Appendix F – Planting Guide

Summary

This appendix provides an overview of planting considerations for structural stormwater Best Management Practices (BMPs), with the goal of selecting plants that are well-suited for a specific design and site. This planting guide provides information on incorporating native plantings that are well-adapted to site conditions and plants that are most tolerant to site limitations. The guidance also includes several examples of planting pallets to meet aesthetic and functional goals.

Maintenance and Care Considerations

As with any element of a stormwater BMP, plantings require maintenance and care. This care can be simplified with careful consideration of planting needs. The following key concepts can help ensure success, reduce maintenance needs, and create an aesthetically pleasing stormwater BMP:

- **Planting schedule.** Newly established trees will be stressed when planting in high heat and low water conditions, while many perennials will be stressed by a late frost.
- **Planting methods.** There are some simple tricks of the trade to help plantings become more self-sufficient. For example, coercing some tree roots to grow deeper into soils by setting up a system for deep watering rather than surface watering.
- **Intercropping.** While the term intercropping primarily applies to large-scale agriculture, the principles can be applied to any garden or landscaping. Planting nitrogen fixers can reduce fertilization needs or improve poor soil, and planting ground covers can reduce erosion, weeding and watering needs, and more.
- **Planting Tolerance.** Each plant has an ability or limited ability to handle various chemicals, moisture, and temperature extremes. The simplest way to address this is to implement native plants well-conditioned to the site conditions.

Each of these concepts is described in greater detail in the sections below, including additional resources to find further information. In addition to being strategic with site design to minimize maintenance, there are also methods to make maintenance of plantings easier. The table below outlines routine maintenance needs and some considerations to make maintenance easier.

Maintenance Consideration	Frequency	Level of Expertise Required	Other Tips
Watering	Initial planting may need more frequent watering (i.e., weekly or every other week).	None	➢ Training roots to grow deep with underground watering can make your planting less dependent on your efforts. ➢ Mulching and setting drip lines beneath (avoiding top watering) can help reduce waste to evapotranspiration and make each watering more efficient. ➢ Timing planting during shoulder seasons where rain is more likely to occur can reduce watering needs. ➢ Companion planting with ground cover can help reduce evaporation much like mulching.
Weeding & Trash Removal	Trash removal is location dependent. Weeding typically will need to be monthly but can be strategically reduced see column to right.	Minimal knowledge of weeds versus desirable plantings.	➢ Some traditional weeds can be beneficial neighbors, consider allowing those that do provide benefits to your planting to sustain and only eliminate those that may be damaging to your site, such as an invasive like bittersweet. ➢ Mulching and ground cover can reduce the need to frequently weed and water
Fertilization	Annual	Some gardening knowledge. Fertilizer should only be used in quantities necessary for specific plantings.	➢ Timing with optimal weather conditions can limit run off and root burn. ➢ Companion planting can reduce fertilization needs, see the plant list below.
Structure Stabilization	Annual /Additional as needed per storm frequency	Some knowledge in landscape design (or engineering if design is complex)	➢ Cover crops can help stabilize sloping sides and reduce maintenance needs.
Soil Health	Project start and as needed (if needed).	Minimal knowledge needed if test is sent to a lab.[98]	

[98] Connecticut Agriculture Experiment Station offers free soil testing to Connecticut residents.

Safety Consideration

Before beginning construction of any kind, one must assure the safety of those involved in site construction as well as long-term maintenance of the site including stormwater management measures. Consider access for maintenance – what are the risks at the site and can they be mitigated? Consider what may lay below ground at the site. Anyone using power or mechanized equipment who disturbs the earth on or below the surface must call the clearinghouse for a location request. You must call for a locate request at least two full working days but not more than 30 days before any excavation starts excluding holidays & weekends). There are two ways to access this free service:

1. File an online e-ticket at https://www.cbyd.com/
2. Call 811

Planting Selection

When selecting plants, the primary considerations are the local environmental factors and the intended function of the site. When considering these factors, also account for the conditions that the proposed stormwater BMP will create as well as the natural landscape around the site. Below is a list of essentials and potential site considerations:

- **USDA Plant Hardiness Zone.** This is the standard by which landscapers, gardeners, and homeowners can determine which plants will survive at a given location.
- **Frequency of flooding,** whether creating an intentionally planted wet area like a stormwater pond/wetland or evaluating the natural tendency for the site to flood. Not all plants will tolerate flooding; as such, consider the flooding characteristics of the site in addition to the hydrologic conditions that are needed for a specific type of stormwater BMP.
- **Soil Health.** Soil health plays an important role in planting success. If at all possible, limiting the disturbance of the top organic layer is optimal. When this is not possible, there are many plants that can tolerate differing levels of soil quality.
- **Site stabilization.** Consider the effectiveness for the proposed plantings to provide site stabilization. Cover crops and plants with deeper root structure can often function and survive better than many other species.
- **Salinity.** Considering salt tolerance of plant species can mean the difference between a self-sustaining landscape and costly replantings in many sites near roads and sidewalks or coastal sites.
- **Pollutants of concern.** Many plant species are particularly adapted to filtration of particular pollutants and have even been utilized at contaminated sites for these qualities. Knowing the specific potential pollutants of a site will help select plants for optimal

pollutant removal. EPA's Phytoremediation Guide provides a helpful consolidation of phytoremediation resources.

- **Sun Exposure.** Different plant species have differing needs for sunlight. Consider the sun exposure of the site and if the site is to include trees or shrubs that will introduce shading.

In addition to considering site environmental conditions, plant diversity is key to successful functioning and reduced maintenance. A monoculture is far more susceptible to disease and pests and can be more costly in the long run. Plant diversity can provide additional benefits by ensuring a healthier pollinator population, better site stabilization, and less maintenance and fertilization (see the section below on planting companions intercropping for further information). It is also important to avoid introducing invasive species and, where possible, restricting plant selection to native species to help retain diverse, productive landscaping.

As noted above, when developing planting plans choosing plants that can tolerate and thrive in similar or complementary conditions (i.e., shade tolerant plants that will survive beneath shade of tree, or sets of wet tolerant plants for sites like stormwater ponds/wetlands) is necessary for success of the design. There is a plethora of plant databases that provide detailed plant needs, planting instructions, and native status. This authors of this Manual have reviewed and recommend the following to obtain reliable up-to-date information:

- https://plants.usda.gov/
- https://plantdatabase.uconn.edu/
- https://can-plant.ca/ecommerce/woody-plants
- https://plants.ces.ncsu.edu/plants
- https://www.arborday.org/trees/treeguide
- https://www.fs.usda.gov/treesearch/
- https://www.conncoll.edu/the-arboretum/ecological-landscaping/
- https://wetland-plants.sec.usace.army.mil/nwpl_static/v34/home/home.html
- https://www.ct-botanical-society.org/gardening-with-natives/

The additional resources below provide further information for function-specific design and specific maintenance guidance.

- https://nemo.uconn.edu/raingardens/
- https://ct.audubon.org/conservation/plant-native-species
- https://portal.ct.gov/DEEP/Invasive-Species/Invasive-Species
- https://cipwg.uconn.edu/
- https://www.pollinator.org/guides
- https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5368392.pdf
- https://www.conncoll.edu/the-arboretum/ecological-landscaping/
- https://www.wildflower.org/plants/index.php
- https://www.pca.state.mn.us/sites/default/files/pfsd-section2.pdf
- http://www.newmoonnursery.com/plan

- https://cipwg.uconn.edu/wp-content/uploads/sites/244/2013/12/CTCoastal_planting.pdf

Intercropping & Planting Companions

As noted above, the term "intercropping" is typically used in the context of large-scale agriculture, but intercropping principles can be applied to any garden or functional landscaping including stormwater BMPs. "Planting companions" is a more popular term with landscaping and small scale-gardening and can be incredibly useful but can also lead to a variety of unconfirmed sources and information that may be too experimental for the purposes of users of this Manual. Therefore, the focus of this section highlights how intercropping can be beneficial to landscaping/gardening and for stormwater BMPs. As noted by Oliver Duchene et al.:

> *"Intercropping is a powerful way to promote a more diversified plant community in the field, thereby enabling complementary and facilitative relationships."* [99]

Enabling the complementary and facilitative relationships can aid in reducing costs, maintenance needs, increase survivorship of plantings, increase biodiversity, and more. This co-beneficial partnership of plants, while a modern application to commercial farming and government guidance, is far from new knowledge that can be credited to First Nations all around the America's but even right those right here in the Northeast.[100, 101] As such, these practices are not only beneficial financially and sustainably, but also culturally. Some of the key benefits of intercropping with regards to stormwater control are:

- **Attracting Pollinators.** Providing pollinator pathways through landscaping can be aesthetic and provide the additional support needed to assure success of pollinator populations. Even simple actions like allowing for dandelions, clovers and other species commonly found in New England Lawns can be beneficial for pollinators.[102, 103]

- **Deterring or Distracting Pests.** Introducing plants that are either attractive to pests to keep them from your preferred plants or plants that will naturally deter pests can be an

[99] Duchene, Olivier, Vian, Jean-François, and Celette, Florian. legume for agroecological cropping systems: Complementarity and facilitation processes and the importance of soil microorganisms. A review. Agriculture, Ecosystem and Environment. 240,149-616 (2017) https://doi.org/10.1016/j.agee.2017.02.019

[100] Kimmerer,R.W. Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants. Milkweed Editions October 2013.

[101] Kimmerer, R. W Native Knowledge for Native Ecosystems. Journal of Forestry. 98(8):4-9 (2000)

[102] Gathof, A.K., Grossmann, A.J., Herrmann, J. *et al.* Who can pass the urban filter? A multi-taxon approach to disentangle pollinator trait–environmental relationships. *Oecologia* 199, 165–179 (2022). https://doi.org/10.1007/s00442-022-05174-z

[103] https://www.pollinator-pathway.org/about

effective and cost reducing approach. Common Yarrow is a good example, as it will attract insects that are predators to aphids[104, 105] and deter other pests such as mosquitoes.[106]

- **Reducing Watering Needs.** The physical structure of some plants' growing habits can be beneficial. Ground covers can reduce evapotranspiration and runoff and increase infiltration into the soil surrounding other plantings. By reducing the water loss, scheduled waterings can be significantly reduced if not even eliminated in many cases. Several studies have noted reduced water stress and even instances of negating the impacts of arid conditions when utilizing ground cover crops interplanted among the desired plantings.[107, 108, 109]

- **Reducing Fertilization Needs.** Nitrogen is necessary for plant growth but is often applied in such a way that is causes water quality problems. Including plants that are efficient nitrogen fixers can greatly reduce the need for synthetic or fossil-based fertilizer. One study found that this practice, if applied to the world's grain legumes, could reduce the global (for all uses) requirements for fossil-based fertilizers by 26%.[110] Many plants, grasses

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[104] Torsten Meiners, Elisabeth Obermaier, Hide and seek on two spatial scales – vegetation structure effects herbivore oviposition and egg parasitism, *Basic and Applied Ecology*, Volume 5, Issue 1, 2004, Pages 87-94, https://doi.org/10.1078/1439-1791-00182

[105] N. J. Bostanian ,H. Goulet,J. O'Hara,L. Masner &G. Racette Intercropping with Towards Insecticide Free Apple Orchards: Flowering Plants to Attract Beneficial Arthropods. *Bioscience Control and Technology*. Volume 14: Issue 1, 2003, Pages 25-37 https://doi.org/10.1080/09583150310001606570

[106] Jaenson TG, Pålsson K, Borg-Karlson AK. Evaluation of extracts and oils of mosquito (Diptera: Culicidae) repellent plants from Sweden and Guinea-Bissau. *J Med Entomol.*;43(1), Pages 113-9. 2003 https://doi.org/10.1093/jmedent/43.1.113

[107]Nelson, William C. D., Hoffmann, Munir P., Vadez, Vincent, Rötter, Reimund P., Koch, Marian and Whitbread, Anthony M. Can intercropping be an adaptation to drought? A model-based analysis for pearl millet–cowpea. *Journal of Agronomy and Crop Science*. 00, Pages 1-18, 2021 https://onlinelibrary.wiley.com/doi/epdf/10.1111/jac.12552

[108] Baker, Sophie, "Intercropping for Water Conservation: Environmental and Economic Implications of a Sustainable Farming Practice in California's Central Valley" (2020). Scripps Senior Theses. 1583. https://scholarship.claremont.edu/scripps_theses/1583

[109] Nyawade, S.O., Karanja, N.N., Gachene, C.K.K. *et al.* Intercropping Optimizes Soil Temperature and Increases Crop Water Productivity and Radiation Use Efficiency of Rainfed Potato. *Am. J. Potato Res.* 96, 457–471 (2019). https://doi.org/10.1007/s12230-019-09737-4

[110] Jensen, E.S., Carlsson, G. & Hauggaard-Nielsen, H. Intercropping of grain legumes and cereals improves the use of soil N resources and reduces the requirement for synthetic fertilizer N: A global-scale analysis. Agron. Sustain. Dev. 40, 5 (2020). https://doi.org/10.1007/s13593-020-0607-x

and trees have associative relationships with nitrogen fixing bacteria, like clover, switch grass and grey alder, that can provide beneficial nitrogen inputs into the soils.[111, 112]

- **Increasing Biodiversity.** Biodiversity is not only increased by directly diversifying the plant species, but also increases the biodiversity of soil microbes and pest predators in certain conditions.[113, 114]

Planting Palette Examples

Utilizing these principles outlined in this appendix, four planting palette guides are provided in this section for vegetated stormwater BMPs. Designers should use these planting palette guides as determined appropriate and applicable for a given site. These palettes are not exhaustive and are only provided here as examples.

The planting palette guides are guided checklists intended to meet a variety of site needs, including low-maintenance and, where needed, salt-tolerant vegetation. The examples provided in these palette guides are limited to native plants, which are preferred wherever practicable. If non-native species are used, careful and thorough research is required to ensure that invasive species are not introduced. These palettes also include pollinators to support biodiversity and improve the ecosystem by cleaning air, purifying water and soil, and preventing erosion. Note that these palettes are provided as a starting point; it is the ultimate responsibility of the designer to select vegetation that is suited for the project location. Additional and more specific planting palettes that may be useful can be found in the RIDOT Linear Stormwater Manual.

[111] Roley SS, Duncan DS, Liang D, Garoutte A, Jackson RD, Tiedje JM, Robertson GP. Associative nitrogen fixation (ANF) in switchgrass (Panicum virgatum) across a nitrogen input gradient. PLoS One. 13(6), (2018) https://doi.org/10.1371/journal.pone.0197320

[112] Nancy A. Eckardt and David D. Biesboer. Ecological aspects of nitrogen fixation (acetylene reduction) associated with plants of a Minnesota wetland community. Canadian Journal of Botany. 66(7): 1359-1363. https://doi.org/10.1139/b88-190

[113] Viviana Alarcón-Segura, Ingo Grass, Gunnar Breustedt, Marko Rohlfs, Teja Tscharntke. Strip intercropping of wheat and oilseed rape enhances biodiversity and biological pest control in a conventionally managed farm scenario. Journal of Applied Ecology. 59 (6) pages 1513-1523. https://doi.org/10.1111/1365-2664.14161

[114] Lian T, Mu Y, Jin J, Ma Q, Cheng Y, Cai Z, Nian H. Impact of intercropping on the coupling between soil microbial community structure, activity, and nutrient-use efficiencies. PeerJ. 8 (7) (2019). https://doi.org/10.7717/peerj.6412

Figure A-1. Planting Palette Example A

Location Suitability	Legend: Sunny; Partly Shaded; Directly Adjacent to Roadways; Wet Areas						
BMP Suitability	Dry Water Quality Swale	Dry Extended Detention Basin	Stormwater Pond	Bioretention	Infiltration Trench	Infiltration Basin	Filter Strip

Plant Photo	Name	Attributes		Notes
	*Ceanothus americanus,* New Jersey Tea	• Nitrogen fixing • Can grow nutritionally poor soils • Beneficial for pollinators & wildlife • Quick to establish	• Salt tolerant • Deep roots provide good erosion control • Drought tolerant • Best for upland zone • Prefers well drained soils	Spacing 4-5 Feet
	*Lobielia cardinalis,* Cardinal Flower	• Prefers Wet to Moist Soil • Best for Wet meadow, Emergent or Submergent Zones	• Somewhat tolerant of salt and urban pollution	Spacing 18- 24 inches
	*Juncus tenuis,* Path Rush	• Drought and flooding tolerant • Tolerant of compacted soils • Moderately tolerant of salt • Nitrogen fixing	• Good for nesting birds • Good cover crop to reduce weeding needs • Deer Resistant	Spacing 12 inches
	*Asclepias tuberosa,* Butterfly Weed	• Beneficial for pollinators • Drought tolerant • Best for upland zone • Moderate salt tolerance	• Deer resistant • Best to seed in fall	Spacing 18-24 inches
	*Coreopsis tinctoria Nutt,* Golden Tickseed	• Beneficial for Pollinators • Flooding tolerant prefers moist soil • Best for wet meadow and emergent zones	• Moderate salt tolerance	Sow at least 2 lb of pure live seed per acre

Figure A-2. Planting Palette Example B

Location Suitability	**Legend** Sunny	Partly Shaded	Directly Adjacent to Roadways	Wet Areas		
BMP Suitability	Stormwater Pond	Bioretention	Infiltration Trench		Infiltration Basin	Filter Strip

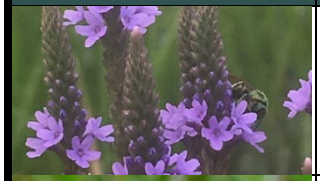
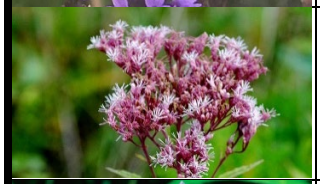
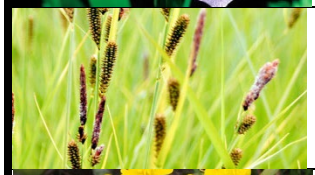
Plant Photo	Name	Attributes		Notes
	*Verbena hastata,* Swamp Verbena	• Livestock will not eat • Beneficial for pollinators • Quick to establish • Prefers wet to moist soil	• Best for wet meadow, emergent or submergent zones • Moderate salt tolerance • Nitrogen fixing	Spacing 12-24 inches
	*Eupatorium maculatum,* Spotted Joe Pye Weed	• Prefers wet to moist soil • Best for wet meadow, emergent or submergent zones • Prefers sandy soils but will grow in non-sandy wetlands	• Beneficial for pollinators • Drought tolerant • Fibrous roots can make it ideal for erosion control	Spacing: 4-5 feet on center
	*Iris versicolor,* Harlequin Blueflag	• Preference for acidic soils • Good filter of excess nutrients • Deer resistant • In wet soils will thrive without fertilizer • Wet to moist soils	• Best for wet meadow, emergent or submergent zones • Roots can be good erosion control	Spacing 2-3 Feet
	*Carex stricta,* Tussock Sedge	• Drought tolerant for short periods • Prefers standing water or moist soils • Deer resistant	• Nitrogen Fixing • Best for wet meadow, emergent or submergent zones • Good filter for water clarity	Spacing 1-3 Feet
	*Caltha palustris,* Marsh Marigold	• Beneficial for pollinators • Flooding tolerant, prefers moist soil • Best for wet meadow and emergent zones • Deer resistant	• High salt tolerance • Alkaline tolerant • Beneficial for wood ducks • Good ground cover	Spacing 12 inches

Figure A-3. Planting Palette Example C

Location Suitability		**Legend** Sunny; Partly Shaded; Directly Adjacent to Roadways; Wet Areas	
BMP Suitability	Bioretention	Dry Extended Detention Basin	
Plant Photo	**Name**	**Attributes**	**Notes**
	*Cercis canadensis L.* Eastern Redbud	• Provides flowers in early spring • Tolerates a wide range of pH but will grow best in alkaline soils • Grows deep tap root in first few years if conditions are conducive • Rounded vase shape provides good summer shade • Known to be wind and ice tolerant • Not salt tolerant • Drought tolerant	Spacing 20-30 Feet
	*Phlox divaricata L.* Wild Blue Phlox	• Beneficial for pollinators • Good ground cover • Tolerant of wide range of soil types and pH • Shade tolerant, good for beneath trees • Drought tolerant • Deer resistant	Spacing 12 inches
	*Phlox subulata,* Moss Phlox	• Beneficial for Pollinators • Drought tolerant • Deer resistant • Prefers sun • Tolerant of nutrient poor soils • Moderately salt tolerant • Mildly alkaline tolerant • Good ground cover	Spacing 12-24 inches

Photo Sources:
Palette A (Top-Bottom): EPA.GOV via wikicommons, Judy Gallagher, CC BY 2.0 via Wikimedia Commons, Stefan.lefnaer, CC BY-SA 4.0 via wiki commons https://www.conservect.org/product/crccd-butterfly-weed/, https://www.fs.fed.us/wildflowers/plant-of-the-week/coreopsis_tinctoria.shtml
Palette B (Top – Bottom): HLWolfe, CC BY-SA 4.0 via Wikimedia Commons, Joshua Mayer CC BY-SA 2.0 Wikimedia Commons , Government of Quebec via Wikimedia Commons , gmayfield10, CC BY-SA 2.0 , via Wikimedia Commons, Eppu, CC BY 4.0 via Wiki Commons
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