species in mind, giving ample room for the plants to grow. Over time, views, sun/shade patterns, and other conditions may change. The landscape should be resilient and there should be an understanding of how succession will work on the site.

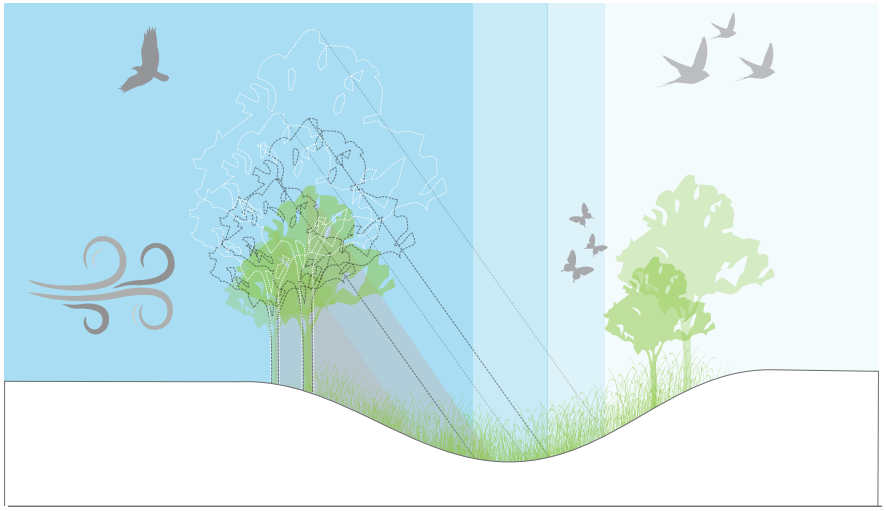
Varied Site Conditions

Consider the climate at the site level. One plant or massing within a system may have an effect on the adjacent plant or massing and can create a localized micro-climate. Also, adjacent structures, existing vegetation, or site features can create varied climate throughout the day or even across seasons.

An Evolving Landscape

Over time, some of these conditions may change, creating diversity and varied types of habitats. The amount of shade, soil moisture, etc is affected by the placement of vegetation and the design of the system in association with the site. It is important to take these aspects into account when selecting plants and their placement.

Figure 2.2.5: Micro-climate Diagram



This image represents how to anticipate how light levels and wind exposure will change over the lifetime of the GSI system. Wildlife can play a role in developing site level climate conditions as well.

Figure 2.2.6: Micro-climate Over Time



Example: The diagram shows how micro-climates in an area can change over time. The plants and design of a system may have an impact on the local environment, vegetation, habitat, etc. The opposite effect may also be true.

Maintenance

Planning for maintenance helps to create designs that are more resilient and cost-effective over time. Understanding PWD's maintenance tasks and schedules for the various SMP types is critical - refer to the GSI Maintenance Manual for more detail. This resource can be found in *"Chapter 6: References"* of this document.

Reduce Maintenance Needs

Typical maintenance includes removing competitive species that can hinder the growth of target plant species; and removing sediment, trash, and debris from storage areas, piping, inlets, and other structures. Maintenance tasks may also include a range of other activities including repairing erosion and soil issues, mulching, cutting back vegetation, pruning trees, removing graffiti, watering, and replanting or reseeding areas.

MINIMIZE WATERING

Choose vegetation according to the hydrology of the system to minimize needs for supplemental watering after establishment.

MINIMIZE REPAIRS

Choose robust vegetation for upstream areas where flow will be most heavily concentrated to eliminate need for erosion repair.

MINIMIZE WEEDING

As much as possible, design a landscape that will require minimal weeding. Evaluate if the project would benefit from installing plugs or containers, and select the appropriate spacing at these predictable points depending on the needs of the system (e.g. sheet flow on steep slopes, balding at entry points, deterring nearby invasive species, partner expectations for quick establishment, or slow spreading rate of selected species).

Maintenance Access

Know how and where maintenance will access clean-outs, inlets, or other features. Recognizing the need for access, be sure that selected species for these areas will not impede access. Grass-like species are recommended as they are both durable and can readily grow back. Consider access for the following equipment: vactor trucks, watering hoses, wheelbarrows, and personnel. Consider that maintenance and public pathways may also be included in the design.

Figure 2.2.7: Surface Maintenance of SMP



Kemble Park - Surface maintenance team at work.

Figure 2.2.8: Subsurface Maintenance of SMP



Shissler Recreation Center - Crews performing routine subsurface maintenance on a rain garden.



Maintenance Access

Plan for how maintenance vehicles will access the site such as this vactor truck, which is typically used to flush subsurface components.

Sunlight

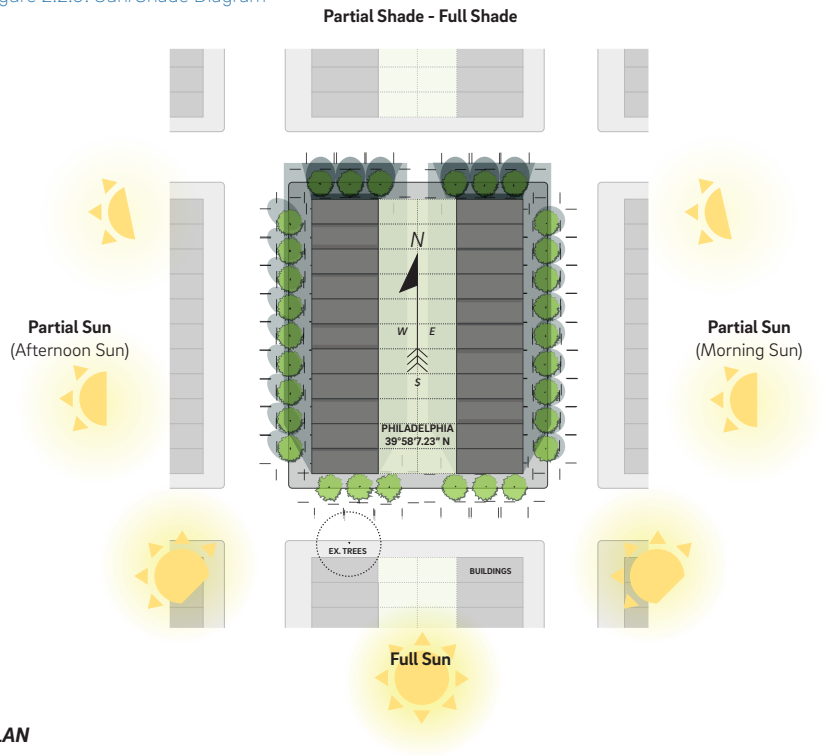
A plant's light preference is listed as full sun, partial shade, or full shade. In an urban environment, full sun conditions are common. However, street trees, buildings, and other structures may provide shade during portions of the day.

Light Requirements

A sun/shade study should be completed for each site. Selecting plants that are intolerant of the existing light conditions will lead to unnecessary replacement costs, or poor and potentially unsightly plant performance.

FULL SUN	*PARTIAL SHADE*	*SHADE*
6+ hours of sunlight/day	**4-6 hours** of sunlight/day	**< 4 hours** of sunlight/day

Figure 2.2.9: Sun/Shade Diagram



PLAN

Shadows from adjacent blocks can alter sun/shade levels on targeted block.

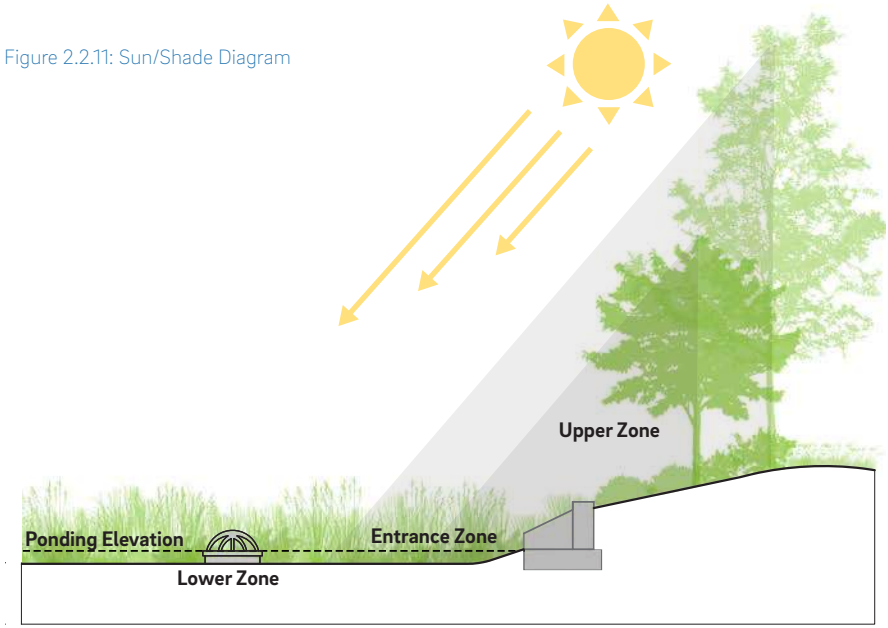
Figure 2.2.10: Example of Daily Sun Exposure



AM FULL SUN ***PM PARTIAL SHADE***

Example of changing light patterns throughout the day.

Figure 2.2.11: Sun/Shade Diagram



SECTION

Diagram showing the impact adjacent structures can have on a system.

Sun / Shade

Portions of this system experience varying degrees of sunlight throughout the day. Species were selected according to these changing conditions.



Hydrology

Arguably the most nuanced component of GSI landscape design, hydrology plays a key role in system function. It is critical for designers to understand how stormwater will enter, pond, and dissipate in a system. Also paramount is to understanding how much stormwater is entering the system and to anticipate what type of sediment or pollutant load are likely to be carried in with the stormwater.

Hydrologic Zone Elevation

Plants have differing tolerances to moisture levels, with some plants capable of withstanding long periods of inundation and other plants responding poorly to long-term inundation. Each design should consider the upper zone, lower zone, and entrance zone within the SMP as shown in the image on the following page and in *"Figure 2.2.12: Hydrology Zone Diagram"*. The boundaries for these hydrologic zones will depend on the designed maximum depth, ponding level, level of overflow structure, frequency of inundation, and infiltration rate. Also consider the loading ratio of the drainage area to the size of the surface of the system when selecting plant species. High loading ratios may necessitate species that are hardier and can withstand higher pollutant levels.

ENTRANCE ZONE

The point where stormwater will be entering the system can be a difficult area for selecting plants. This zone is typically where there will be the highest velocity and volume of water entering as well as the highest concentration of sediment and pollutant loads. Therefore, selecting durable species that have strong structures and root systems is critical. This area is typically where the most maintenance occurs, so it is important to select plants that are resilient to maintenance activity.

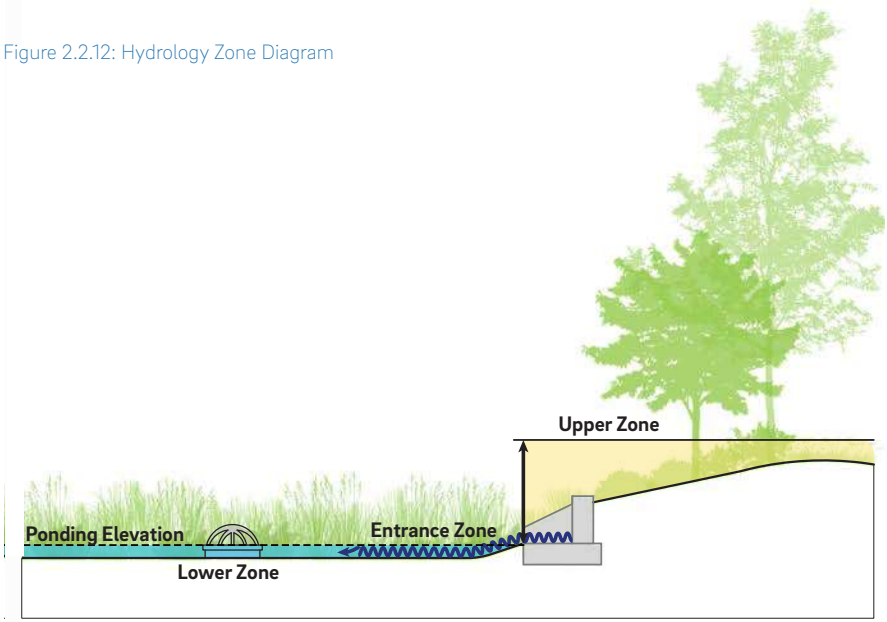
Salinity Tolerance

The use of de-icing salts in winter to maintain safe roadways and walkways is a common practice in Philadelphia. In particular, schools and snow emergency routes experience a higher application. These salts may have an adverse impact on plant material and GSI located in the right-of-way and/or receiving stormwater runoff from the right-of-way. A variety of sources were used to assess salinity tolerance, but research is still limited at this time. Plants with a high tolerance may be most appropriate to use in right-of-way.

Soil

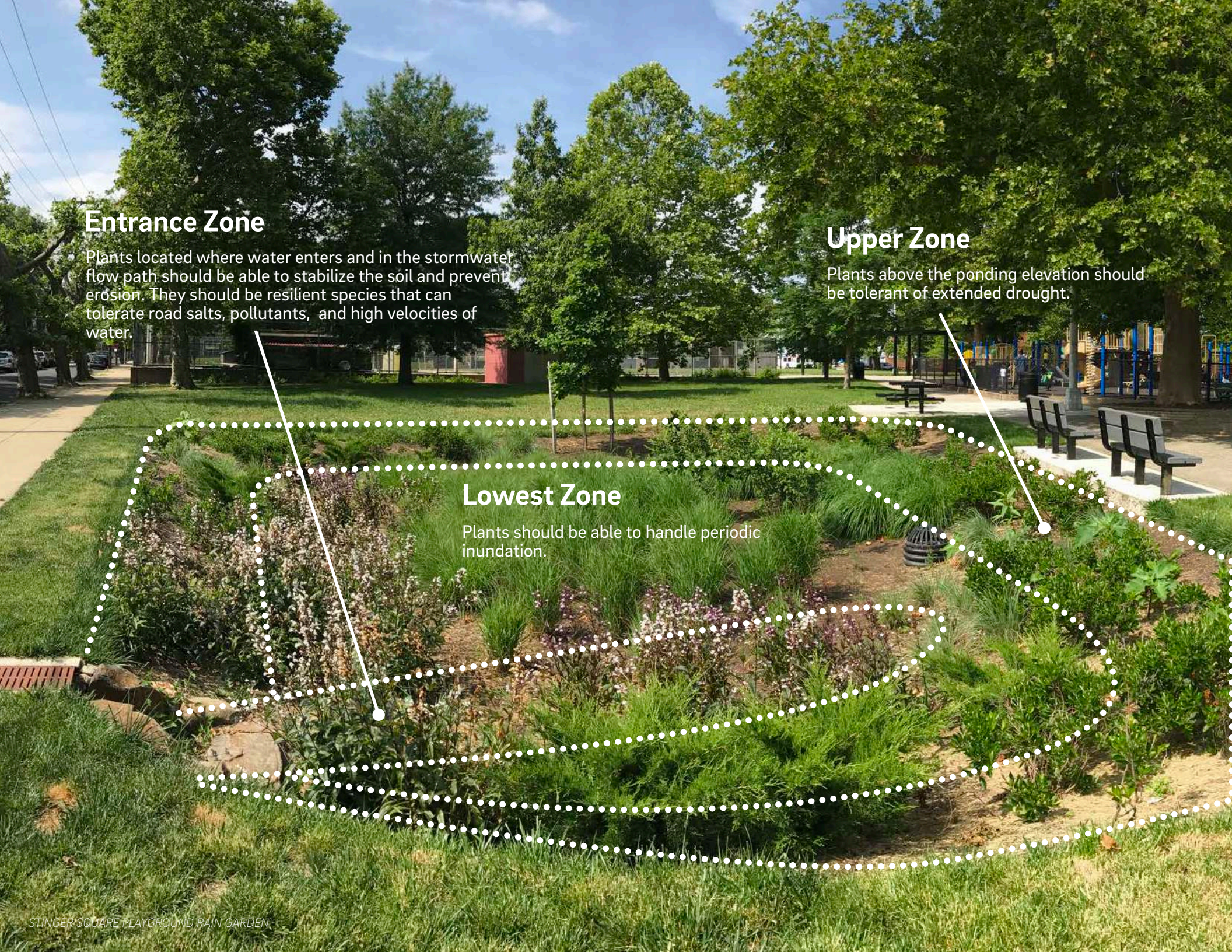
Most sites need engineered stormwater soil. PWD's specification for planting soil should be used for tree pit instillations. PWD's stormwater soil should be selected for all other systems where stormwater passes through the soil profile. Refer to the soil specification when selecting plants.

Figure 2.2.12: Hydrology Zone Diagram



SECTION

Diagram showing the different hydrology zones in profile.



STINGER SQUARE PLAYGROUND RAIN GARDEN

2.3 Summarizing Landscape Design

HEIGHT

Plant heights (both at planting and at maturity) should be appropriate to the SMP. Where sight lines are to be preserved, especially relevant for GSI within the right-of-way, be sure there is a clear zone between 4' and 7'. Overhead utilities and soil volumes are also important considerations, especially when determining tree species.

PLANT WIDTH

Plant width, growth rate, and spreading habit will determine the number of plants required in a given system. For trees, shrubs, and herbaceous plants that do not spread heavily, use the species' mature width as the standard for developing the planting plan. Refer to the *"Maintenance"* section in this document.

BLOOM TIME

Bloom time is a best estimate based on site observations and suggestions from local nurseries and gardens. Each site will have unique seasonal considerations depending on when it is most active. For projects that will be visible throughout the season, select both early and late blooming species.

COLOR

Color helps to create focal points throughout the SMP. Plants may have more than one possible bloom color, especially when considering various species or cultivars. Foliage can also bring unique colors to the diversity of the plant palette.

WINTER INTEREST

Sites that are active in the wintertime (e.g. streets, schools) should include plants that are evergreen, have berries, or colorful stems and stalks. This is not only an aesthetic consideration but also helps to alert people of changes in grade. Plants with woody structure (e.g. trees and shrubs) will continue to be visible in winter even with snowy conditions. Refer to the *"Define the Edge"* and *"Visual Interest"* sections of this document.

FALL INTEREST

Trees or shrubs with colorful leaves and flowering herbaceous or grasses with late season interest, displaying noteworthy colors, textures, or forms, are desired for sites that are active during the fall season.

Figure 2.3.1 : Nursery Stock Standards (Source: American Standard for Nursery Stock)

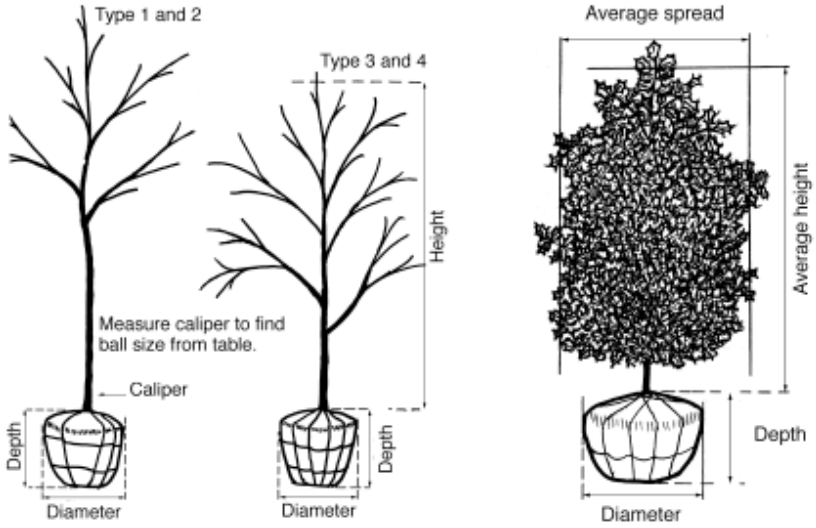


Diagram of how to measure height, spread, and caliper size of tree specimens.

Figure 2.3.2: Shrub with Seasonal Interest



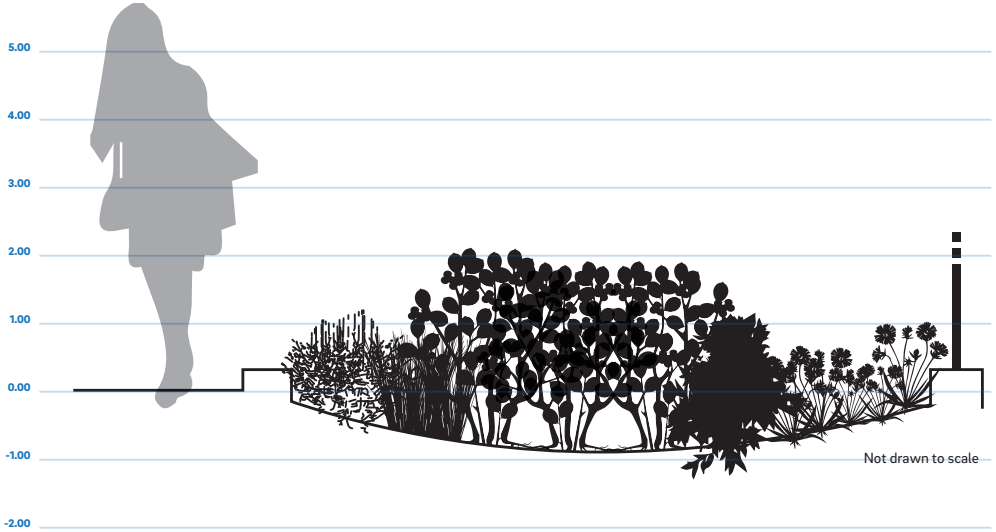
Photos showing the red twig dogwood (Cornus sericea) throughout the four seasons.

Composing A Palette for Year-Round Interest

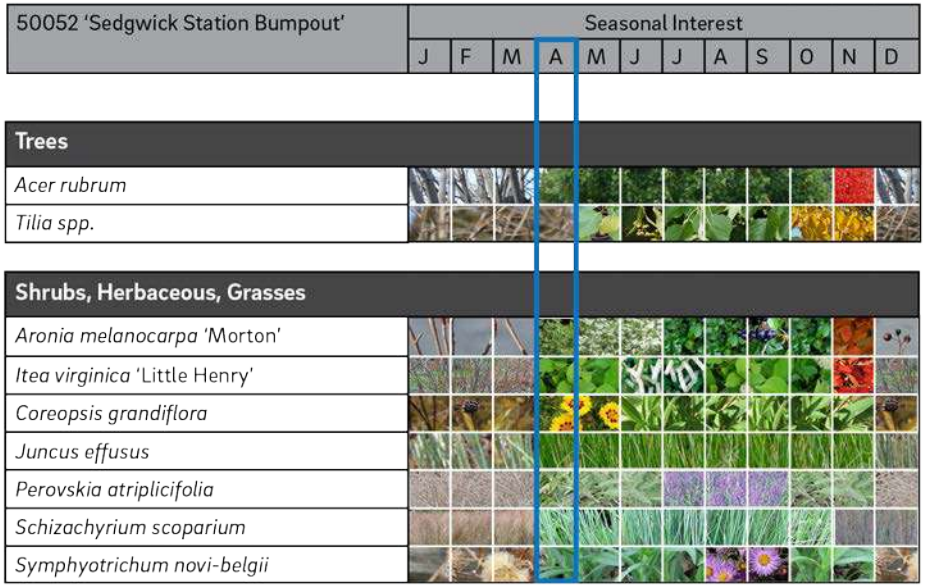


APRIL

Sedgwick Station bumpout with its first year's growth demonstrates spring-time seasonal interest and overall aesthetic composition through considerate plant selection.



Cross-section of plant palette at Sedgwick Station Bumpout depicts the varying heights, textures, and plant widths found in the system. First year's growth is depicted here and in the image to the left.



Seasonal Color Chart of 50052 shows what colors and bloom times are expected in each season. The April colors are depicted in the image to the left.

Plant Selection



chapter 3

KEMBLE PARK RAIN GARDEN

3.1 General Plant Selection Criteria

The following criteria should be used to select plants for GSI projects:

Regional Climate

The 2012 USDA Plant Hardiness Zone Maps are the standard by which gardeners and growers can determine which plants are most likely to thrive at a location. The maps shown are based on the average annual minimum winter temperature, divided into 10-degree F zones. Philadelphia is located within Hardiness Zone 6B.

Site specific conditions may vary, especially due to urban conditions. As the program evolves over the coming years, these zones may change and more southern adapted species may be more suitable for the local area.

NATIVES

When selecting plants, consider the use of native species that would naturally grow in the local region. Native plants may not be appropriate for every situation in the urban environment given the site specific location or design strategy, though should be used where effective. The use of natives creates desirable conditions for local wildlife. Contacting a local nurseries can help in challenging situations by offering more specific knowledge of local plant species.

LOCALLY SOURCED

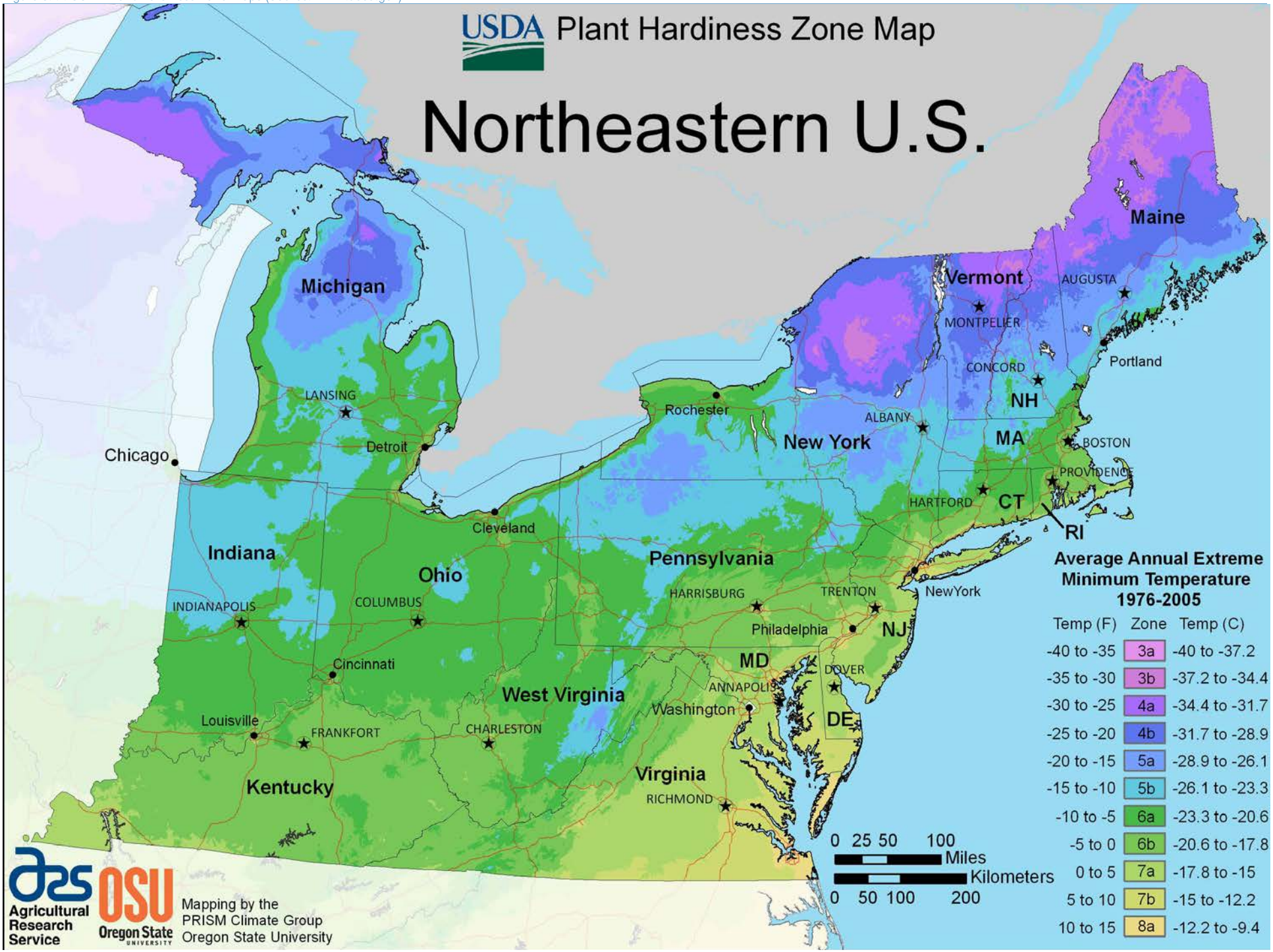
Plants that are grown locally may be better able to adapt to the local conditions. Refer to *"Table 3.1.1: Local list of Plant Nurseries within the Region"* for a list of local plant nurseries with in the Philadelphia region.



Table 3.1.1: Local list of Plant Nurseries within the Region

NAME	*ADDRESS*	Contact Information (Website / Phone Number)	Type of Plant Material	Type of Plant Container
Archewild	2191 Hillcrest Rd, Quakertown, PA 18951	www.archewild.com (855) 752-6862	All Plants	B&B, Containers, Plugs
Barton Nurseries	949 New Durham Road, Edison, NJ 08817	www.bartonnurseries.com (732) 287-5222	Trees & Shrubs	B&B
Clear Ridge Nursery	217 Clear Ridge Road, Union Bridge, MD 21791	www.clearridgenursery.com (410) 775-7700	Trees & Shrubs	Containers
Clearview Nursery	1910 Clearview Road, Souderton, PA 18964	www.clearviewplants.com (215) 723-6444	Shrubs, Herbaceous, Grasses	Containers, Plugs
Coles Nursery	3061 Street Road, Lahaska, PA 18931	www.colesnurseries.com (215) 794-8863	Trees & Shrubs	B&B
County Line	811 Harleysville Pike, Franconia, PA 19438	www.countylinenursery.net (215) 723-8955	All Plants	B&B, Containers
Feeney's Nursery	1381 Durham Road, Buckingham, PA 18912	www.feeneyswholesale.com (215) 598-1100	All Plants	B&B, Containers
Fernbrook Nursery	150 Georgetown, Rd, Bordentown, NJ 08505	www.fernbrooknursery.com (609) 298-4391	Trees & Shrubs	B&B, Containers
Harmony Hill Nursery	45 Buck Road, Downingtown, PA 19335	www.hhnurseryllc.com (610) 873-2495	Trees & Shrubs	B&B, Containers
Holly Days Nursery	1201 Horosham Road, Ambler, PA 19002	hollydaysnursery.com (215) 283-3228	Trees & Shrubs	B&B, Containers
Hopewell Nursery	309 Woodruff Road, Bridgeton, NJ 08302	www.hopewellnursery.com (856) 451-5552	All Plants	B&B, Containers
J.C. Hill Tree Farms, Inc.	123 W Rauschs Rd, Orwigsburg, PA 17961	www.jchilltreefarms.com (570) 943-2019	Trees	B&B
Johnson Farms	1633 RT. 77, Deerfield, NJ 08313	www.johnsonfarmsinc.com (856) 358-1123	All Plants	B&B, Containers
Kurt Bluemel, Inc.	2740 Greene Lane, Baldwin, MD 21013	www.kurtbluemel.com (800) 498-1560	Herbaceous, Grasses	Containers, Plugs
Moon Nurseries	145 Mood Road, Chesapeake City, MD 21915	www.moonnurseries.com (410) 755-6600	All Plants	B&B, Containers
New Moon Nursery	975 Barretts Run Road, Bridgeton,NJ 08302	www.newmoonnursery.com (888) 998-1951	Herbaceous, Grasses	Plugs
North Creek Nurseries	388 North Creek Road, Landenberg, PA 19350	www.northcreeknurseries.com (610) 255-0100	Herbaceous, Grasses	Plugs
Octoraro Native Plant Nursery	6126 Street Road, Kirkwood, PA 17536	www.octoraro.com (717) 529-3160	Trees & Shrubs	Containers, Plugs
Pleasant Run Nursery	93 Ellisdale Road, Allentown, NJ 08501	pleasantrunnursery.com (609) 259-8585	All Plants	Containers
Tuckahoe Nurseries, Inc.	2 Tarkiln Road, Belleplain, NJ 08270	tuckahoenurseries.com (609) 861-0533	Trees & Shrubs	B&B, Containers
Tree Authority	602 Minsi Trail, Perkasie, PA 18944	www.treeauthority.net/home.html (215) 694-9607	Trees	Containers

Figure 3.1.1: USDA Plant Hardiness Zone Maps (Source: www.usda.gov)



SEE 2024 ADDENDUM FOR UPDATE

Tree Selection Criteria

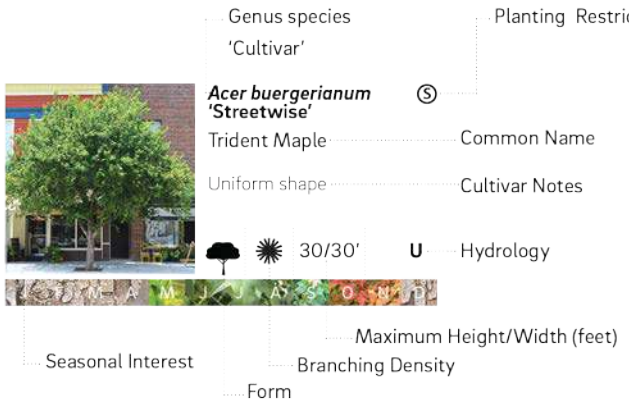
Tree selection criteria is primarily based on site conditions and issues most relevant to SMPs. A tree's maximum height and width should be used to determine its appropriateness in a given space.

To increase resiliency against tree pests and diseases, PWD strives to select a diversity of tree species within a project area. However, to achieve visual continuity, block-by-block the designer may plant in groups of 2-4 trees by species or alternate species of similar growth habits such as size, shape, and branching density. Cornell University has an online guide on how to group species for visual similarity.[1] Consideration of textures and colors of foliage and blooms by month may also improve aesthetics at a site.

Planting restrictions for specific species should be followed as described herein. When listed on a design plan, fall dig hazard trees must include substitutes should project planting occur in the fall. Landscape-only trees may be used for rain gardens and other off-street projects, but not in the right-of-way where sight lines must be preserved. *Acer* and *Prunus* trees should be planted sparingly, since they have historically been over planted both within PWD systems and throughout the City. Consideration should also be given to system type and where the tree is being planted within the system (e.g. within the entrance, lower, or upper zones or as a street tree in a tree trench).

Below is an annotated example of tree imagery that can be found on the following pages for each of PWD's recommended trees.

EXAMPLE OF TREE IMAGERY:



SELECTION CRITERIA

1	Classification	Uses
Canopy	Maximum Height > 30 Feet	Where Space Is Available For Growth, Landscapes
Understory	Maximum Height < 30 Feet	Where Growth Is Limited (E.g. Under Wires), Landscapes
2	**Form**	**Uses**
	Spreading: Width >/= Height	Wider Sidewalks, Landscapes
	Upright: Width < Height	Narrow Sidewalks, Landscapes
	Columnar: Width Much < Height	Narrowest Spaces
3	**Branching Density**	**Uses**
	Dense: Greater Than 50% Opaque	Select Similar Density For Visual Similarity On Streets
	Open: Less Than 50% Opaque	
4	**Size**	**Uses**
N/N'	Maximum Height/Width (Feet)	Height/Width Selected Should Consider Topography In Order To Preserve Sight Lines
5	**Hydrology**	**Uses**
U	Upper	Tree Pits, Upper Slopes Of Rain Gardens
L	Lower	Bumpouts, Planters, Swales, Bottom Of Rain Gardens
6	**Seasonal Interest**	**Uses**
	See Seasonal Pictures.	Select Color/Textures Of Foliage And Blooms To Increase Interest

PLANTING RESTRICTIONS

1		
Ⓕ	Fall dig hazard	Requires a substitute if planted in fall
2		
Ⓛ	Landscape only	Do not use in the right-of-way
3		
Ⓢ	Use sparingly	Limit planting of this overused species
4		
	Prefers partial shade	Avoid planting in direct sun
	Prefers full sun	Avoid planting in shade

[1] *"Visual Similarity and Biological Diversity: Street Tree Selection and Design" by Nina Bassuk, Peter Trowbridge, and Carol Grohs. <http://www.hort.cornell.edu/uhi/outreach/pdfs/visually_compatible_trees.pdf>*

Shrub, Grass, & Flowering Herbaceous Selection Criteria

Plant selection criteria for shrubs, grasses, and flowering herbaceous species is based on site conditions and issues most relevant to SMPs. Sunlight requirements, maximum plant size, and hydrologic requirements are necessary for determining a species' appropriateness in a given space. Additional criteria may be relevant depending on the site.

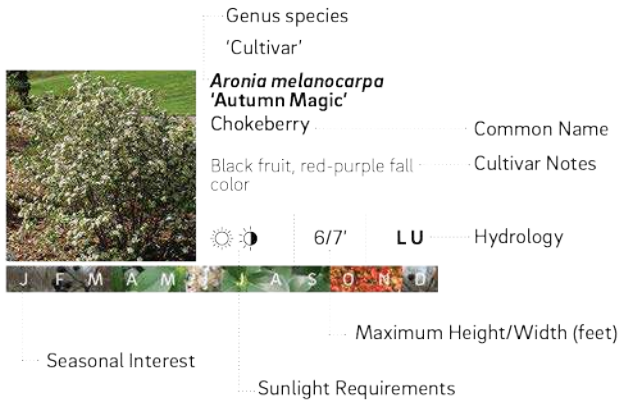
In general, you can use shrubs in addition to trees to create year-round structure, especially along edges to delineate maintenance borders or step-downs from sidewalks. Grasses and flowering herbaceous species are typically used to provide robust coverage and stabilization within a system. Depending on the site, other secondary design parameters may be considered, such as seasonal interest through colors, textures, and heights or wildlife habitat.

Below is an annotated example of plant imagery that can be found on the following pages for each of PWD's recommended shrubs, grasses, and flowering herbaceous species.

SELECTION CRITERIA

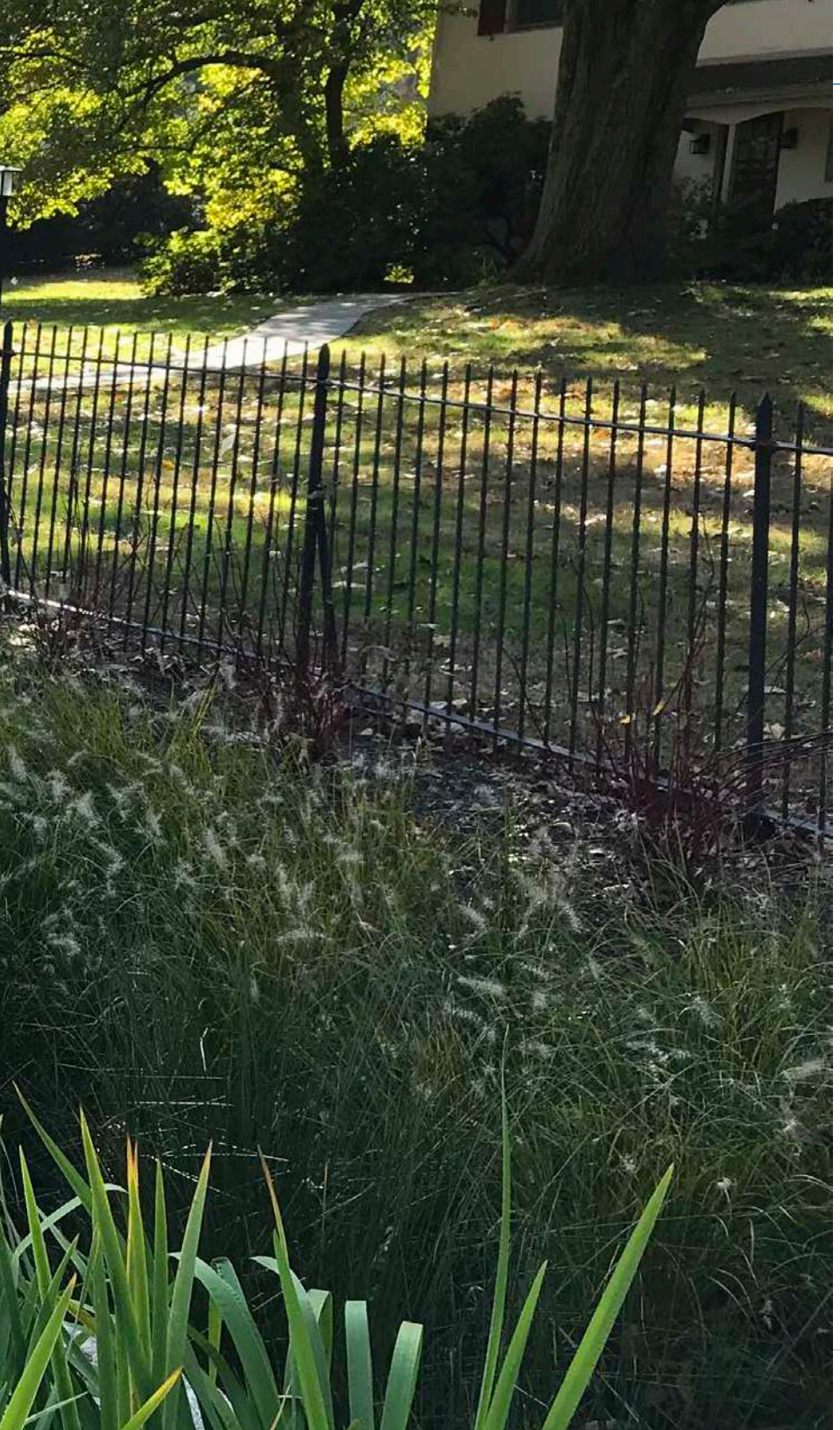
1	Sunlight	Uses
☼	Full Sun	6 or more hours of direct sunlight per day
◑	Partial Shade	3-6 hours of direct sunlight per day
●	Full Shade	Less than 3 hours of direct sunlight per day
2	Size	Uses
N/N'	Maximum Height/Width (feet)	Height/width selected should consider topography in order to preserve sight lines
3	Hydrology	Uses
U	Upper Zone	Tree pits, upper slopes of rain gardens
L	Lower Zone	Bumpouts, planters, swales, bottom of rain gardens
E	Entrance Zone	Curb cuts and velocity dissipaters
4	Seasonal Interest	Uses
	See seasonal pictures.	Select color/textures of foliage and blooms to increase interest

EXAMPLE OF PLANT IMAGERY:





SUNSET & NORWOOD RAIN GARDEN



3.2 Plant Lists

The following plant list is recommended by the Philadelphia Water Department for GSI systems. While this is not an all-inclusive list, landscape plans should select predominantly from this list unless directed otherwise.

SEE 2024 ADDENDUM FOR UPDATE

Canopy Trees



Acer rubrum
Red Maple
Ⓢ
70/50′ LU



***Acer x freemanii* 'Celzam' CELEBRATION**
Celebration® Maple
Uniform habit, tolerant of urban conditions
Ⓢ
50/35′ LU



Betula lenta
Sweet Birch
ⒻⓁ
55/45′ LU



***Carpinus betulus* 'Fastigata'**
European Hornbeam
Narrow
40/30′ U



***Acer rubrum* 'Karpick'**
Red Maple
Columnar, yellow-orange in fall
Ⓢ
50/20′ LU



***Acer x freemanii* 'Marmo'**
Marmo Freeman Maple
Uniform habit with strong central leader, fruitless
Ⓢ
70/40′ LU



Betula nigra
River Birch
ⒻⓁ
70/60′ LU



***Carpinus betulus* 'Frans Fontaine'**
European Hornbeam
Narrow
40/20′ U



Acer saccharinum
Silver Maple
ⓈⓁ
80/70′ LU



Aesculus flava
Yellow Buckeye
Ⓛ
70/50′ L



***Betula nigra* 'BNMTF' DURAHEAT**
River Birch
Tolerant of urban pollution, heat and aphid resistant
ⒻⓁ
40/35′ LU



Carya glabra
Pignut Hickory
Ⓛ
80/40′ LU



Acer saccharum
Sugar Maple
ⓁⓈ
80/60′ LU



Aesculus hippocastanum
Horse Chestnut
75/65′ L



***Betula nigra* 'Cully' HERITAGE**
River Birch
Heat tolerant, large glossy dark green leaves
ⒻⓁ
70/60′ LU



Carya ovata
Shagbark Hickory
Ⓛ
90/70′ LU



***Acer saccharum* 'Green Mountain'**
Sugar Maple
More tolerant of heat, dry conditions, and high pH
ⓁⓈ
60/45′ LU



***Aesculus x carnea* 'Briotii'**
Red Horsechestnut
Larger, dark red flowers
Ⓛ
35/35′ L



Carpinus betulus
European Hornbeam
60/60′ U



***Celtis laevigata* 'All Seasons'**
Sugarberry
Adaptable, uniform growth, minimal litter
60/55′ U

SEE 2024 ADDENDUM FOR UPDATE

Canopy Trees



***Celtis occidentalis* 'Prairie Pride'** Ⓛ
Hackberry

Less fruit

55/50′ U



***Cryptomeria japonica* 'Yoshino'** ☼ Ⓛ
Japanese Cedar

Symmetrical, fast growth, good winter color

40/30′ U



***Gleditsia triacanthos inermis* 'Shademaster'**
Honeylocust

Fruitless, deeper shade

70/70′ LU



Juniperus virginiana Ⓕ Ⓛ
Eastern Red Cedar ☼

65/25′ U



Cercidiphyllum japonicum
Katsura

60/50′ LU



Eucommia ulmoides
Hardy Rubber Tree

60/50′ U



***Gleditsia triacanthos inermis* 'Skyline'**
Honeylocust

Fruitless, pyramidal, strong central leader

45/35′ LU



***Juniperus virginiana* 'Princeton Sentry'** Ⓕ Ⓛ
Eastern Red Cedar ☼

Narrow

30/10′ U



Chamaecyparis thyoides Ⓛ
Atlantic White Cedar

50/40′ LU



***Ginkgo biloba* 'Autumn Gold'** ☼
Ginkgo

Conical, good fall color

50/30′ U



***Gymnocladus dioicus* 'Espresso'** ☼
Kentucky Coffeetree

Fruitless, vase-shaped

75/50′ U



Koelreuteria paniculata ☼
Golden Rain Tree

40/40′ LU



Cladrastis kentukea
Yellowwood

50/55′ U



***Ginkgo biloba* 'Magyar'** ☼
Ginkgo

Narrow, upright

60/30′ U



Halesia carolina
Carolina Silverbell

40/35′ U



***Liquidambar styraciflua* 'Rotundiloba'** ☼ Ⓕ
Sweetgum

Seedless, pyramidal

70/30′ LU



Corylus colurna
Turkish Filbert

80/50′ U



***Ginkgo biloba* 'Princeton Sentry'** ☼
Ginkgo

Nearly columnar

50/30′ U



Juniperus chinensis Ⓛ
Chinese Juniper

50/20′ U



Liriodendron tulipifera Ⓛ Ⓕ
Tulip Tree ☼

90/50′ U

SEE 2024 ADDENDUM FOR UPDATE

Canopy Trees



***Liriodendron tulipifera* 'Fastigiatum'** Ⓛ Ⓕ
Tulip Tree

Columnar

50/20′ **U**



Parrotia persica
Persian Parrotia

40/30′ **U**



Quercus bicolor Ⓕ
Swamp White Oak

60/60′ **LU**



Quercus phellos Ⓕ
Willow Oak

70/50′ **LU**



Metasequoia glyptostroboides Ⓛ
Dawn Redwood

100/25′ **LU**



Platanus occidentalis Ⓛ
American Sycamore

100/100′ **LU**



Quercus imbricaria Ⓕ
Shingle Oak

60/60′ **U**



Quercus robur Ⓕ
English Oak

70/70′ **U**



Nyssa sylvatica Ⓛ Ⓕ
Blackgum

50/30′ **LU**



***Platanus x acerifolia* 'Bloodgood'**
London Planetree

Some anthracnose resistance

85/70′ **LU**



Quercus lyrata Ⓕ
Overcup Oak

60/60′ **LU**



***Quercus robur* 'Fastigiata'** Ⓕ
English Oak

Narrow

60/20′ **U**



***Nyssa sylvatica* 'Tupelo Tower'** Ⓛ Ⓕ
Blackgum

Narrow

40/15′ **LU**



***Platanus x acerifolia* 'Exclamation'**
London Planetree

Upright, anthracnose resistant

60/30′ **LU**



Quercus macrocarpa
Bur Oak

Ⓛ Ⓕ

80/80′ **U**



***Quercus alba x robur* 'Crimschmidt'** Ⓕ
English Oak

Narrow

40/20′ **U**



Ostrya virginiana Ⓕ
Hop Hornbeam

40/30′ **U**



Quercus alba Ⓕ
White Oak

80/80′ **U**



Quercus muehlenbergii Ⓕ
Chickapin Oak

60/70′ **U**



***Quercus robur* 'Attention'** Ⓕ
English Oak

Narrow

60/15′ **U**

SEE 2024 ADDENDUM FOR UPDATE

Canopy Trees



Quercus rubra
Northern Red Oak

75/75′ U



Quercus shumardii
Shumard Oak

60/40′ LU



Quercus x warei 'Long Regal Prince'
Regal Prince Oak
Vigorous, resistant to powdery mildew, narrow

60/25′ U



Sorbus aucuparia 'Fastigata'
Mountainash
Narrow

60/25′ U



Taxodium distichum
Bald Cypress

70/45′ LU



Tilia americana 'Redmond'
American Basswood
Pyramidal, dense

70/50′ LU



Tilia cordata
Littleleaf Linden

70/50′ U



Tilia tomentosa
Silver Linden

70/50′ U



Tilia tomentosa 'Green Mountain'
Silver Linden
Faster growth, heat/drought tolerant

70/50′ U



Tilia tomentosa 'Sterling'
Silver Linden
Heat/drought tolerant; resists Japanese beetle

50/35′ U



Ulmus americana 'Jefferson'
American Elm
Smaller, narrower

50/50′ LU



Ulmus americana 'New Harmony'
American Elm
Vase-shaped, resistant to Dutch Elm disease

70/65′ LU



Ulmus americana 'Valley Forge'
American Elm
Broad, dense

70/60′ LU



Ulmus parvifolia
Chinese Elm

50/40′ U



Zelkova serrata 'Green Vase'
Zelkova
Upright

70/40′ U



Zelkova serrata 'Halka'
Zelkova
Looser habit

50/30′ U



Zelkova serrata 'Mushashino'
Zelkova
Narrow

45/20′ U



Zelkova serrata 'Village Green'
Zelkova
Fast growing, upright, vigorous

60/50′ U

SEE 2024 ADDENDUM FOR UPDATE

Understory Trees



***Acer buergerianum* 'Streetwise'** Ⓢ
Trident Maple

Uniform shape

30/30′ **U**



***Acer truncatum x platanoides* 'Keithsform'** Ⓢ
Norwegian Sunset® Maple

Heat tolerant

35/20′ **LU**



***Amelanchier laevis* 'Cumulus'**
Allegheny Serviceberry

Upright, yellow-orange in fall

30/20′ **LU**



Carpinus caroliniana ◑
American Hornbeam

35/35′ **LU**



Acer campestre Ⓢ
Hedge Maple

35/35′ **U**



***Acer truncatum x platanoides* 'Warrenred'** Ⓢ
Pacific Sunset® Maple

Heat tolerant, fast growing

30/25′ **LU**



Amelanchier lamarckii Ⓛ
Juneberry

25/25′ **LU**



Cercis canadensis Ⓕ
Eastern Redbud

30/35′ **U**



Acer tataricum Ⓢ
Tatarian Maple

20/20′ **U**



Amelanchier arborea Ⓛ
Downy Serviceberry

25/25′ **LU**



***Amelanchier x grandiflora* 'Autumn Brilliance'**
Apple Serviceberry

Red in fall

25/25′ **LU**



***Cercis canadensis* 'Appalachian Red'** Ⓕ
Eastern Redbud

Tiny fuchsia-pink to red flowers

25/25′ **U**



Acer tataricum subsp. ginnala Ⓢ
Amur Maple

20/20′ **LU**



Amelanchier canadensis Ⓛ
Shadblow Serviceberry

30/20′ **LU**



***Amelanchier x grandiflora* 'Princess Diana'**
Apple Serviceberry

Wide-spreading branches, red in fall

25/20′ **LU**



***Cercis canadensis* 'Merlot'** Ⓕ
Eastern Redbud

Purple foliage, drought & heat resistant

15/15′ **U**



Acer truncatum Ⓢ
Shantung Maple

25/20′ **U**



Amelanchier laevis
Allegheny Serviceberry

15/35′ **LU**



***Amelanchier x grandiflora* 'Robin Hill'**
Apple Serviceberry

Upright, red-yellow in fall

25/15′ **LU**



***Cercis canadensis f. alba* 'Royal White'** Ⓕ
Eastern Redbud

Larger white flowers, early blooming

25/25′ **U**

SEE 2024 ADDENDUM FOR UPDATE

Understory Trees



Chionanthus retusus Ⓛ
Chinese Fringtree

20/20′ **LU**



Chionanthus virginicus Ⓛ
Fringetree

20/20′ **LU**



Cornus florida ⒻⓁ
Flowering Dogwood

30/30′ **U**



***Cornus florida* 'Appalachian Snow'** ⒻⓁ
Flowering Dogwood

Vigorous, white flower

20/20′ **U**



***Cornus florida* 'Cherokee Brave'** ⒻⓁ
Flowering Dogwood

Vigorous, red flower

25/25′ **U**



***Cornus florida* 'Cherokee Chief'** ⒻⓁ
Flowering Dogwood

Red-pink, new foliage tinged with red

25/25′ **U**



***Cornus florida* 'Cherokee Princess'** ⒻⓁ
Flowering Dogwood

Large, reliable blooms

30/30′ **U**



Cornus florida var. rubra ⒻⓁ
Flowering Dogwood

Red-pink

30/30′ **U**



Cornus kousa ⒻⓁ
Kousa Dogwood

30/30′ **U**



Cornus mas ⒻⓁ
Cornelian Cherry

25/20′ **U**



Cornus officinalis ⒻⓁ
Japanese Cornel
Dogwood

25/25′ **LU**



***Cornus x rutgersensis* 'Rutban'** Ⓕ
Aurora Dogwood

18/24′ **U**



Cotinus obovatus Ⓛ
American Smoke Tree

30/30′ **U**



Crataegus crus-galli var. inermis Ⓕ
Cockspur Hawthorn

30/30′ **U**



Crataegus flava Ⓕ
Yellowleaf Hawthorn

30/30′ **U**



***Crataegus laevigata* 'Superba'** Ⓕ
English Hawthorn

Disease resistant

20/20′ **U**



Crataegus x lavalleei Ⓕ
Lavalle Hawthorn

25/18′ **U**



Crataegus phaenopyrum Ⓕ
Washington Hawthorn

30/30′ **U**



***Crataegus punctata* 'Ohio Pioneer'** Ⓕ
Dotted Hawthorn

Essentially spineless

30/30′ **U**



***Crataegus viridis* 'Winter King'** Ⓕ
Green Hawthorn

Profuse bloom

35/35′ **U**

SEE 2024 ADDENDUM FOR UPDATE

Understory Trees



Maackia amurensis
Amur Maackia

30/30′ U



***Malus* 'Golden Raindrops'**
Crabapple

Yellow fruit, fine-textured

20/15′ U



***Malus* 'Snowdrift'**
Crabapple

White flowers, resistant to fireblight and scab

20/20′ U



***Prunus serrulata* 'Kwanzan'**
Japanese Cherry

Double pink flowers

30/30′ U



***Magnolia grandiflora* 'Bracken's Brown Beauty'**
Southern Magnolia

Hardy

30/25′ LU



***Malus* 'Harvest Gold'**
Crabapple

Yellow fruit, fine-textured

25/15′ U



***Malus* 'Spring Snow'**
Crabapple

White flowers, upright, dense, fruitless

25/20′ U



***Prunus subhirtella* 'Autumnalis'**
Higan Cherry

Blooms again in fall

35/30′ U



Magnolia virginiana
Sweetbay Magnolia

35/35′ LU



***Malus* 'Prairie Fire'**
Crabapple

Pink flowers, dense, round, disease resistant

20/20′ U



***Malus* 'Sugartyme'**
Crabapple

White flowers, red fruits

18/15′ U



***Prunus x hillieri* 'Spire'**
Sargent Cherry

Narrow

30/20′ U



***Magnolia virginiana* 'Green Mile'**
Sweetbay Magnolia

Narrow, reliably evergreen

25/20′ LU



***Malus* 'Robinson'**
Crabapple

Pink flowers, wide

25/25′ U



Prunus maackii
Amur Chokecherry

30/25′ U



***Prunus x incam* 'Okame'**
Okame Cherry

Upright, early bloom

25/20′ U



***Magnolia virginiana* 'Moonglow'**
Sweetbay Magnolia

Upright, reliably evergreen, slightly larger flowers

35/20′ LU



***Malus* 'Royal Raindrops'**
Crabapple

Purple foliage

20/16′ U



***Prunus sargentii* 'Columnaris'**
Sargent Cherry

Narrow, vase-shaped

30/20′ U



Prunus x yedoensis
Yoshino Cherry

40/40′ U

SEE 2024 ADDENDUM FOR UPDATE

Understory Trees



***Prunus virginiana* 'Canada Red'** Ⓢ

Common Choke-cherry

Green leaves turning to purple foliage

25/20′ U





Stewartia koreana

Korean Stewartia

25/15′ U





Stewartia monadelphia

Tall Stewartia

25/25′ U





Styrax japonicas

Japanese Snowbell

30/30′ U





***Syringa reticulata* 'Ivory Silk'**

Japanese Tree Lilac

Upright, compact

25/20′ U





***Syringa reticulata* 'Regent'**

Japanese Tree Lilac

Narrow

30/20′ U





***Syringa reticulata* 'Summer Snow'**

Japanese Tree Lilac

Compact

30/25′ U



Shrubs



***Aronia melanocarpa* 'Morton' IROQUOIS BEAUTY**
Chokeberry

Compact

☼ ◑ 3/5′ L U

J F M A M J J A S O N D



***Aronia melanocarpa* 'UCONNAM165' LOW SCAPE MOUND**
Chokeberry

Low growing

☼ ◑ 2/2′ L U

J F M A M J J A S O N D



***Cornus alba* 'Minbat' BATON ROUGE**
Tatarian Dogwood

Vivid red stems

☼ 4/4′ L

J F M A M J J A S O N D



***Cornus sericea* 'Farrow' ARCTIC FIRE**
Red Twig Dogwood

Dwarf cultivar, non-spreading form

☼ ◑ 3/4′ E L

J F M A M J J A S O N D



***Cornus sericea* 'Kelseyi'**
Red Twig Dogwood

Short, less vivid red

☼ 2/2′ E L

J F M A M J J A S O N D



Diervilla lonicera
Bush Honeysuckle

☼ ◑ 3/4′ U

J F M A M J J A S O N D



***Diervilla lonicera* 'Copper'**
Bush Honeysuckle

Copper-red new growth

☼ ◑ 3/3′ U

J F M A M J J A S O N D



Fothergilla gardenii
Dwarf Fothergilla

☼ ◑ 3/4′ U

J F M A M J J A S O N D



***Hypericum frondosum* 'Sunburst'**
Golden St. John's Wort

Larger flowers, lower growing

☼ ◑ 4/4′ L U

J F M A M J J A S O N D



***Hypericum kalmianum* 'Deppe' SUNNY BOULEVARD**
Kalm St. John's Wort

More flowers, mounded

☼ ◑ 3/4′ L U

J F M A M J J A S O N D



***Hypericum kalmianum* 'Gemo'**
Gemo St. John's Wort

Tough, flowers for long period of time

☼ ◑ 3/3′ U

J F M A M J J A S O N D



Hypericum prolificum
Shrubby St. John's Wort

Typically grows 1' - 4' (Less frequently to 5')

☼ ◑ 5/4′ L U

J F M A M J J A S O N D



***Ilex glabra* 'Compacta'**
Inkberry

Mounded

☼ ◑ 4/6′ E L U

J F M A M J J A S O N D



***Ilex verticillata* 'Jim Dandy'**
Winterberry Holly

Dwarf male pollinator

☼ ◑ 4/5′ E L U

J F M A M J J A S O N D



***Ilex verticillata* 'Nana' RED SPRITE**
Winterberry Holly

Dwarf female, mounded

☼ ◑ 3/4′ E L U

J F M A M J J A S O N D



***Itea virginica* 'Henry's Garnet'**
Sweetspire

Larger flowers, good fall color

☼ ◑ 4/6′ E L U

J F M A M J J A S O N D



***Itea virginica* 'Merlot'**
Sweetspire

Dwarf cultivar, deep wine-red in fall

☼ ◑ 3.5/3′ E L U

J F M A M J J A S O N D



***Juniperus horizontalis* 'Bar Harbor'**
Creeping Juniper

Low, blue-green foliage to purple in winter

☼ 1/6′ U

J F M A M J J A S O N D



***Juniperus virginiana* 'Grey Owl'**
Eastern Red Cedar

Dwarf, silver grey

☼ 3/6′ U

J F M A M J J A S O N D



***Myrica pensylvanica* 'Morton'**
Bayberry

Compact, female clone (needs male for good fruit)

☼ ◑ 5/7′ E L U

J F M A M J J A S O N D

Shrubs



Myrica pensylvanica
'Morton Male'
Silver Sprite™ Bayberry

Non-fruiting male cultivar

5/6′ **E LU**



Physocarpus opulifolius
'Donna May' LITTLE DEVIL
Ninebark

Rounded, deep burgundy leaves, pinkish flowers

4/4′ **LU**



Physocarpus opulifolius
'Seward' SUMMER WINE
Ninebark

Deeply cut, wine-red foliage, white flowers

5/5′ **LU**



Physocarpus opulifolius
'SMPOTW' TINY WINE
Ninebark

Fine texture, deep purple leaves, pink flowers

4/4′ **LU**



Prunus laurocerasus
'Otto Luyken'
Cherry Laurel

Compact, broadleaf evergreen

4/8′ **U**



Rhus aromatica
'Gro-Low'
Gro-Low Sumac

Dwarf, spreading

2/8′ **U**



Spiraea betulifolia
'Tor'
White Spiraea

White flowers, mounded

3/3′ **U**



Spiraea japonica
'Goldmound'
Japanese Spiraea

Yellow leaves, pink flowers

3/4′ **U**



Spiraea japonica
'Little Princess'
Japanese Spiraea

Pink flowers

3/3′ **U**



Spiraea japonica
'Neon Flash'
Japanese Spiraea

Red flowers, red new growth

3/3′ **U**



Viburnum dentatum
'Blubzam' BLUE BLAZE
Arrowwood Viburnum

Compact, blue fruit, reddish-purple fall color

5/5′ **U**



Viburnum dentatum
'Chistom' BLUE MUFFIN
Arrowwood Viburnum

Compact, intense blue fruit, orange-red in fall

5/3′ **U**



Viburnum dentatum
'KLMSeventeen' LITTLE JOE
Arrowwood Viburnum

Compact, purple in fall

5/5′ **U**

Flowering Herbaceous



***Achillea millefolium* 'Moonshine'**
Yarrow

Yellow flowers, silver-gray foliage

☼ 2/1′ U

J F M A M J J A S O N D



***Achillea millefolium* 'Parprika'**
Yarrow

Red flowers with yellow centers

☼ 2/2′ U

J F M A M J J A S O N D



***Achillea millefolium* 'Terra Cotta'**
Yarrow

Orange flowers

☼ 3/3′ U

J F M A M J J A S O N D



***Agastache* 'Blue Fortune'**
Hyssop

Long-lasting blue flowers

☼ 3/2′ U

J F M A M J J A S O N D



***Agastache* 'Purple Haze'**
Hyssop

Long-lasting purple flowers

☼ 3/2′ U

J F M A M J J A S O N D



***Allium* 'Millenium'**
Prairie Onion

Purple flowers

☼ 2/2′ U

J F M A M J J A S O N D



***Allium* 'Summer Beauty'**
Prairie Onion

Lavender flowers

☼ 2/2′ U

J F M A M J J A S O N D



Amsonia hubrichtii
Threadleaf Bluestar

◑ 3/3′ LU

J F M A M J J A S O N D



Amsonia tabernaemontana
Eastern Bluestar

☼◑ 3/3′ U

J F M A M J J A S O N D



***Amsonia x* 'Blue Ice'**
Eastern Bluestar

Compact, darker blue flowers

☼◑ 1.5/1.5′ U

J F M A M J J A S O N D



Aquilegia canadensis
Columbine

◑● 3/2′ L

J F M A M J J A S O N D



Asclepias incarnata
Swamp Milkweed

☼ 4/3′ L

J F M A M J J A S O N D



Asclepias tuberosa
Butterfuly Weed

☼ 3/2′ U

J F M A M J J A S O N D



***Astilbe chinensis* 'Pumila'**
Chinese Astilbe

Superb purple color, compact

◑● 1/2′ U

J F M A M J J A S O N D



***Astilbe chinensis* 'Visions'**
Chinese Astilbe

Superb purple color, compact

◑● 2/2′ U

J F M A M J J A S O N D



Baptisia australis
Blue False Indigo

☼◑ 4/4′ LU

J F M A M J J A S O N D



Calamintha nepeta ssp. nepeta
Lesser Calamint

☼ 1.5/2′ U

J F M A M J J A S O N D



***Calamintha nepeta* 'White Cloud'**
Calamint

Extremely long-blooming

☼◑ 2/2′ U

J F M A M J J A S O N D



***Chelone lyonii* 'Hot Lips'**
Turtlehead

Richer pink flowers, deeper green foliage

◑● 4/3′ L

J F M A M J J A S O N D



Conoclinium coelestinum
Mistflower

☼◑ 3/2′ L

J F M A M J J A S O N D

Flowering Herbaceous



Coreopsis grandiflora
'SunKiss'
Large-flowered Tickseed

Compact, excellent heat tolerance, long-blooming

2/2′ **U**



Coreopsis lanceolata
Lance-leaf Tickseed

1/1.5′ **U**



Coreopsis pubescens
'Sunshine Superman'
Star Tickseed

Compact, ever-blooming

1/1′ **U**



Coreopsis verticillata
'Zagreb'
Whorled Tickseed

Compact, upright, long bloom

2/2′ **U**



Crocus vernus
Spring Crocus

.5/.5′ **U**



Echinacea purpurea
Purple Coneflower

5/2′ **U**



Echinacea purpurea
'Kim's Knee High'
Purple Coneflower

Reddish-purple, very long bloom time, sturdy

2/2′ **U**



Echinacea purpurea
'Ruby Star'
Purple Coneflower

Large flowers, sturdy

5/2′ **U**



Eurybia divaricata
White Wood Aster

3/2′ **L**



Eutrochium dubium
'Little Joe'
Joe Pye Weed

Compact dwarf version

4/3′ **L**



Galanthus nivalis
Snowdrop

.75/.5′ **U**



Geranium macrorrhizum
Bigroot Geranium

1/2′ **U**



Geranium macrorrhizum
'Album'
Bigroot Geranium

White flowers

1/2′ **U**



Geranium maculatum
Wild Geranium

2/1.5′ **U**



Helleborus niger
Christmas Rose

1/2′ **U**



Hemerocallis sp.
Daylily

Select species with max. height of 4′ or under

4/2′ **U**



Hibiscus moscheutos
'Luna Red'
Swamp Rose Mallow

Compact dwarf version

3/2′ **L**



Iris cristata
Dwarf-crested Iris

1/1′ **U**



Iris sibirica
Siberian Iris

4/2′ **E L**



Iris versicolor
Blue Flag Iris

3/3′ **E L**

Flowering Herbaceous



Iris versicolor
'Gerald Darby'
Blue Flag Iris

Purple-red at base of stalk in spring

☼ | 3/3′ | E L

J F M A M J J A S O N D



Monarda bradburiana
Eastern Bee Balm

☼ ◑ | 2/2′ | L

J F M A M J J A S O N D



Packera aurea
Golden Ragwort

☼ ◑ | 3/2′ | L

J F M A M J J A S O N D



Perovskia atriplicifolia
'Peeka Blue'
Russian Sage

Compact, upright

☼ ◑ | 3/3′ | U

J F M A M J J A S O N D



Leucanthemum x superbum
'LaCrosse'
Shasta Daisy

Compact

☼ | 1/2′ | U

J F M A M J J A S O N D



Monarda didyma
'Jacob Cline'
Bee Balm

Tough

☼ ◑ | 2/2′ | L

J F M A M J J A S O N D



Packera obovata
Round-leaved Ragwort

☼ ◑ | 1.5/1′ | L

J F M A M J J A S O N D



Physostegia virginiana
'Miss Manners'
Obedient Plant

Clumping, sturdy upright stems, long bloom

☼ ◑ | 3/2′ | L U

J F M A M J J A S O N D



Leucanthemum x superbum
'SnowCap'
Shasta Daisy

Shortest

☼ | 2/1′ | U

J F M A M J J A S O N D



Monarda fistulosa
Wild Bergamot

☼ ◑ | 4/3′ | U

J F M A M J J A S O N D



Penstemon digitalis
'Dark Towers'
Foxglove

Dark red foliage, lavender flowers

☼ ◑ | 3/2′ | L U

J F M A M J J A S O N D



Physostegia virginiana
'Pink Manners'
Obedient Plant

Similar to Miss Manners but pink

☼ ◑ | 3/2′ | L U

J F M A M J J A S O N D



Liatris spicata
Dense Blazing Star

☼ | 4/1.5′ | L U

J F M A M J J A S O N D



Narcissus minor
Trumpet Daffodil

☼ ◑ | .5/1′ | U

J F M A M J J A S O N D



Penstemon digitalis
'Husker Red'
Foxglove

Red foliage, white flowers

☼ ◑ | 3/2′ | L U

J F M A M J J A S O N D



Physostegia virginiana
'Vivid'
Obedient Plant

Diminutive, purplish pink blooms, long blooms

☼ ◑ | 2/2′ | L U

J F M A M J J A S O N D



Lobelia cardinalis
Cardinal Flower

☼ ◑ | 4/2′ | L

J F M A M J J A S O N D



Nepeta x faassenii
'Walker's Low'
Catmint

Periwinkle blue flowers, compact, mounding

☼ ◑ | 3/2′ | U

J F M A M J J A S O N D



Perovskia atriplicifolia
'Little Spire'
Russian Sage

Very compact

☼ ◑ | 2/2′ | U

J F M A M J J A S O N D



Pycnanthemum muticum
Mountain Mint

☼ ◑ | 3/3′ | L

J F M A M J J A S O N D

Flowering Herbaceous



Rudbeckia fulgida
Orange Coneflower

☼ ◑ 3/3′ **U**

J F M A M J J A S O N D



Rudbeckia hirta
Black-eyed Susan

☼ 3/2′ **U**

J F M A M J J A S O N D



Rudbeckia triloba
Brown-eyed Susan

☼ ◑ 3/2′ **U**

J F M A M J J A S O N D



Salvia nemorosa
'Blue Hill'
Sage

Light purple flowers

☼ 2/2′ **U**

J F M A M J J A S O N D



Salvia nemorosa
'Cardonna'
Sage

Purple flowers, purple stems

☼ 2/2′ **U**

J F M A M J J A S O N D



Sedum
'Autumn Joy'
Stonecrop

Sturdy flowers start pink and turn to rust in fall

☼ 2/2′ **U**

J F M A M J J A S O N D



Solidago rugosa
'Fireworks'
Roughleaf Goldenrod

Compact, cascading, bright yellow, tough

☼ 3/2′ **LU**

J F M A M J J A S O N D



Solidago sphacelata
'Golden Fleece'
Autumn Goldenrod

Compact, golden yellow, tough, long bloom

☼ ◑ 2/2′ **LU**

J F M A M J J A S O N D



Solidago sphacelata
Little Lemon® 'Dansolitlem'
Autumn Goldenrod

Very compact, light yellow, tough, long bloom

☼ ◑ 1/1.5′ **LU**

J F M A M J J A S O N D



Symphotrichum cordifolium
'Avondale'
Blue Wood Aster

Prolific bloomer

◑ ☀ 3/2′ **LU**

J F M A M J J A S O N D



Symphyotrichum laeve
'Bluebird'
Smooth Aster

Tough, abundant

☼ ◑ 3/2′ **LU**

J F M A M J J A S O N D



Symphyotrichum novae-angliae
'October Skies'
Aromatic Aster

Tough, lavender

☼ ◑ 2/2′ **LU**

J F M A M J J A S O N D



Symphyotrichum novae-angliae
'Purple Dome'
Smooth Aster

Tough, deep purple

☼ ◑ 2/3′ **LU**

J F M A M J J A S O N D



Symphyotrichum novi-belgii
'Woods Blue'
New York Aster

Dwarf version

☼ ◑ 1/1.5′ **U**

J F M A M J J A S O N D



Symphyotrichum oblongifolium
'Raydon's Favorite'
Aromatic Aster

Tough, violet blue

☼ ◑ 3/1′ **LU**

J F M A M J J A S O N D



Vernonia lettermanii
'Iron Butterfly'
Ironweed

Shorter

☼ 3/3′ **L**

J F M A M J J A S O N D



Veronica spicata
'Icicle'
Spiked Speedwell

White flowers, long bloom time

☼ ◑ 2/2′ **U**

J F M A M J J A S O N D



Veronica spicata
'Sunny Border Blue'
Spiked Speedwell

Blue, upright

☼ ◑ 2/2′ **U**

J F M A M J J A S O N D

Grasses & Groundcovers



Acorus gramineus
Sweet Flag

1/1' L



***Acorus gramineus* 'Ogon'**
Sweet Flag

Variegated

1/1' L



Bouteloua curtipendula
Sideoats Grama

2.5/2' U



Bouteloua gracilis
Blue Grama Grass

2/2' U



***Bouteloua gracilis* 'Bonde Ambition'**
Blue Grama Grass

Chartreuse flowers

3/2' U



***Calamagrostis acutiflora* 'Avalanche'**
Feather Reed Grass

Variegated, pinkish green blooms, more compact

4/2' U



***Calamagrostis acutiflora* 'Karl Foester'**
Feather Reed Grass

Green stems, pink blooms turn to tan

5/2' U



***Calamagrostis acutiflora* 'Overdam'**
Feather Reed Grass

Compact, variegated, early bloom

3/2' U



Carex amphibola
Creek Sedge

1/1' LU



Carex cherokeensis
Cherokee Sedge

1/1.5' LU



Carex eburnea
Bristle-leaf Sedge

1/1' U



Carex emoryi
Riverbank Sedge

2/2' E L



Carex flacca
Blue-green Sedge

1/1.5' LU



Carex flaccosperma
Blue Wood Sedge

1/1' L



***Carex laxiculmis* 'Hobb' BUNNY BLUE**
Spreading Sedge

Silvery blue, dense, evergreen

1/1' L



***Carex morrowii* 'Ice Dance'**
Japanese Sedge

Spreading

1/2' L



***Carex oshimensis* 'Evergold'**
Sedge

Long golden leaves with green margins, evergreen

1/1.5' L



Carex pensylvanica
Pennsylvania Sedge

1/1' U



Carex radiata
Eastern Star Sedge

2.5/2' LU



Carex stricta
Tussock Sedge

3/2' E L

Grasses & Groundcovers



Carex vulpinoidea
Fox Sedge

3/2′ **E L**

J F M A M J J A S O N D



Chasmanthium latifolium
Northern Sea Oats

3/3′ **L**

J F M A M J J A S O N D



***Chasmanthium latifolium* 'River Mist'**
Northern Sea Oats

Variegated

3/3′ **L**

J F M A M J J A S O N D



Dennstaedtia punctilobula
Hay-scented Fern

2/3′ **U**

J F M A M J J A S O N D



Deschampsia cespitosa
Tufted Hair Grass

3/2′ **L U**

J F M A M J J A S O N D



***Deschampsia cespitosa* 'Goldtau'**
Tufted Hair Grass

Compact, longer blooms, dark green foliage

2/3′ **L U**

J F M A M J J A S O N D



***Deschampsia cespitosa* 'Pixie Fountain'**
Tufted Hair Grass

Dwarf, silvery blooms

2/1.5′ **L U**

J F M A M J J A S O N D



Deschampsia flexuosa
Crinkled Hair Grass

3/2′ **U**

J F M A M J J A S O N D



Dryopteris marginalis
Marginal Wood Fern

2/2′ **U**

J F M A M J J A S O N D



Eragrostis spectabilis
Purple Lovegrass

2/2′ **U**

J F M A M J J A S O N D



***Festuca glauca* 'Casca11' BEYOND BLUE**
Blue Fescue

Bright blue, evergreen

1/2′ **U**

J F M A M J J A S O N D



***Festuca glauca* 'Elijah Blue'**
Blue Fescue

Grey blue, evergreen

1/2′ **U**

J F M A M J J A S O N D



Festuca longifolia
Hard Fescue

2/1′ **U**

J F M A M J J A S O N D



Festuca rubra
Red Fescue

2/1′ **L U**

J F M A M J J A S O N D



***Helictotrichon sempervirens* 'Saphirsprudel'**
Blue Oat Grass

Bluer, tough

3/2′ **U**

J F M A M J J A S O N D



Juncus effusus
Soft Rush

4/4′ **E L**

J F M A M J J A S O N D



***Juncus inflexus* 'Blue Arrow'**
Soft Rush

Blue color, smaller

1.5/3′ **E L**

J F M A M J J A S O N D



Juncus tenuis
Path Rush

2/2′ **E L U**

J F M A M J J A S O N D



***Leymus arenarius* 'Blue Dune'**
Blue Dune Grass

Bluish, tough

3/2′ **U**

J F M A M J J A S O N D



Liriope muscari
Lilyturf

1.5/1′ **L U**

J F M A M J J A S O N D

Grasses & Groundcovers



Liriope spicata
Creeping Lilyturf

2/2′ LU



***Panicum virgatum* 'Cape Breeze'**
Switch Grass

Compact upright habit, drougt tolerant

2.5/2′ LU



***Pennisetum alopecuroides* 'Burgundy Bunny'**
Fountain Grass

Burgundy, short

1/1′ LU



***Schizachyrium scoparium* 'Standing Ovation'**
Little Bluestem

Black fruit, red-purple fall color

4/2′ U



Muhlenbergia capillaris
Pink Muhly Grass

3/3′ U



***Panicum virgatum* 'Hot Rod'**
Switch Grass

Purple/red in fall

4/2′ LU



***Pennisetum alopecuroides* 'Cassian'**
Fountain Grass

Yellow fall color

3/2′ LU



***Schizachyrium scoparium* 'The Blues'**
Little Bluestem

Blue turning red in fall

4/2′ U



***Muhlenbergia capillaris* 'White Cloud'**
Muhly Grass

White late bloom, upright

3/3′ U



***Panicum virgatum* 'Northwind'**
Switch Grass

Drougt tolerant

5/2.5′ LU



***Pennisetum alopecuroides* 'Hamlen'**
Fountain Grass

Dark green foliage

3/3′ LU



***Sedum rupestre* 'Angelina'**
Stonecrop

Orange fall color

0.5/2′ U



Panicum anceps
Fall Panicum

4/2′ L



***Panicum virgatum* 'Ruby Ribbons'**
Switch Grass

Mahogany fall color

4/3′ LU



***Pennisetum alopecuroides* 'Little Bunny'**
Fountain Grass

Like 'Hamlen', shorter

2/2′ LU



***Sedum ternatum* 'Larinem Park'**
Three-leaved Stonecrop

Compact, red fall color

0.5/2′ U



Panicum rigidulum
Redtop Panicgrass

5/3′ L



***Panicum virgatum* 'Shenandoah'**
Switch Grass

Compact upright habit, drougt tolerant

4/4′ LU



***Schizachyrium scoparium* 'Prairie Munchkin'**
Little Bluestem

Smaller, maroon in fall

3/2′ U



Sesleria autumnalis
Autumn Moor Grass

1/1′ U

Grasses & Groundcovers



Sporobolus heterolepis
Prairie Dropseed

☼ 3/3′ U

J F M A M J J A S O N D

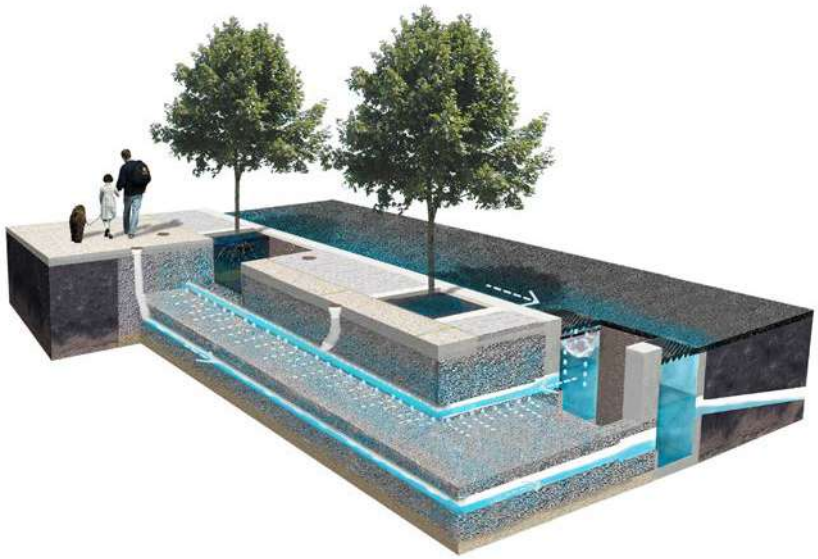
Landscape Design Approaches



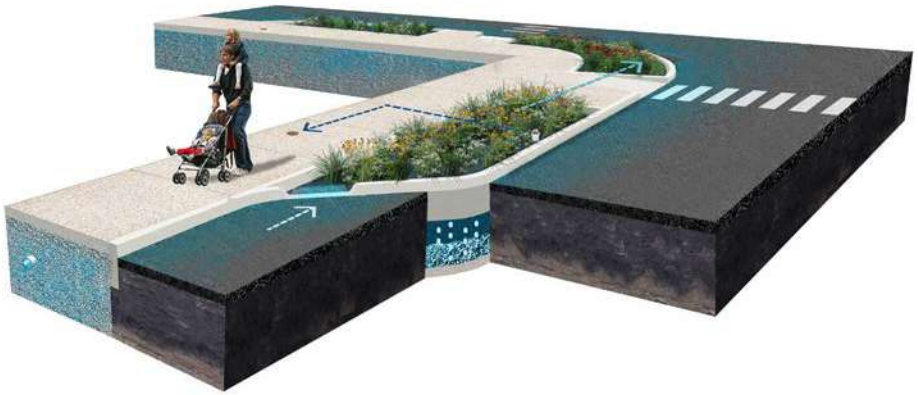
chapter 4

VENICE ISLAND RECREATION CENTER STORMWATER PLANTERS

Figure 4.1.1: Diagrams of SMP Types



STORMWATER TREE TRENCH



STORMWATER BUMPOUT (CORNER)



STORMWATER PLANTER



RAIN GARDEN (SMALL)



STORMWATER BUMPOUT (MID-BLOCK)



RAIN GARDEN (LARGE)

4.1 Stormwater Management Practice (SMP) Typologies

Over the past decade, PWD has made a significant commitment to the design and construction of GSI demonstration projects throughout the City. To see all the projects implemented to date, reference the *Big Green Map*.

The following practices are frequently implemented within the City of Philadelphia:

- Stormwater Tree Trenches
- Stormwater Planters
- Stormwater Bump-outs
- Rain Gardens

On the following pages, these frequently used Stormwater Management Practices (SMPs) will be outlined with some potential challenges that may be faced when designing the landscape for the system, and suggested landscape approaches to combat some of these problems.

Stormwater Tree Trenches

Potential Challenges

- Existing structures, trees in adjacent properties, and overhead utilities as well as tree pit size may be limiting to growth.
- Sight lines must be maintained for safety.
- Foot traffic may compact soils.
- Plants may be exposed to pollutants from the street such as road salts.
- Pests can devastate tree populations.

Recommended Landscape Approaches

TREES

- Select from standard PWD tree pit dimensions, which aim to provide 20 - 25 square feet of soil area for each tree (Refer to the *"Street Tree Standards"* section of this document).
- Know the mature height and spread of tree species. Use large trees in boulevards or where space is available for the greatest stormwater function and increased shade. Use small trees in areas with overhead restricted space, such as locations under wires or under trees in adjacent properties. Use trees with a columnar habit for narrow sidewalks and streets with large trucks.
- Plant a diversity of tree species to guard against the possibility of large-scale devastation by insect and disease pests; select species that are tolerant of street conditions including wind, heat, salt spray, drought, and pollution (Refer to *"2.2 Landscape Design Guidelines"*).
- Individual tree pits should be mulched and tree lawns should be seeded with turf grass. No shrub, herbaceous, or groundcover species are typically planted beneath trees, unless otherwise specified by PWD.



Palmer & Frankford Tree Trench ("Big Green Block")



Richmond Library Tree Trench


HARTRANFT SCHOOL TREE TRENCH

TREE PITS

DESIGN CHALLENGES

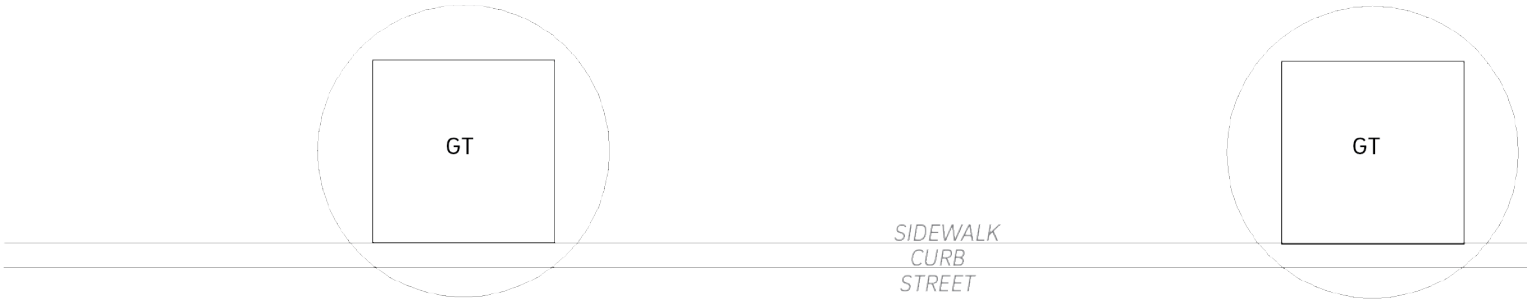
- Low biodiversity in existing park trees
- Adjacent street parking heavily used



SOLUTIONS

- Differed tree species from existing park trees to increase canopy biodiversity
- Standard sized tree pits allow people to park and open car doors easily





PLAN

0 ft 2.5 ft 5 ft 10 ft 15 ft

SCALE: 1"=5'

Gleditsia triacanthos



Location: Malcolm X Park

TREE LAWN

DESIGN CHALLENGES

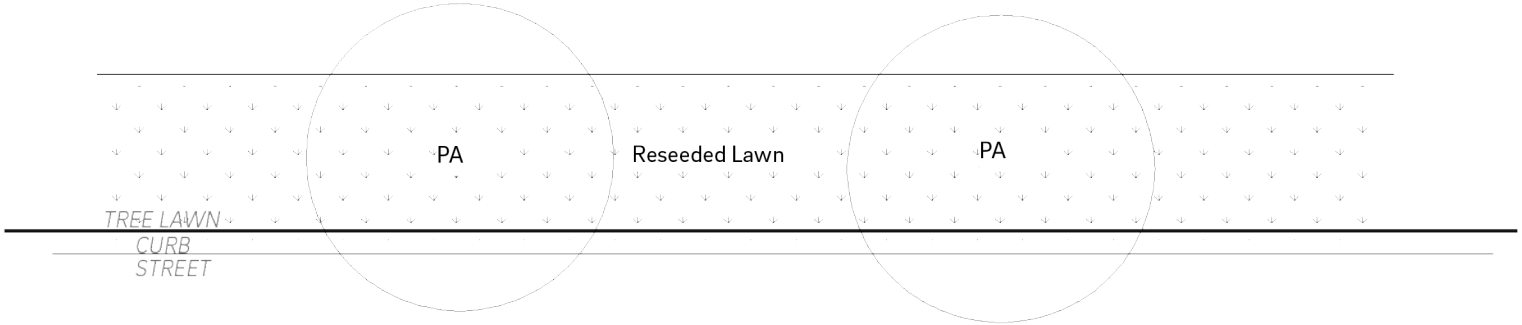
- Wide street
- Few pedestrian crossings
- High pollutant load
- Important to maintain views



SOLUTIONS

- Large, stately trees and can be limbed up to maintain views
- Turf grass spreads quickly, and is tolerant to shade, drought and foot traffic
- Tree species is tolerant of urban pollutants





PLAN



SCALE: 1"=5'

Platanus
x acerifolia



Location: N. 22nd St. & Benjamin Franklin Pkwy.

UNDERSTORY TREES BENEATH OVERHEAD WIRES

DESIGN CHALLENGES

- Overhead utilities
- Community desire for spring flowering color

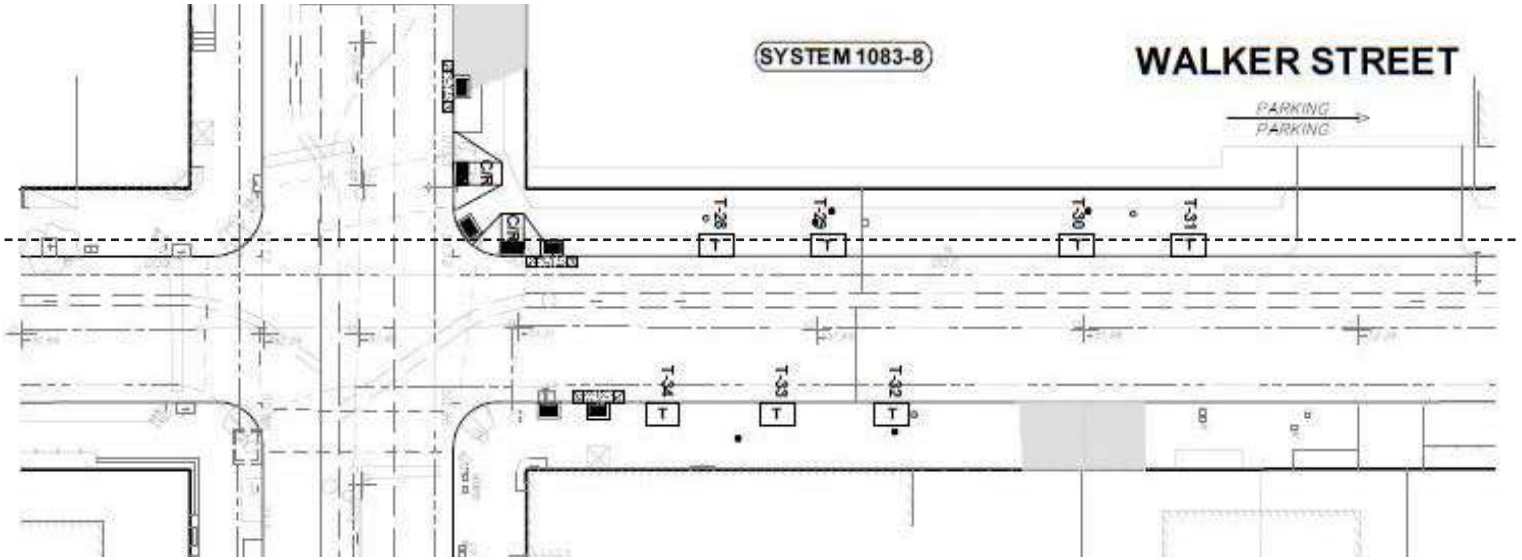


SOLUTIONS

- Understory trees selected that will naturally have a shorter mature height, reducing potential conflict with wires
- Flowering trees provide some seasonal interest to the neighborhood



OVERHEAD WIRES



Not to Scale

Malus spp.



Location: Walker St. & Van Kirk St.

MULTIPLE SPECIES WITH SIMILAR FORM IN ALTERNATING PATTERN

DESIGN CHALLENGES

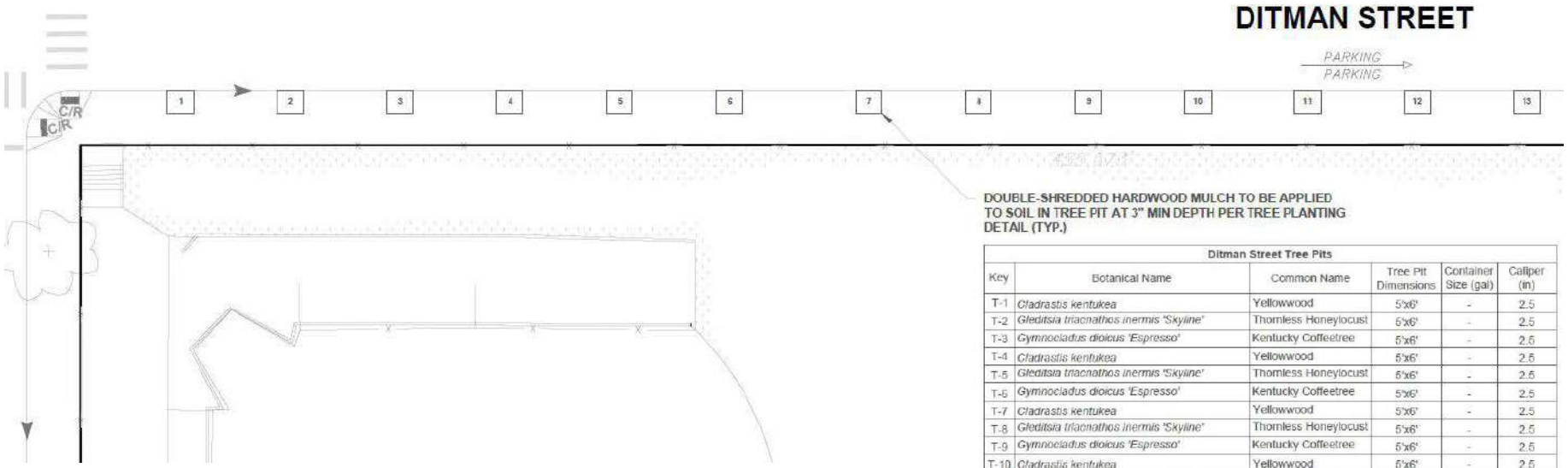
- System occupies entire block with many regularly-spaced tree pits - creating the potential to plant a single species corridor



SOLUTIONS

- Three tree species selected with similar branching habits and fall color - to increase biodiversity while preserving similar form





Not to Scale

DOUBLE-SHREDDED HARDWOOD MULCH TO BE APPLIED TO SOIL IN TREE PIT AT 3" MIN DEPTH PER TREE PLANTING DETAIL (TYP.)

Ditman Street Tree Pits

Key	Botanical Name	Common Name	Tree Pit Dimensions	Container Size (gal)	Caliper (in)
T-1	*Cladrastis kentukea*	Yellowwood	5'x6'	-	2.5
T-2	*Gleditsia triacnathos inermis 'Skyline'*	Thornless Honeylocust	5'x6'	-	2.5
T-3	*Gymnocladus dioicus 'Espresso'*	Kentucky Coffeetree	5'x6'	-	2.5
T-4	*Cladrastis kentukea*	Yellowwood	5'x6'	-	2.5
T-5	*Gleditsia triacnathos inermis 'Skyline'*	Thornless Honeylocust	5'x6'	-	2.5
T-6	*Gymnocladus dioicus 'Espresso'*	Kentucky Coffeetree	5'x6'	-	2.5
T-7	*Cladrastis kentukea*	Yellowwood	5'x6'	-	2.5
T-8	*Gleditsia triacnathos inermis 'Skyline'*	Thornless Honeylocust	5'x6'	-	2.5
T-9	*Gymnocladus dioicus 'Espresso'*	Kentucky Coffeetree	5'x6'	-	2.5
T-10	*Cladrastis kentukea*	Yellowwood	5'x6'	-	2.5
T-11	*Gleditsia triacnathos inermis 'Skyline'*	Thornless Honeylocust	5'x6'	-	2.5
T-12	*Gymnocladus dioicus 'Espresso'*	Kentucky Coffeetree	5'x6'	-	2.5
T-13	*Cladrastis kentukea*	Yellowwood	5'x6'	-	2.5

Cladrastis kentukea



Gleditsia triacanthos



Gymnocladus dioicus



Location: Moss Playground

Stormwater Planters

Potential Challenges

- Plant heights should be less than 3' above top of curb elevation to maintain sightlines.
- Plants may be exposed to pollutants from the street such as road salts.
- The soil level within a planter is below the grade of the street and may be difficult for pedestrians to see in snowy conditions.
- Planters are adjacent to pedestrian traffic.
- Relative to the other GSI typologies, planters are small in size and likely have the most constricted planting space.
- Planters may be in full sun or in part shade.

Recommended Landscape Approaches

GENERAL

- Select 2-5 species for maximum impact. Larger planters may have more species.
- For areas where a high salt load is expected, select species with salt tolerance.
- Take note of sun/shade patterns and select species accordingly.
- Larger planters can be opportunities to plant trees.

TREES AND SHRUBS

- For larger planters, use small shrubs or trees to fill the space of the planter. If using shrubs, be sure that the size of the shrub is appropriate to the size of the planter.
- Select species that have winter interest such as compelling bark, colorful stems or persisting berries.
- Select dwarf or compact cultivars of shrub species to avoid blocking sight lines as the species matures.
- Use trees and/or shrubs as year round structures to call attention to the sunken elevation of the planter.

FLOWERING HERBACEOUS, GRASSES & GROUNDCOVERS

- Use colorful blooms and varied textures to signal to passersby that the sunken vegetation is a deliberate and maintained landscape.
- Avoid blocking sight lines when selecting species.



Roosevelt Playground Planter



Venice Island Planters



COLUMBUS SQUARE PLANTER

PLANTER WITH SHRUBS

DESIGN CHALLENGES

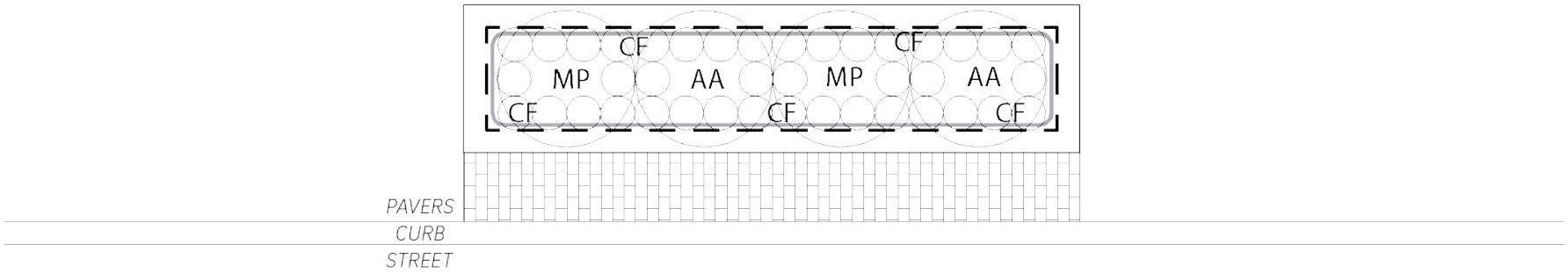
- Planter soil is below the level of the sidewalk
- High volumes of pedestrian traffic
- Important to maintain views
- High pollutant load
- Partial shade



SOLUTIONS

- Selected shrubs grow to fill in the planter, and act as a safety barrier for pedestrian traffic
- Shrubs are dwarf cultivars or can be pruned so as to preserve views
- Selected shrubs and grass can handle high pollutant loads and shade





PLAN



SCALE: 1"=5'

Myrica pensylvanica



Aronia arbutifolia



Carex flacca



Location: S. 13th St. & Reed St.

PLANTER WITH TREES

DESIGN CHALLENGES

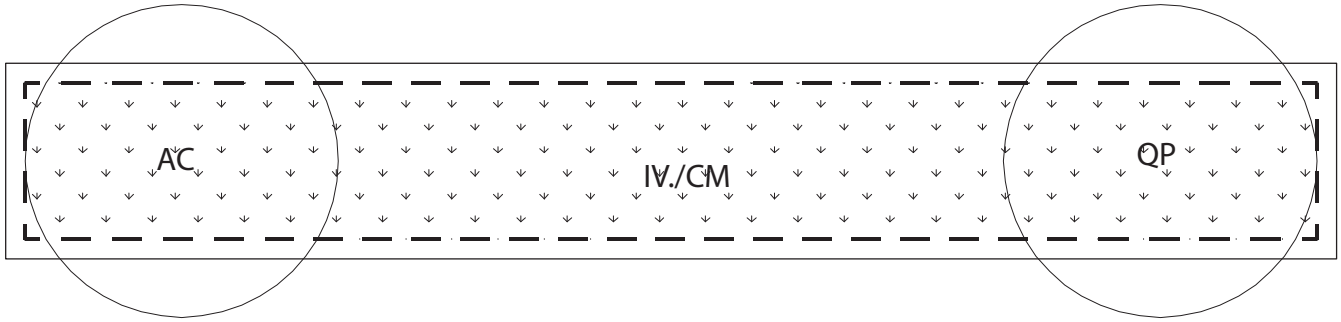
- Adjacent to public parking lot
- Changes in elevation throughout the site design risk blocking viewsheds



SOLUTIONS

- Trees provide shade for parked cars and pedestrians
- Limbed up canopy trees paired with simple groundcover under 3' ht. preserves sight lines







SCALE: 1" = 5'

Amelanchier canadensis



Acer saccharum



Quercus phellos



Carex morrowii



Carex emoryi



Carex vulpinoidea



Iris versicolor



Location: Venice Island Park

Stormwater Bumpouts

Potential Challenges

- Maintain visibility for traffic. Dense vegetation should be less than 4' above top of curb elevation.
- Bumpouts may be difficult to see in snowy conditions and risk being overrun by cars or pedestrians. Traffic delineators are placed along the cartway-side curb to help increase visibility of the curb extension.
- Systems may experience stormwater flows with high energy and erosion can be an issue. Plants may be exposed to pollutants from the street such as road salts.
- Bumpouts are relatively small in size. Too many plants can appear chaotic.
- Bumpouts are most often in full sun conditions.

Recommended Landscape Approaches

GENERAL

- Select species that can tolerate salt and full sun.
- Select 2-7 species for maximum impact.

TREES

- Trees can provide structure and shade. They are highly recommended for mid-block locations where visibility may be less of a concern; however, corner locations must preserve views according to Streets Department regulations. Refer to *"Figure 5.1.8: Street Tree Planting Diagram"*.

SHRUBS

- Include shrubs with winter interest.
- Place shrubs along the back edge of the bumpout near the sidewalk on flat-bottom bumpouts
- Place shrubs in the middle centerline of the bumpout near the stormwater flow path of bumpout with sloped sides.

FLOWERING HERBACEOUS, GRASSES & GROUNDCOVERS

- Accent the planting with color from early and late blooms and texture from grasses and grass-likes.
- Plant form should be low and compact, to preserve sight lines and avoid flopping over onto the sidewalk or roadway.



Ferko Playground Bumpout



Mt Airy Church Bumpout



QUEEN LANE BUMPOUTS

BUMPOUT WITH SHRUBS

DESIGN CHALLENGES

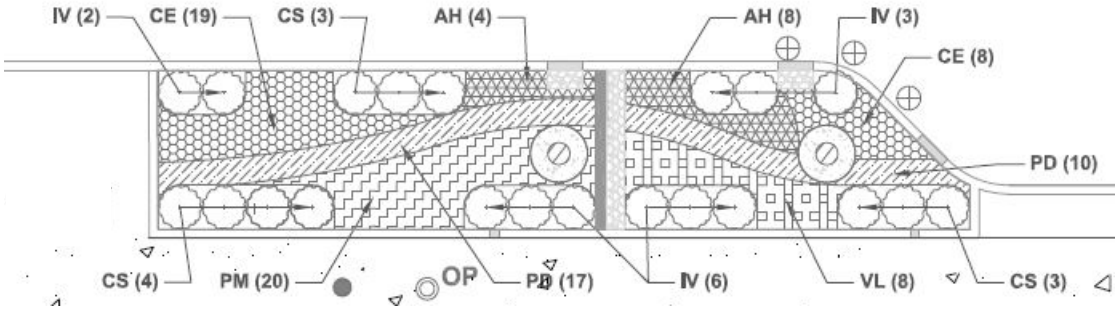
- Bumpouts will have roadway pollution, significant inundation as well as periods of drought
- Plants must be low to preserve sight lines
- Drop-off on sidewalk side



SOLUTIONS

- The plant palette includes species with drought and inundation tolerance able to handle salts and other urban pollutants
- Shrubs are planted along the sidewalk edge to buffer drop-off
- Plants with contrasting colors and textures help to create interest in a palette of uniform heights





Not to Scale

Cornus sericea



Itea virginica



Amsonia hubrichtii



Carex emoryi



Penstemon digitalis



Pycnanthemum muticum



Vernonia lettermanii



Location: 1898 W. 65th Ave.

BUMPOUT WITH TREES

DESIGN CHALLENGES

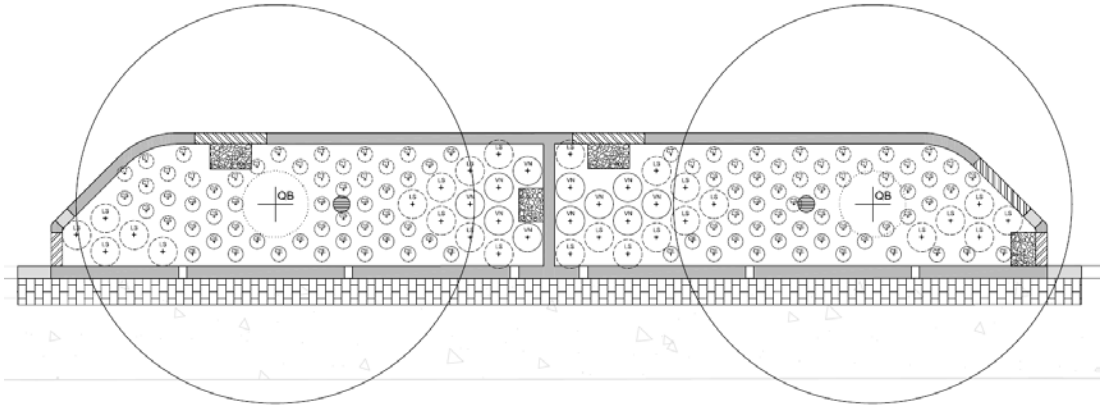
- High traffic area with desire for trees to make bumpouts highly visible
- Plants must be able to handle full sun conditions when initially planted and also partial shade as new trees grow



SOLUTIONS

- Trees are limbed up to preserve sight lines
- Selected groundcover can handle both full sun and partial shade and is low to preserve sight lines





Not to Scale

Quercus bicolor



Carex emoryi



Carex stricta



Carex vulpinoidea



Vernonia lettermanii



Location: 3110 W. Queen Lane

Rain Gardens

Potential Challenges

- Rain gardens can have the most variability in hydrology, existing site conditions, and shape design relative to the other GSI typologies.
- Rain gardens can have significant visible grade changes.
- Rain gardens may be adjacent to other site programming.
- Concentrated high-energy flows from outfall locations can cause erosion within the system, and sheet-flowing adjacent runoff can cause erosion at the edges and slopes.

Recommended Landscape Approaches

GENERAL

- Rain gardens may have varying environmental conditions. A sun-shade study should be completed along with a definition of the hydrologic zones.
- Select species depending on the size of the rain garden. Smaller gardens with little environmental variation will require fewer species than larger gardens with more variation.
- The rain garden should fit with the surrounding landscape, considering preferences of the landowner and user groups.
- Consider edge conditions of rain garden - to avoid slope erosion, may want to use curb, cobble, or other treatment to direct flow. (Refer to the *"Define the Edge"* section of this document)

TREES

- Can use trees to provide structure, shade, spring blooms, fall color, and wildlife habitat.
- Rain gardens present an opportunity to plant multi-stemmed as well as single-stemmed trees.

SHRUBS

- Shrubs planted along the edge of the system can create a barrier from other site uses.

FLOWERING HERBACEOUS, GRASSES & GROUNDCOVERS

- Use color and texture to create the showiest display for the time of year a site will be most active.



Harrowgate Park Rain Garden



Welsh School Rain Garden



WISSINOMING PARK RAIN GARDEN

ACTIVE RECREATION SITE

DESIGN CHALLENGES

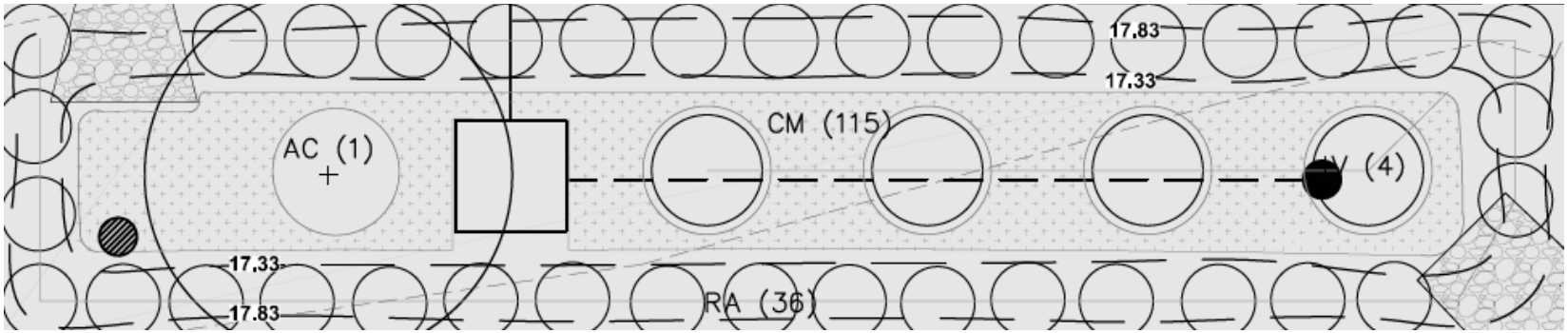
- Small recreational site with high levels of activity



SOLUTIONS

- Simple planting palette for a small space. Trees, shrub, and groundcover layers fill the space
- Sumac spreads quickly and is resistant to trampling





Not to Scale

Amelanchier canadensis



Rhus aromatica



Ilex verticillata



Carex morrowii



Location: S. 20th St. & Tasker St.

TRAFFIC TRIANGLE

DESIGN CHALLENGES

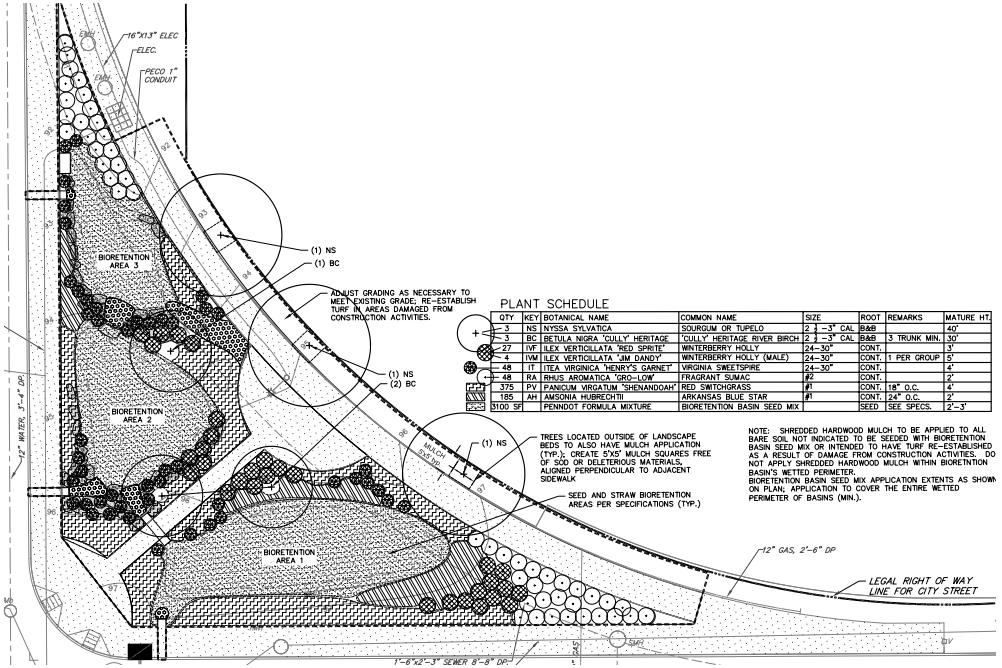
- Highly visible location with pedestrian activity
- Must meet PennDOT standards Pub 408
- 3 hydrologic zone changes
- Existing sewer lateral beneath project area



SOLUTIONS

- Plant selection provides a variety of colors and textures year-round
- Pedestrian pathways cut through the site
- Trees kept away from the existing sewer and away from street side to preserve site lines





PLANT SCHEDULE

QTY	KEY	BOTANICAL NAME	COMMON NAME	SIZE	ROOT	REMARKS	MATURE HT.
3	NS	NYSSA SYLVATICA	SOURGUM OR TUPELO	2 ½ –3" CAL	B&B		40'
3	BC	BETULA NIGRA 'CULLY' HERITAGE	'CULLY' HERITAGE RIVER BIRCH	2 ½ –3" CAL	B&B	3 TRUNK MIN.	30'
27	IVT	ILEX VERTICILLATA 'RED SPRITE'	WINTERBERRY HOLLY	24–30"	CONT.		3'
4	IVM	ILEX VERTICILLATA 'JIM DANDY'	WINTERBERRY HOLLY (MALE)	24–30"	CONT.	1 PER GROUP	5'
48	IT	ITEA VIRGINICA 'HENRY'S GARNET'	VIRGINIA SWEETSPIRE	24–30"	CONT.		4'
48	RA	RHUS AROMATICA 'GRO–LOW'	FRAGRANT SUMAC	#2	CONT.		2'
375	PV	PANICUM VIRGATUM 'SHENANDOAH'	RED SWITCHGRASS	#1	CONT.	18" O.C.	4'
185	AH	AMSONIA HUBRECHTII	ARKANSAS BLUE STAR	#1	CONT.	24" O.C.	2'
3100 SF		PENNDOT FORMULA MIXTURE	BIORETENTION BASIN SEED MIX		SEED	SEE SPECS.	2'–3'

NOTE: SHREDDED HARDWOOD MULCH TO BE APPLIED TO ALL BARE SOIL NOT INDICATED TO BE SEEDED WITH BIORETENTION BASIN SEED MIX OR INTENDED TO HAVE TURF RE–ESTABLISHED AS A RESULT OF DAMAGE FROM CONSTRUCTION ACTIVITIES. DO NOT APPLY SHREDDED HARDWOOD MULCH WITHIN BIORETENTION BASIN'S WETTED PERIMETER.
BIORETENTION BASIN SEED MIX APPLICATION EXTENTS AS SHOWN ON PLAN; APPLICATION TO COVER THE ENTIRE WETTED PERIMETER OF BASINS (MIN.).

Not to Scale

Nyssa sylvatica



Betula nigra



Ilex verticillata



Itea virginica



Rhus aromatica



Panicum virgatum



Amsonia hubrichtii



Location: Stenton Ave & E. Washington Ln.

PASSIVE PARK WITH SMALL/MEDIUM SYSTEM

DESIGN CHALLENGES

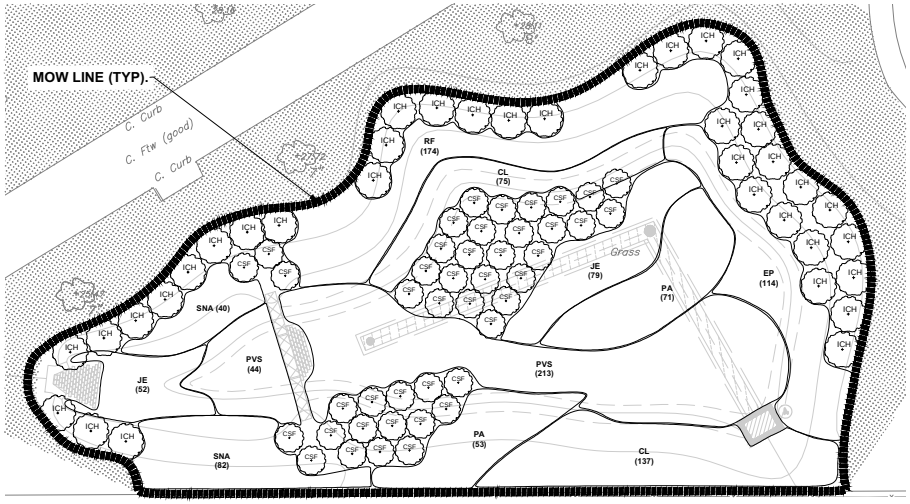
- Several large trees
- Community wanted a garden-like appearance



SOLUTIONS

- Existing trees were preserved and protected as much as possible
- Plants are selected with respect to sun and shade patterns
- Contrasting textures and colors provide interest year-round





Echinacea purpurea



Rudbeckia hirta



Symphyotrichum laeve



Cornus sericea



Juniperus horizontalis



Pennisetum alopecuroides



Panicum virgatum



Juncus effusus



Location: Harrowgate Park, Kensington Ave. & E. Tioga St.

PASSIVE PARK WITH LARGE SYSTEM

DESIGN CHALLENGES

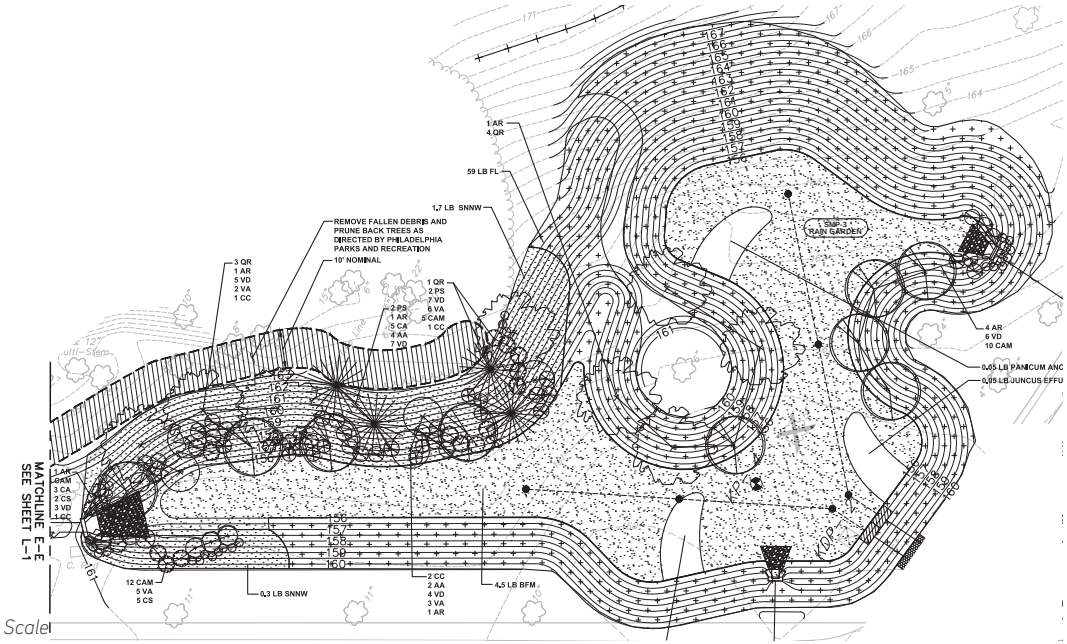
- Very large stormwater basins within a well-loved community park
- Community desired colorful plantings and a well-defined and intentional landscape
- Community requested that site lines be preserved



SOLUTIONS

- Bottom and side of the basin is seeded with low-maintenance grasses
- Massings of colorful shrubs and perennials create "ribbons of color" along the top and bottom of the slopes
- Existing trees were preserved





Not to Scale

Cercis canadensis



Quercus rubra



Cornus sericea



Rudbeckia fulgida



Echinacea purpurea



Physocarpus opulifolius



Coreopsis verticillata



Hibiscus moscheutos



Pycnanthemum muticum



Sedum x



Festuca longifolia



Location: Kemble Park, Ogontz Ave. & W. Olney Ave.

SCHOOLYARD

DESIGN CHALLENGES

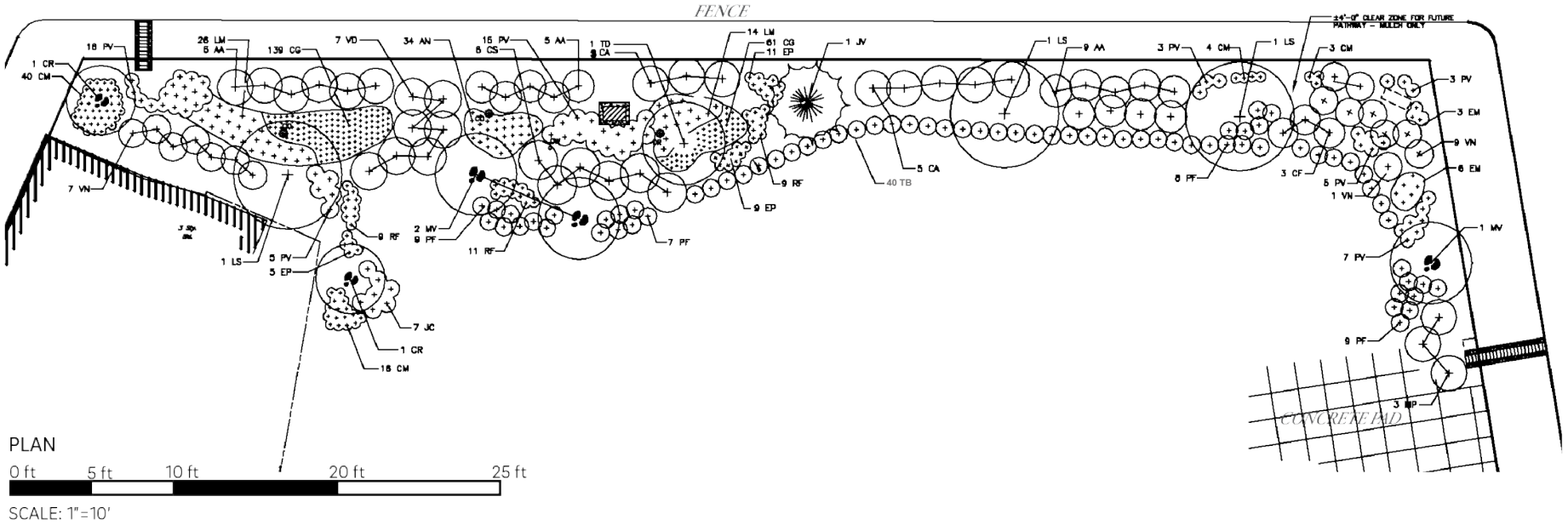
- Active play area adjacent to an edge of the SMP
- Desire to promote educational opportunities and support habitat
- Site is most active in fall, winter, and spring



SOLUTIONS

- Evergreen shrub borders protect the edges
- Diverse plant community with natives to Pennsylvania provides educational opportunities
- Colorful shrubs and grasses provide interest year-round





PLAN

0 ft 5 ft 10 ft 20 ft 25 ft

SCALE: 1"=10'


Gleditsia triacanthos


Magnolia virginiana


Taxodium distichum


Aronia arbutifolia


Juniperus virginiana


Cornus sericea


Myrica pensylvanica


Carex pensylvanica


Panicum virgatum


Baptisia australis


Helleborus niger

Location: Montrose St. & S. 6th St.

SYSTEM ADJACENT TO SCHOOL (IN ROW)

DESIGN CHALLENGES

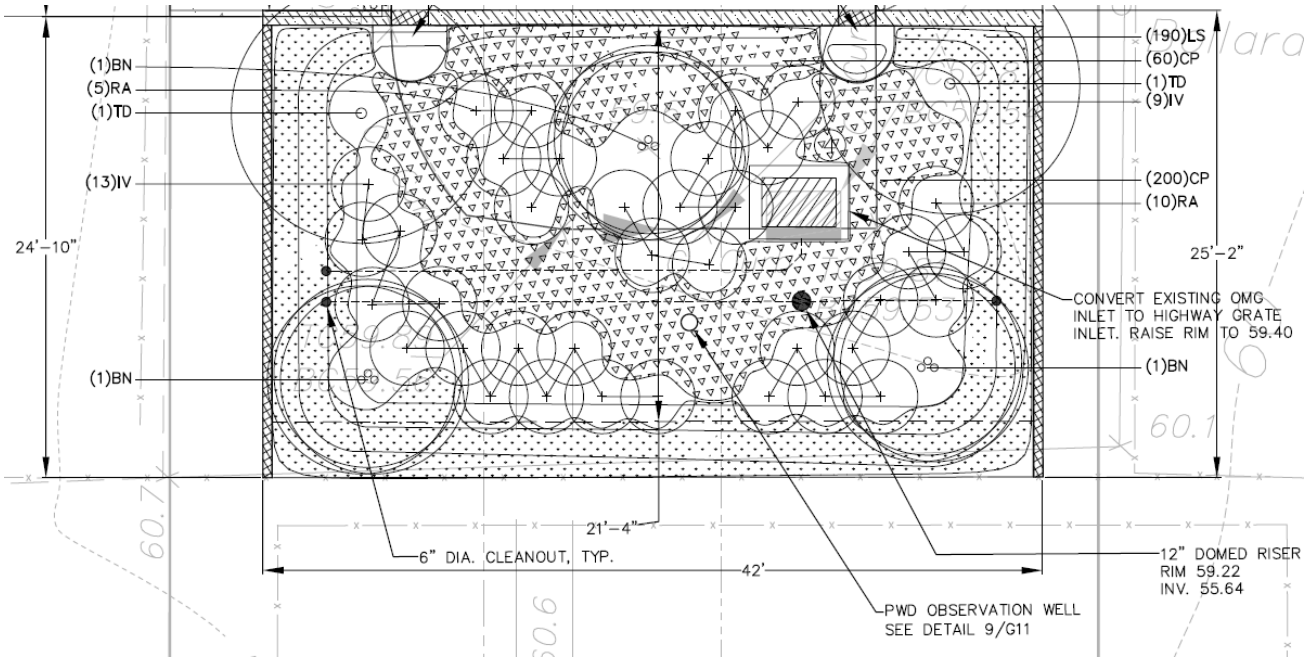
- Located at a dead end street, at edge of school fields
- Site will be most viewed in the fall/winter when school is in session



SOLUTIONS

- Emphasis is on fall and winter color (birch has interesting texture while sweetspire and sumac turn brilliant red in fall)
- Groundcover is low to the ground to preserve sight lines





Betula nigra



Taxodium distichum



Itea virginica



Rhus aromatica



Carex pensylvanica



Liriope spicata



Location: 4th St. & Dakota St.

Landscape Design Requirements



chapter 5

BERKS & SEDGLEY RAIN GARDEN

Introduction

This section of the guidebook lists requirements that designers must follow when designing GSI for the Philadelphia Water Department (PWD). The information presented is developed to provide consistency between documents and system designs produced for PWD.

5.1 Design Requirements

DESIGN REFERENCES

- City of Philadelphia guidelines for street tree placement must be followed. These guidelines are listed in this manual (the *"Construction Tree Protection"* section), and also published in the Philadelphia Complete Streets Design Handbook.
- Use the design guidance given throughout this manual when producing the landscape plans for GSI projects. For further design guidance not listed in this manual, refer to resources listed in *"Chapter 6: References"*.

DRAFTING

- For drafting requirements, see PWD's GSI Survey and Drawing Standards.
- Component Tree ID numbers are generated by GSO at the time of utility review. These will need to be included in the correct formate on the landscape plans, as noted by the PWD GSI Survey and Drawing Standards.

PLANT SELECTION

- All landscape plans produced for the Philadelphia Water Department should select species from *Chapter 3: Plant Selection* (unless otherwise approved). Characteristics for each species are listed to provide guidance on plant selection. If a species is not suitable for a specific part of a system (such as hydrologic zone, salt tolerance, etc), it should be revised accordingly. All exceptions to the full list must be approved by the Department on a project by project basis.

PROPOSED PLANT SIZES, SPACING, AND SOILS

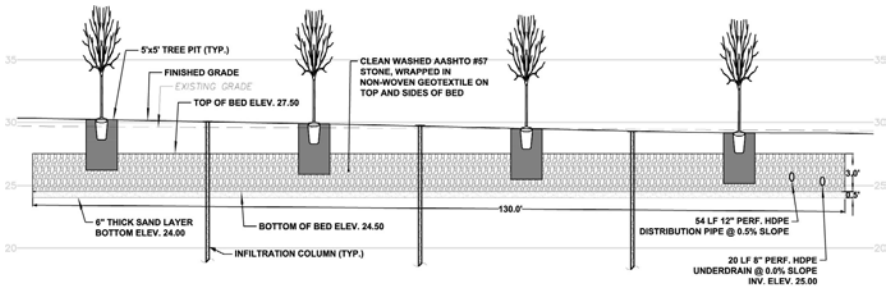
- Maximize tree pit openings and soil box volumes as much as possible. Tree pits should be a PWD standard dimension (refer to *"PWD Street Tree Standards"*).
- Stormwater Soil is generally applied to systems where stormwater runoff is directed to pass through the soil profile for system function, whereas Planting Soil is generally applied where stormwater runoff is not directed to pass through the soil profile for system function. Designers should reference the PWD Green Master Specification for further information.
- Compost and mulch (3" depth) will be applied to PWD soils (whether it is Stormwater or Planting Soil) before planting vegetation.
- 36" of soil depth should be provided as a minimum for tree pits in GSI systems. It is preferred, but not required that tree pits extend to the subgrade without stone storage below. For parcel based projects, where the subgrade is better suited for plant growth, and there is no stone beneath the tree pit, 24" of new soil depth may be acceptable. This must be approved by PWD before specifying less than 36". For further guidance, refer to the guidelines listed in this manual, as well as the ANSI Z60.1 requirements.
- *"Table 5.1.1 : Plant Sizes and Spacing"* demonstrates the approved ranges for PWD's GSI Projects.

Table 5.1.1 : Plant Sizes and Spacing

TYPE	SUB-TYPE	SIZE	CONT.	SPACING*	SOIL DEPTH*
Tree	Single stem	2 - 2 1/2" cal.	B & B	Width of mature tree	36"
	Multi-stem or Coniferous	5 - 6' ht., 6-8' ht., 8'-10' ht., or 10'-12' ht.	B & B or Container	Width of mature tree	
	Trees in Vegetated Systems	#10, #15, #20, #25	Container	Width of mature tree	36"
Shrub	All Shrubs	#3, #5, #7	Container	30" - 48"	24"
Herbaceous/ Grass	Containers	#1 - #2	Container	15" -24"	24"
	Plugs	4" min.	Tray	6 - 12"	18"
	Seed mixes	*N/A*	Bag	Broadcast seed	18"
	Bulbs	*N/A*	Container or Bag	6 - 18"	12"
	Lawn (Seed)	*N/A*	Bag	Broadcast seed	6"
	Lawn (Sod)	*N/A*	Pallet	Sod installation	6"
	Lawn (Hydroseed)	*N/A*	Equipment/ Labor	Hydroseed installation	6"
For more information on plant spacing, refer to "Table 2.2.1: Plant Spacing Table & Diagram"					

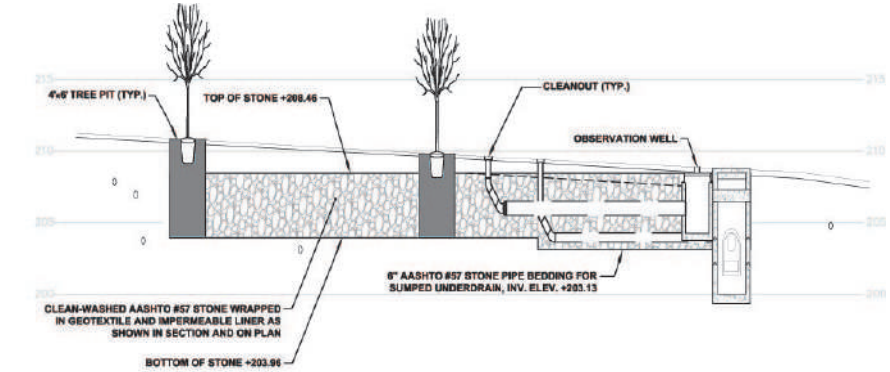
The above size and spacing parameters must be followed. If other sizing is desired, it must be approved by PWD and will be considered on a project by project basis. Spacing ranges refer to the mature spread/ width of the species - specify accordingly.

Figure 5.1.1: Example Tree Pit Design with 36" Depth of Soil



This design shows a series of tree pits with 36" soil depths, and a PWD standard 5'x5' tree pit opening.

Figure 5.1.2: Example Tree Pit Design with Greater than 36" Depth of Soil



This design shows a pair of tree pits with greater than 36" soil depths, extended to the subgrade without stone storage below, and a PWD standard 4'x6' tree pit opening.

Figure 5.1.3: Root ball Sizing

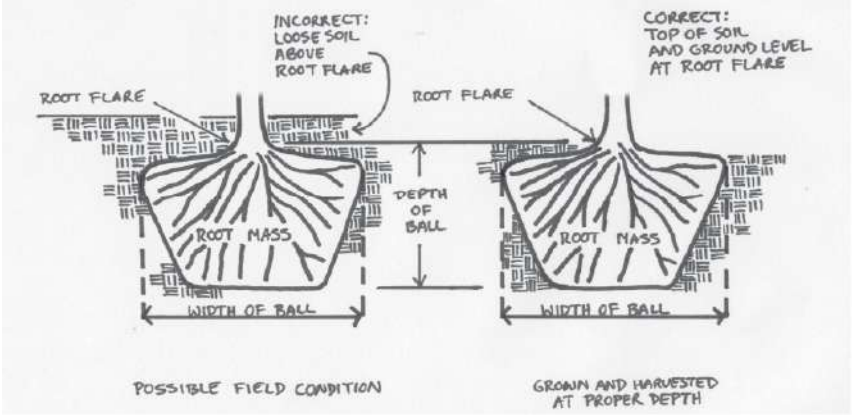


Diagram showing the proper B&B harvesting based on ANSI Z60.1 standards. (ANSI Z60.1)

Table 5.1.2: Container Class Volume Ranges

Table 1 – Container class volume ranges

Container class specification	Container volume range		Box size equivalent
	Cubic Inches Min - Max	Cubic Centimeters Min - Max	
#SP1	6 ½ - 8	106 - 131	
#SP2	13 - 15	213 - 246	
#SP3	20 - 30	328 - 492	
#SP4	51 - 63	836 - 1033	
#SP5	93 - 136	1524 - 2229	
#1	152 - 251	2492 - 4115	
#2	320 - 474	5246 - 7770	
#3	628 - 742	10285 - 12164	
#5	785 - 1242	12860 - 20360	
#7	1337 - 1790	21913 - 29343	
#10	2080 - 2646	34090 - 43376	
#15	2768 - 3696	45376 - 60589	
#20	4520 - 5152	74096 - 84457	20-inch box
#25	5775 - 6861	94669 - 112472	24-inch box
#45	9356 – 11,434	153317 – 187377	36-inch box
#65	13514 - 16517	221456 – 246051	42-inch box
#95/100	20790 – 25410	340686 - 416394	48-inch box

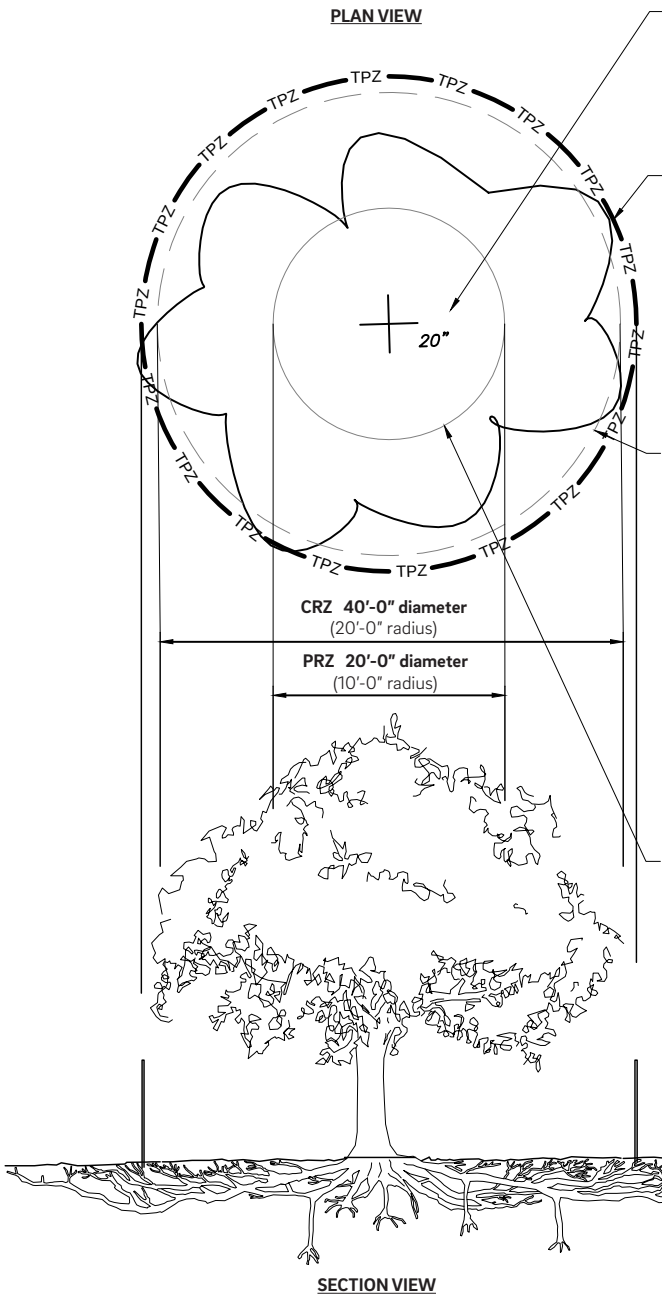
Table showing the acceptable soil volume ranges per container class specification based on ANSI Z60.1 standards (ANSI Z60.1).

Construction Tree Protection

- Existing trees and other vegetation that will remain as part of the project must be shown at their current size. Accurate, to-scale, dripline(s) of tree canopies and trunk DBH size(s) must be shown in accordance with the GSI Survey and Drawing Standards.
- Healthy existing trees should be preserved whenever possible, following the Construction Tree Protection requirements listed in the GSI Typical Details, the Survey and Drawing Standards as well as the Master Green Specifications.
- Designers are responsible for determining where the Critical Root Zone (CRZ) and Prohibited Root Zone (PRZ) are for all trees adjacent to anticipated construction areas and activities. Establishing these extents will determine which areas are acceptable for excavation, trenching, and compaction from heavy equipment.
- Tree Protection Zone (TPZ) must be shown on E&S plans for all trees being preserved that are adjacent to or within the Limit of Disturbance (LOD). Site access points should be considered when drafting and specifying the layout and amount of fencing needed for the construction tree protection. The area within the construction tree protection fencing is referred to as the TPZ and should be labeled as such on the plans. Once established with fencing, **no** work, including excavation or placement of equipment, should occur within this zone. To accurately delineate the TPZ, one foot of radius from the trunk of the tree should be established for each diameter inch of DBH.

  Example: a 10" DBH tree would have a TPZ that is 10 feet in radius (20 feet in diameter) away from the trunk of the tree all the way around.
- Since the TPZ is depicting a fenced area around trees that are to be protected, the line should be drafted to accurately show the extents of a single tree or grouping of trees and their associated CRZ(s) that are to be protected with construction tree protection fencing (see figures in this section).
- If the limit of disturbance requires disturbing existing trees, then permission must be given from both PWD and the landowner. Additional protection such as a mulch layer and planking around the trunk of the tree may be needed if access is necessary within the CRZ of a tree that will remain. The extents of mulch will then need to be shown on the E&S plans (see *"Figure 5.1.5: Construction Tree Protection with Root Buffer Protection"*) in addition to a planking detail (typically used for street trees - see Master Green Specification) if work must occur within the CRZ. This all should be confirmed with the project manager.
- Trees that are 12" DBH or less shall not be considered to possess a CRZ for the purposes of project review, however; they shall possess a PRZ that must be protected.
- For more information on Construction Tree Protection, see the GSI Typical Details and Section 01535 Construction Tree Protection in PWD's Master Green Specification (request the latest version of the specification from your project manager).

Figure 5.1.4: Typical Construction Tree Protection



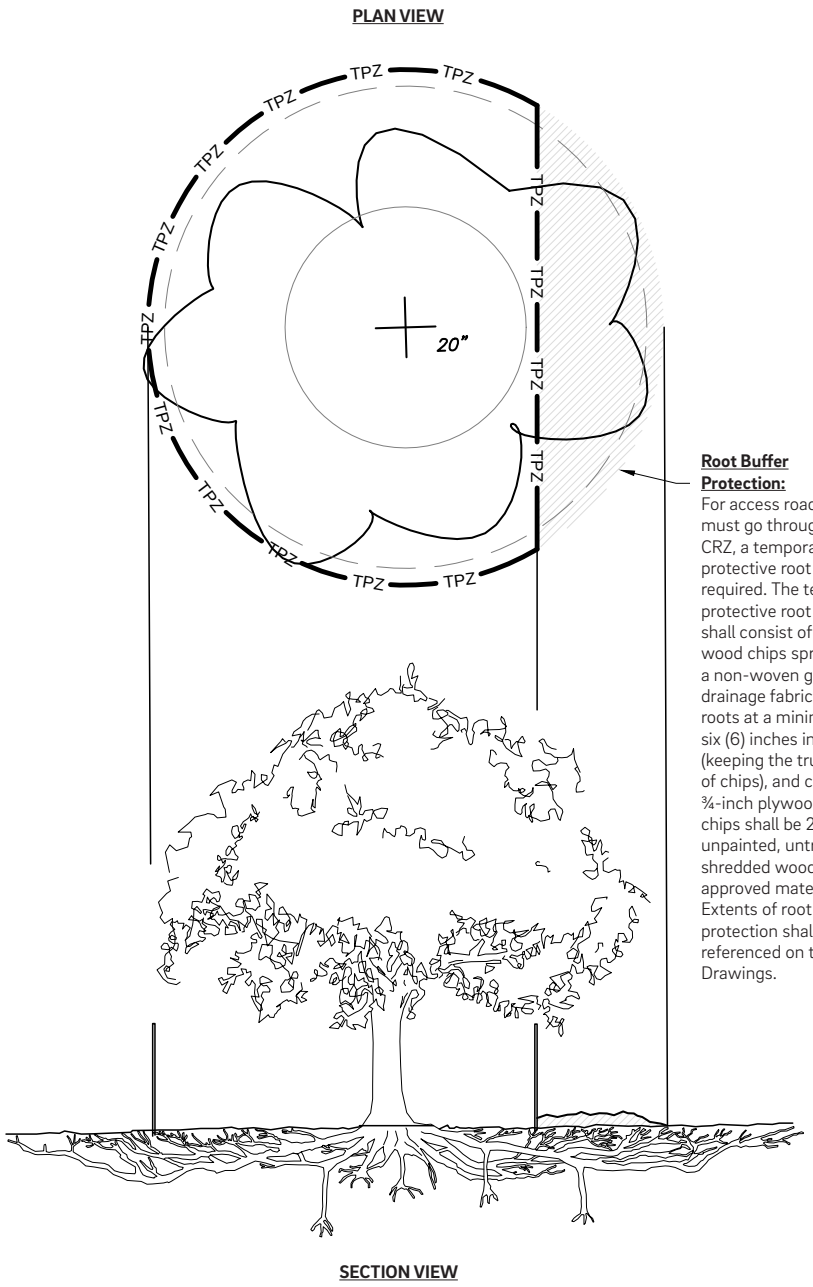
Diameter at Breast Height (DBH):
The diameter at breast height (DBH) refers to the diameter of the tree trunk at four and a half feet (4 ½') from ground surface. This is a standard measurement used by tree professionals.

Tree Protection Zone (TPZ):
The tree protection zone (TPZ) refers to the arborist defined area surrounding the trunk intended to protect the roots and soil to ensure future tree health and stability. The TPZ is comprised of tree protection fencing using the dimension of the CRZ, unless otherwise authorized by PWD or the PP&R Arborist. The TPZ shall be installed as shown on the Drawings.

Critical Root Zone (CRZ):
The critical root zone (CRZ) shall be a zone surrounding a tree equal to one (1) foot in radius for each one (1) inch DBH of the tree to be protected. Excavation within the CRZ by mechanical means is prohibited; all excavation shall be performed with hand tools and care taken to disturb as little of the existing root formations as possible. The CRZ shall be delineated using tree protection fencing. Tree protection fencing shall be as indicated on the Drawings. If no tree protection fencing is identified on the Drawings, the tree protection fencing shall be as depicted in the Erosion and Sediment Control Detail attached to these Specifications.

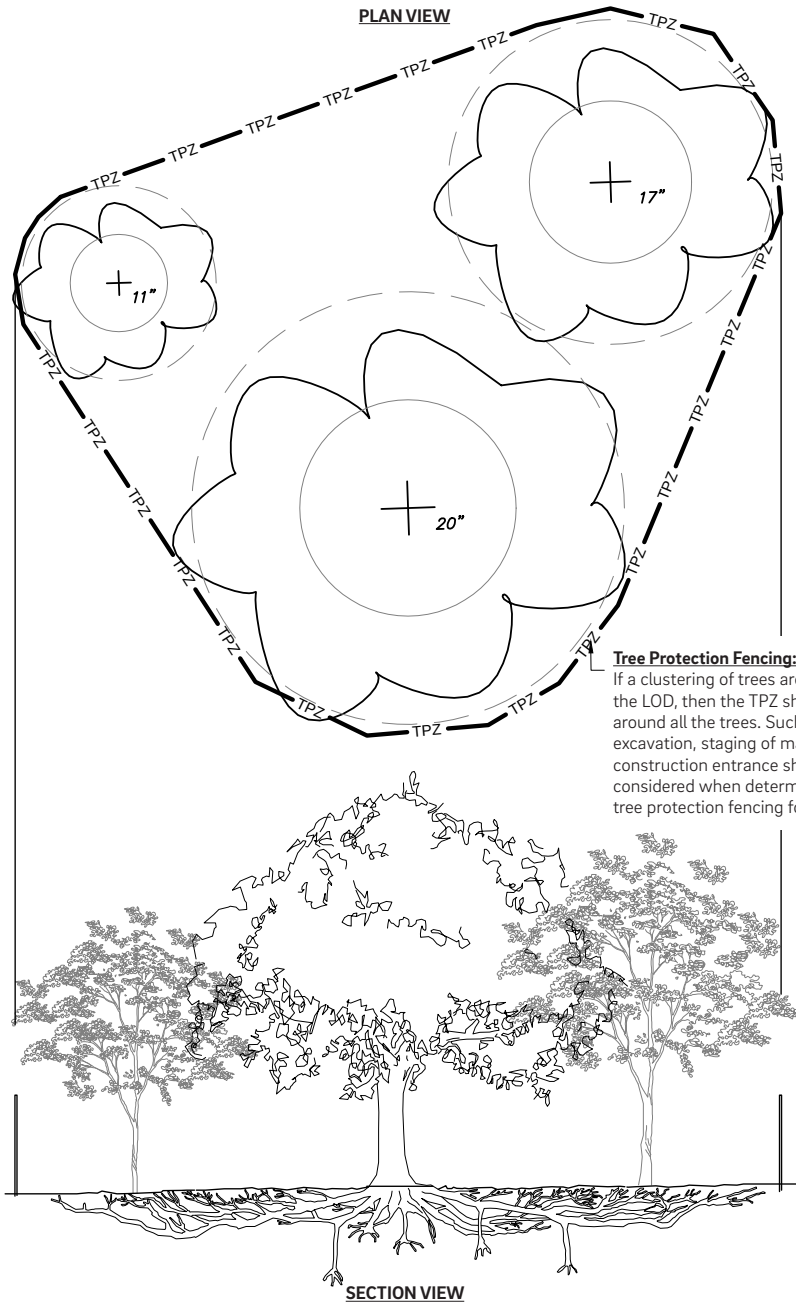
Prohibited Root Zone (PRZ):
The prohibited root zone (PRZ) shall be a zone surrounding a tree equal to one-half (½) foot in radius for each one (1) inch DBH of the tree to be protected. Excavation within the PRZ is prohibited, unless specifically authorized by the City/ Project Arborist. In no instance shall excavation within six (6) feet of the base of a tree be authorized. Tree replacement or equivalent compensation may be required for any extensive root system damage caused by construction activities.

Figure 5.1.5: Construction Tree Protection with Root Buffer Protection



Root Buffer Protection:
For access roads that must go through the CRZ, a temporary protective root buffer is required. The temporary protective root buffer shall consist of shredded wood chips spread on a non-woven geotextile drainage fabric, over the roots at a minimum of six (6) inches in depth (keeping the trunk clear of chips), and covered by ¾-inch plywood. Wood chips shall be 2-inch unpainted, untreated shredded wood or approved material. Extents of root buffer protection shall be referenced on the Drawings.

Figure 5.1.6: Construction Tree Protection of a Grouping of Trees



Tree Protection Fencing:
If a clustering of trees are within or adjacent to the LOD, then the TPZ should be established around all the trees. Such things as limits of excavation, staging of materials, and access/ construction entrance should also be considered when determining the extents of tree protection fencing for the TPZ.

Street Tree Standards

The street offset guidelines are taken from the Philadelphia Complete Streets Design Handbook. See the *"Figure 5.1.8: Street Tree Planting Diagram"* diagram that illustrates the Philadelphia Streets Department spacing requirements. This diagram can be found at *https://www.phila.gov/departments/department-of-streets/design-construction/standards-and-guidelines/#/?table=Furnishing%20zone%20detail*.

Where PWD standards differ from Streets Department standards, the information is called out on the diagram and listed below.

PWD Street Tree Standards

TREE PIT SPACING

- Understory Tree Spacing (15 ft - 20 ft): Understory trees should only be used in situations where there are overhead wires, space constraints, or specifically requested by the community.
- Canopy Tree Spacing (20 ft - 30 ft): Larger, canopy trees should be used in most instances where there are no overhead constraints.
- Spacing recommendations may vary within ranges depending on the specific species or length and layout of the block. Confirm spacing design with project manager.

TREE PIT SIZES

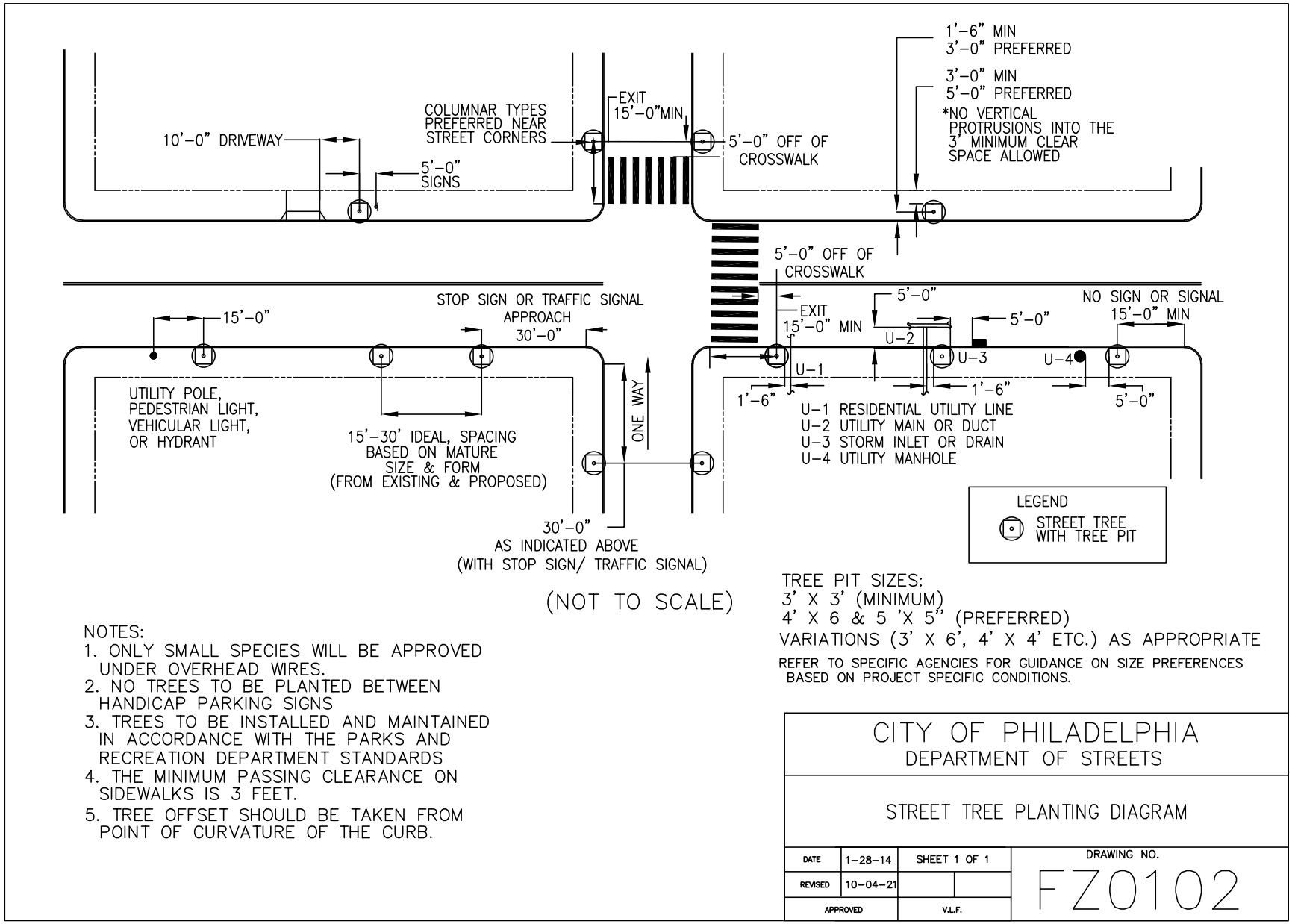
- 4′ x 6′
- 5′ x 5′
- 3′ x 6′ (Narrow Site Conditions Only)

Figure 5.1.7: Tree Placement on Residential Block



Morris Leeds School - Tree placement along residential block; following guidelines shown in Fig. 5.1.8.

Figure 5.1.8: Street Tree Planting Diagram



City of Philadelphia Streets Diagram illustrates street tree placement and offset requirements on Philadelphia City blocks. For PWD street tree standards, including tree pit dimensions and street tree spacing, refer to Chapter 6 'PWD Street Tree Standards' (page 94).

References



chapter 6

29TH & CHALMERS BUMPOUT


NATIONAL CEMETERY SWALE

Philadelphia Water Department Resources

GSI Planning & Design Resource Directory

A complete catalogue of all resources needed to provide GSI planning & design services to PWD. Pertinent documents to landscape design include:

- Approved Plant List Spreadsheet
- Maintenance Manual
- Planning & Design Manual
- Typical Details
- Survey and Drawing Standards

(http://philadelphiawater.org/gsi/planning-design/resource_directory.html)

Green Streets Design Manual

The Philadelphia Water Department worked closely with the Mayor's Office of Transportation and Utilities, the Streets Department, Philadelphia Parks and Recreation, and other public utilities, partners, and agencies to develop detailed design templates for green streets that are flexible enough to be applied in a variety of urban street conditions. (http://www.phillywatersheds.org/img/GSDM/GSDM_FINAL_20140211.pdf)

Plant Reference Tools

Integrated Taxonomic Information System

This website houses authoritative taxonomic information for plants, animals, fungi, and microbes. (www.itis.gov/index.html)

Guidebook of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation, and Uses by Michael Dirr

A thorough reference on trees and shrubs.

National Wetland Plant List

The U.S. Army Corps of Engineers maintains the National Wetland Plant List, which includes wetland indicator statuses and related documents. (rsgisias.crrel.usace.army.mil/NWPL/)

The Plants of Pennsylvania by Ann Fowler Roads and Timothy A. Block

An illustrated guide to the flora of Pennsylvania.

USDA Plants

This website has plant fact sheets, information about invasive and noxious weeds, and details about wetland indicator statuses. (http://plants.usda.gov/)

Missouri Botanical Garden Plant Finder

This website has a large list of all types of plants and their associated characteristics, culture, problems, and suggested garden uses. (http://www.missouribotanicalgarden.org/plantfinder/plantfindersearch.aspx)

Cornell University: Urban Horticulture Institute

A compilation of resources related to urban horticulture. (http://www.hort.cornell.edu/uhi/outreach/index.htm)

AmericanHort

An organization that manages industry nursery stock standards through ANSI Z60.1 requirements. Refer to the 2014 version of the standards on their website. (http://americanhort.org/)

Native Trees, Shrubs, and Vines for Urban and Rural America by Gary L. Hightshoe

A reference for trees, shrubs, and vines.

Other Resources

Up By Roots: Healthy Soils in the Built Environment by James Urban, FASLA

James Urban, FASLA is an expert in the field of urban arboriculture and soils. This book and his website (http://www.jamesurban.net/) are resources that are meant to be referenced when designing systems that involve trees.

Planting in a Post-Wild World by Thomas Rainer and Claudia West

A practical guide to designing plant communities for resilient landscapes.

Sowing Beauty by James Hitchmough

A skilled guide on how to design landscapes with sown seed. Describes how to maintain sown spaces over time.

Planting: A New Perspective by Piet Oudolf and Noel Kingsbury

A practical guide to designing plant communities for resilient landscapes.

Green Stormwater Infrastructure

Landscape Design Guidebook

PHILADELPHIA WATER DEPARTMENT